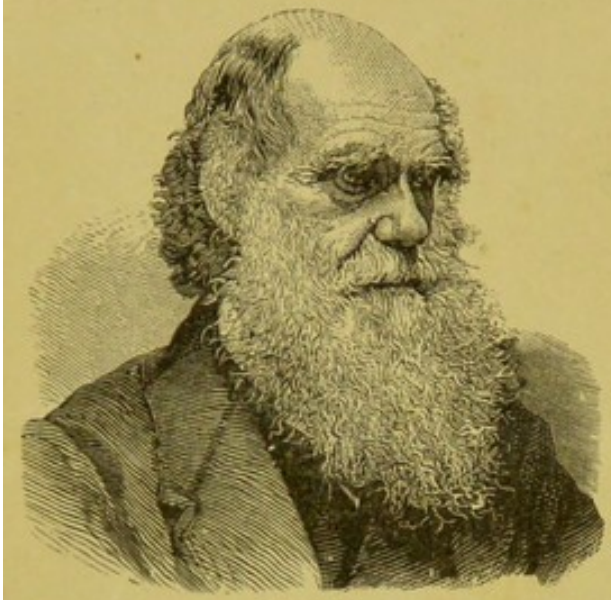
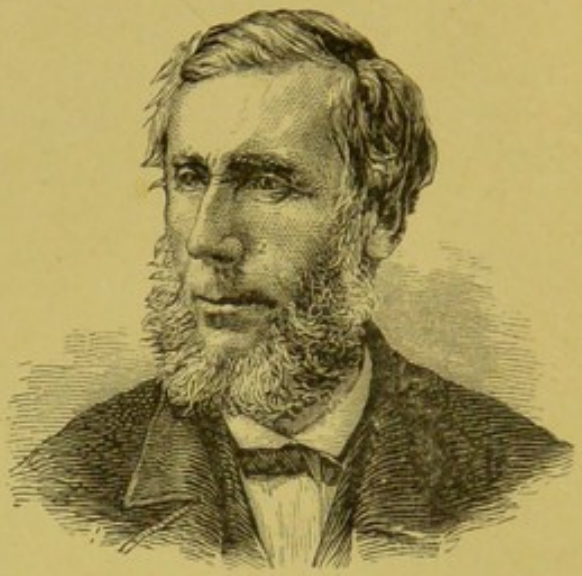
The problem of human life : containing the fundamental principles of the substantial philosophy, with a review of the six great modern scientists, Darwin, Tyndall, Huxley, Haeckel, Helmholtz, and Mayer, upon evolution, spontaneous generation, the nature of force, &c.;, &c; / by Wilford Hall.

The Problem of HUMAN LIFE Here and HEREAFTER



DARWIN.



TYNDALL.

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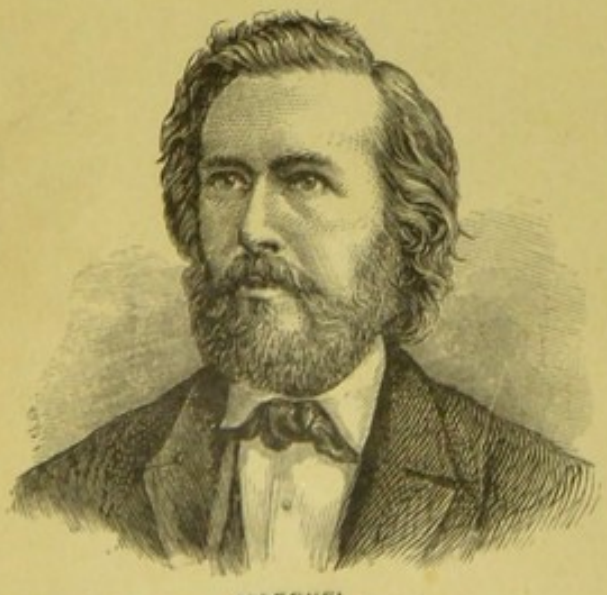

HAECKEL.

MAYER.

THE

PROBLEM OF HUMAN LIFE:

EMBRACING THE

"EVOLUTION OF SOUND" AND "EVOLUTION EVOLVED,"

WITH

A REVIEW OF THE SIX GREAT MODERN SCIENTISTS,

DARWIN, HUXLEY, TYNDALL, HAECKEL, HELMHOLTZ, AND MAYER.

FORTY-SEVENTH THOUSAND.

BY A. WILFORD HALL, Ph. D.,

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DEDICATION.

To the Reader of this book, who may conscientiously desire to arrive at the Truth, and nothing but the Truth, concerning the several matters herein discussed, the following pages are affectionately inscribed by

THE AUTHOR.

PREFACE.

If one object more than any other has exercised a controlling influence over my thoughts and motives in the preparation of this volume, it has been to throw, if possible, some new light from a philosophical and scientific standpoint upon the problem of man's conscious and substantial existence beyond the present life.

Aware of the almost numberless books which have appeared from time to time during the last hundred years with this object partially or wholly in view, I still could not help feeling that the subject had not yet become exhausted. The impression seemed to fasten itself upon me that whether or not I should succeed in finding a single grain of additional golden truth, there nevertheless remained hidden beneath the scoria and rubble of the scientific investigations which are now agitating the minds of advanced thinkers, undreamt-of lodes of precious evidence, favoring, if not absolutely demonstrating, a future state of being,—while in no department of philosophical or biological research were such stores of evidence likely to be discovered so richly deposited as in that which includes the great and complicated problems raised by Modern Evolution.

It is a fact which thoughtful minds can not fail to recognize, that no philosophical theory in any way related to man's origin or destiny, or which in any degree involves man as a sentient and intellectual being, has ever so suddenly sprung into popular favor or taken such general possession of all classes of scientific thinkers as this modern crusade against religion popularly known as Darwinism.

I therefore felt, after years of reading and thoughtful study and after carefully considering the true basis on which this theory rests, that no line of philosophical, metaphysical, or physiological discussion, could possibly furnish so varied an opportunity as this for directly and indirectly unfolding any new ideas I might have hit upon during my investigations bearing on this question of all questions—Are we destined to live after this earthly pilgrimage is ended, or is conscious existence eternally blotted out at death?

Whatever scientific or philosophical discussions, therefore, may be found incidentally woven into this book, they will prove to have an indirect if not a direct bearing on this unparalleled problem of man's perpetual existence. Many of the subjects introduced and much of the reasoning concerning them will no doubt at first strike the reader as irrelevant to this central and paramount question of a future life; yet still, if

the arguments are followed out to their legitimate aim and culmination, they will be seen to tend toward the predominant thought that all things in Nature which exist or can form the basis of a concept are really substantial entities, whether they are the so-called principles or forces of Nature or the atoms of corporeal bodies, even extending to the *life* and *mental powers* of every sentient organism, from the highest to the lowest. And since science has determined that no substance in the universe can be annihilated, there must therefore be deduced a scientific basis for the immortality of the soul if the life and mind should be conclusively shown to be substantial entities.

It matters not, therefore, what analogical questions or facts of science may come before the reader in the preliminary chapters of this book, such as those relating to the substantial or entitative nature of Sound, Light, Heat, Gravitation, Electricity, Magnetism, Odor, Air, &c., they have one intrinsic and paramount object constantly in view, and that is, to insensibly but surely prepare the way for an intelligent conviction in the mind of the reader that the present life can not, in the very nature and fitness of things, be all there is of us or for us.

In view of this matchless consummation, I now venture the assertion that the reader will find, ere he finishes this volume, numerous scientific proofs which may be fairly classed as demonstrative, showing that the life and mental powers are as really substantial entities, though intangible to the physical senses, as are the blood, bone, and muscle, constituting our corporeal organisms.

A writer in the *North American Review* (Thomas Hitchcock), after showing the entire reasonableness of the substantial nature of the soul, calls upon scientists for the physiological and psychological facts which shall demonstrate it, and truly adds: "Certainly, the achievements of science, of which we boast so much, are worth but little if they can not aid us to solve this problem." The facts thus called for are to be found in this volume, though they were written and in type months before the article referred to appeared in the *Review*.

For many years I have had incessantly before me, as the crowning ambition and culminating triumph of my earthly existence, this one superlative achievement, namely, to add a few rationally scientific reasons, hitherto undiscovered, which should go to render a future conscious state of being for man clearly probable, aside from and in addition to theological considerations, and thus bring the certitude of immortality so far into accord with the settled principles of philosophy and science—making it so harmonious and consistent with the current modes of thought—as to command the attention and respect of advanced thinkers and investigators in whatever department of scientific research.

To accomplish so grand a work as this, I saw plainly that, first of all, the complete

overthrow of evolution, by the destruction of the main arguments on which it rests, had become an absolute necessity; for so long as naturalists can triumphantly point to one of their leading scientific facts or physiological phenomena which has not been fairly wrenched from the grasp of evolution, so long will all scientific evidence of man's intrinsic susceptibility of and primordial adaptivity to an immortal state of being have with them but the weight of a provisional hypothesis.

Prior, however, to undertaking the task of breaking through the entrenched works of the evolutionist, and in order to prepare the reader for placing the proper estimate upon these so-called scientific theories which assume to overthrow religion,—such, for example, as Mr. Darwin's doctrine of man's development from the monkey,—I resolved, as an example of what might be expected in the future, to attempt the overthrow of one of the universally accepted theories of science,—a theory which has never been called in question by any writer on the subject, and one which is considered to-day by all scientists as firmly established as the Copernican Theory of Astronomy, or as little to be doubted as the law of gravitation, namely, the Wave-Theory of Sound, out of which has been developed the Undulatory Theory of Light and the more recently constructed theory of Heat as a Mode of Motion.

In this seemingly preposterous and hazardous attempt I was necessarily compelled to undertake the additional task of reviewing no less an authority than Professor Tyndall (the ablest and most popular exponent of the sound-theory now living), and of thus demonstrating the complete unreliability and defenselessness of the scientific opinions and statements of one of the most aggressive advocates of modern evolution, even when treating on the simplest facts of science and making the most ordinary philosophical deductions.

If I have succeeded in this attempt, and if the wave-theory of sound has had to succumb fairly to the arguments brought against it, in defiance of the supposed facts and demonstrations published to the world by this highest living authority, then the reader may justly discount evolution in advance as having no sort of claim on the belief of mankind based on the ground of scientific authority.

I had, moreover, another and distinct object in view in attempting to break down and revolutionize the current sound-theory, as the reader will frequently observe coming to the surface, and that was this: If the wave-theory of sound is really a fallacy in science, then nothing remains to be accepted but the hypothesis that sound consists of corpuscular emissions and is therefore a substantial entity, as much so as is air or odor; and if sound is thus absolutely proved to be a substance, *there can not be the shadow of a scientific objection raised against the substantial or entitative nature of life and the mental powers.*

In that portion of this work relating directly to the review of Mr. Darwin's

theory of transmutation, I have sought primarily to present the arguments in opposition to evolution, spontaneous generation, &c., in such concise and simple language as to make every question discussed at once understood by the most ordinary reader. In seeking to avoid circumlocution, I may have sometimes gone to the extreme the other way; and in aiming at directness of results by dealing with and massing solid and naked facts, may have occasionally hurled too abruptly the monstrous inconsistencies of the doctrine into the teeth of evolution. Whatever apparent want of courtesy certain passages may have at times betrayed, nothing but the kindest of feelings and highest personal and professional regard for the great authors I have had occasion to review, coupled with an earnest desire to rivet the truth and force of my arguments upon the memory of the reader, has had the slightest influence in dictating the tone of such occasional paragraphs.

I have therefore made it my leading object to conduct the discussion and condense the arguments against the theory of man's descent by transmutation from lower animals in such a manner that the most superficial reader shall hereafter have the weapons at hand to meet with irresistible effect even the acknowledged champions of the system, if need be, and thus put a check to its progress where most required.

With what success the following pages shall have carried out this programme, and to what extent they may in the future accomplish the result intimated, the reader must judge after he has perused the volume. It need only be added that the work is frankly offered to the public as an imperfect and humble contribution to what is believed to be the cause of true scientific knowledge, by

THE AUTHOR.

NEW YORK, June 1, 1877.

PREFACE TO THE REVISED EDITION.

Since the early edition of this book was published, partly in meter, the author has had an abundant reason to become satisfied that the metrical form of the argument was a mistake, so far, at least, as the general reading public is concerned. Without disparagement of the force of the arguments thus rhythmically composed, their appropriateness for critical discussions, such as those involved in the investigation of evolution, materialism, etc., can be justly questioned. This mistake, however, which has forced the present revision, was not without its value, since it has given the author occasion to reconsider the entire subject, take advantage of the more recently developed phases of the questions discussed, and to incorporate into his reviews criticisms of fresh scientific researches, particularly those just brought out in Prof. Haeckel's masterly work entitled, The Evolution of Man, examined in the seventh chapter of this book. Many other things contained in the re-written chapters, and necessary to the completeness of the general argument of the work, have been called forth by recent literature on these subjects, and consequently could not have been so effectively discussed by the author at the time the book was originally written.

A demand is beginning to be felt throughout Christendom, particularly among the reading and thinking laity, no less than the clergy—for a book on evolution and kindred materialistic questions, suitable for the common reader, and which shall, by unmistakable arguments, lay the ax at the very root of the tree of descent with blows that can neither be parried nor resisted. It is seriously believed that nothing less than such heroic treatment, without temporizing with evolution or apologizing for its possible truth under any view of natural science, can meet the exigencies of these aggressive theories, or cause the masses of students in our colleges and universities to pause and reflect before making their final decision against the claims of religion. In a word, it is felt that a book on this subject is imperatively needed that not only shall explain every scientific fact upon which these modern doctrines are based, but shall turn such facts, when fairly interpreted, directly against the doctrines thus opposed. Only such treatment of the subject, in opposition to the carping and quibbling tendency of so-called modern science, and the compromising policy of many of the clergy, will have any force in checking the advance of evolution even into the pulpits of our most enlightened evangelical churches. Let the reader, who doubts the danger here intimated, read the introductory chapter of this book, and he will be convinced that we are rapidly approaching a common ground on which all essential distinction between evolution and religion, or even between *spontaneous generation* and God's creative, intelligent intervention is about to be obliterated by this temporizing surrender to so-called science on the part of the most learned divines in our land.

As an evidence of the existence of these dangers, there appeared recently in the New York *Sun* (April 18, 1880,) an editorial article containing this paragraph:

> "To these ideas, and to this philosophy, as we have said, the clergy, learned and pious as they are, seem almost indifferent. No effort is made to confront them and drive them from the field by clearer demonstration, more solid learning, and superior force."

To this statement a writer, replies as follows:

> "The reason why the clergy do not do this is because they cannot. Before the Napoleonic charges of Huxley and Tyndall and Spencer, even, the clergy might have rallied, but their armies are disbanding in the face of the storming party."

Whether this book shall constitute the rallying cry that shall give courage to the straggling and retreating armies of Israel; —whether it shall prove to be a work worthy to be read and circulated by all opponents of these modern scientific doctrines—is not for the author to say. He may say, however, that the accomplishment of this object, in writing the book, has been his aim, and to which end he has labored with all the energy and resources at his command. Imperfectly, in many respects, the work has been done, he admits; but if singleness and intensity of purpose can condone for defects in the manner of execution, he may hope that the general tendency of his book will be in the interests of religion and true science.

In the reviews which have appeared in the religious press, of the early edition, some exceptions have been taken, in noticing the part on Sound, to the personally severe criticisms of Prof. Tyndall's experiments, in which his intelligence in scientific matters is called in question. While the author sincerely thanks his reviewers for these just criticisms of his language and style, and for which he now apologizes (though he has not time, at present, to reconstruct that portion of the book), he nevertheless enjoys the consolation of finding himself in the excellent company of no less an authority than Prof. Tyndall himself, as witness his reply to Dr. Bastian on Spontaneous Generation, in which he unequivocally pronounces his opponent an ignoramus, and I think proves it. The author also enjoys, in this respect, the company of some of our most eminent divines who, in criticising the views of these same scientific authorities, do not hesitate to point out mistakes, and call things by their right names. Instance the Reply to Tyndall by Rev. Dr. McCosh, president of the College of New Jersey, from which I quote a single specimen:

"Eminent as he [Tyndall] is as a scientist, there is no proof that he has studied philosophy." "He talks of Empedocles 'noticing this gap in the doctrine of Democritus,' *whereas every tyro in philosophy knows that Empedocles comes before Democritus.*" Reply to Tyndall, page 4.

This reads very much like some of the severest remarks in Evolution of Sound, and for which no doubt the Doctor will follow the example here set and apologize when he comes to revise his book. My general rejection of standard scientific text-books, as unreliable authority, would seem at first sight unwarranted if not almost preposterous; yet I am indorsed in every word I have said upon that subject by no less an authority than the careful physical investigator and renowned inventor, Mr. Edison, as given in the New York *Herald* of Dec. 31, 1879. I quote a few of his caustic but truthful denunciations:

"They [the text-books] are mostly misleading. I get mad with myself when I think I have believed what was so learnedly set out in them. *There are more frauds in science than any where else.* . . . Take a whole pile of them that I can name and you will find uncertainty *if not imposition* in half of what they state as scientific truth. They have time and again set down *experiments as done by them*, curious out-of-the-way experiments, *that they never did*, and upon which they have founded so-called scientific truths. I have been thrown off my track often by them, and for months at a time. You see a great name and you believe in it. Try the experiment yourself and you find the result altogether different. . . . I tell you I'd rather know nothing about a thing in science, nine times out of ten, than what the books would tell me—for practical purposes, for applied science, the best science, the only science, I'd rather take the thing up and go through with it myself. I'd find out more about it than any one could tell me, and I'd be sure of what I knew. That's the thing. Professor this or that will controvert you out of the books, and prove out of the books that it can't be so, though you have it right in the hollow of your hand all the time and could break his spectacles with it."

Nothing severer than this, against the reliability of scientific authority, can be found in any part of this book.

I will only add that should the clergy and public-spirited laity of the country, upon a careful examination of the arguments of this book, regard them as useful in driving back the now dangerous tide of evolution and materialism, I respectfully solicit their coöperation in extending the circulation of the work, as my own services have so far been given to the cause without money and without price.

THE AUTHOR.

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PROBLEM OF HUMAN LIFE.

CHAPTER I.

THEISTIC EVOLUTION—INTRODUCTION.

[Synopsis of Contents.]

Glimpse at the marvelous progress of the present decade in scientific discovery and invention.—The achievements of Ancient Greece thrown into the shade.—Gradual progress from old-fashioned Atheism to Modern Materialism.—The startling announcement of Evolution in Darwin's Origin of Species.—The sudden change of base by the opposers of Religion.—Darwin's theory hailed with joy by skeptics as a scientific argument against the Bible.—The dilemma of the Clergy over the scientific facts brought to light in Darwin's book.—Many of the Clergy are forced to adopt his views, with the proviso of intelligent design in the various transmutations and changes from species to species.—Theistic Evolution examined, and its unscriptural character shown.—Proofs that Rev. Joseph Cook, Rev. Dr. McCosh, and other clergymen have gone over to Evolution.—The inconsistency of trying to escape the Evolution of Man as well as of lower animals pointed out.—Joseph Cook necessarily includes man by admitting the existence of "gills" in Embryonic Infants.—Dr. McCosh's strange apology for Spontaneous Generation as not necessarily opposed to religion and a belief in the existence of God.—The absurdity of such a position shown.—Conflicting views of Theistic Evolutionists pointed out.—Concluding appeal to the Clergy of this country.

The closing decades of the present century are marked in the history of the world for their unexampled massing of revolutionary discoveries and startling events. No other equal period of historic time has been so fraught with marvelous conceptions, profound advances in philosophic and scientific research, and surprising mechanical inventions, since the dawn of civilization. Even within the present decade it may be truly said that a greater number of surprising scientific discoveries has been developed and announced than in any previous interval of a century in the world's history. This progressive march of intellect, these magnificent strides in man's mastery over Nature, these astounding revelations of the recondite resources of God's Universe now so rapidly unfolding themselves, indicate that man is not living in vain in this world of physical struggle, but that intellectuality is in the ascendant, and that the future, so far from inspiring a feeling of gloom in the minds of thoughtful investigators, is bright with the portents of glorious possibilities and triumphs, which shall outshine the past as the sun, in his superlative glory, out-dazzles the moon. Talk and write as we may of the progressive development and wonderful achievements of Grecian intellect,—the masterly culture of Athens with her profound statesmen and philosophers, her far-seeing military commanders and strategists, her electrical orators, her brilliant poets, her inspired artists, her studious and comprehensive historians,—yet all this array of talent, produced by Attica, and which culminated during the two centuries of her greatest greatness and fame in the persons of her Demosthenes, Aristides, Socrates, Pythagoras, Euclid, Euripides, Plato, Aristotle, Pericles, Herodotus and Xenophon, is but as the title-page to the great volume of achievement when contrasted with the startling record of events in which the intellect of the present generation has figured and is now figuring. The glimmer of the taper becomes conspicuously brilliant from the contrast of general darkness, while a thousand electric lights of a thousand candle-power each would pale their ineffectual glow in the brighter glare of the noonday sun. A single phenomenal Demosthenes in Athens or Cicero in Rome

could sway the multitude as a cyclone moves the forest, and though we now look back and wonder at such marvelous achievements, accomplished so many centuries ago, yet if either of those orators should now drop into our midst, with all his pristine powers, he could not stand beside a Castellar, and would be but an intellectual and oratorical pigmy by the side of our own Sumners, Clays, Websters and Calhouns, whose names are legion all over this land, no one towering sufficiently above his compeers to produce a marked sensation—a state of things attributable to the ubiquitous printing press, the great educator of the masses. Take the best words ever uttered by a Cicero or the best lines ever penned by a Homer, aided by the embellishing powers of the finest translation in existence, and they will bear no comparison to the words and stanzas of our own statesmen and poets read every day in our newspapers, till evidences of the prevalence of intellectual greatness are as plentiful as autumn leaves. Distance lends enchantment to the view no less in estimating oratorical power and artistic genius than in the appreciation of coast and mountain scenery as it recedes from our sight. We go into ecstasy over a massive but ridiculous pile of stones called a pyramid, because it is four thousand years old, while we scarcely notice a modern fountain or monument of the most exquisite design and finish, made by some one we know. In like manner, but to a less degree, we are more influenced by that which is foreign or comes from a distance than by that which even surpasses it when produced right at our own door. The foreign singer, the foreign lecturer, the foreign scientific treatise, the foreign merchandise, even, can become the furor of the hour, when in fact we have superior articles in the same line at home.

But I digress from the theme of this introduction. I have hinted at the progressive strides of our own immediate time, in discovery and invention, as a warning note against surprise, let what will be announced as possible in the future or as already achieved. The age in which we live seems to accelerate its own progressive development by the momentum it receives in each new advance. Where it is to end we know not; but the practical observer, with mind and eye upon the alert, gazes into the near future with a well-grounded expectancy of discoveries in science and philosophy which shall utterly eclipse anything the world has yet witnessed. And while we are thus observers of, and participants in, the benefits resulting to civilized society from the revolutionary mechanical and scientific discoveries which tend to our temporal advancement, making nature the servant of man, and by which his physical condition is heightened, may we not look with confident hope for scientific and philosophical discoveries in other directions, amidst this general intellectual activity, which shall lead the race to a still higher plane of moral and spiritual manhood, giving it a sublimer conception both of Nature and Nature's God? Rejecting the materialistic conclusions of the predominant philosophy of German and English scientists, which tell us that the present life is all there is of us or for us, is it not possible that the great storehouse of nature contains within its secret archives substantial records of truth yet undiscovered by man, which, when opened, shall reveal, with absolute assurance, a substantial duality of entitative being that allies us to an intelligence higher than our own, and to a conscious state of mental activity above, and independent of, our physical surroundings, as surely as our corporeal natures ally us to an earthly life and fit us for a temporal existence?

While new discoveries, in the production of light for our physical illumination, are announced in rapid succession, is there no moral and spiritual light that can be made to flash upon our pathway from that laboratory of Nature whence comes electricity, to show us in all this obscurity of philosophic darkness,—in all this tangled maze of metaphysical materialism,—the dim outlines, even, of the other bank of the river? The writer believes there is such a light yet to be generated by the dynamic power of scientific investigation and applied philosophic research; and it is with the view of gaining this new light, and of establishing this broad assurance of a brighter, and higher, and better hereafter, on scientific grounds, that this book is written.

In the following chapters some effort will be made to find out if science, philosophy, reason, and the common logic of life, do not tell us, in unmistakable words, that we are here for something grander

and more worthy of human intellect, than what seems involved in this present ephemeral existence. And while Ingersoll and Underwood are lecturing the rabble hordes and catering to the depraved tastes of the lowest stratum of human nature by ribald jokes in derogation of religion and the solemn verities of death and a future life, trying to demonstrate themselves and their applauding audiences to be what scarcely needs demonstration,—*brutes* that perish,—it is a proud and sublime work for christian theists to vindicate their manhood and dignity as sons of the God of the universe, made in His own image, and destined to reign with Him as princes of the Royal line forever and ever. Such labor of love, in comforting the cast down, by dispensing sunshine from heaven along the dark pathway of life, when contrasted with the degraded and degrading work of Ingersoll & Co., is like the grand employment of a Newton, a Kepler, or a Copernicus, contrasted with the low and sickening drudgery of the common scavenger and rag-picker. The one represents the glorious eagle which is never so proud and happy as when facing the sun and soaring toward heaven, while the other is a fit symbol of the buzzard, whose glory is in its shame, and whose fondest felicity is in feasting on filth. Will the reader, then, accompany the writer upon his pleasant, though possibly wearisome search, and see if any new discoveries are yet accessible in this much-excavated field of biological, physiological and metaphysical investigation?

For centuries, prior to the last twenty-five or thirty years, scientific investigators who rejected religion and denied the possibility of a future life on materialistic or atheistic grounds, were nevertheless all at sea upon the question of man's origin. That he was here, with a capability of measuring the flights of the planets and of weighing the distant stars in balances, they could not well dispute. That he could have come here by chance, or without some intelligent originating power, seemed a supposition too preposterous to be entertained for a moment, except by those morbidly insane controversialists who cared more for personal triumph than for the claims of logic and reason. Atheists there were who denied the existence of a God because such a being was beyond the recognition of their physical senses. But instantly, again, they were confronted with the fact that man was here, that animals were here, that order reigned in the system of nature, from the delicate geometrical and microscopical chasing of an ocean shell, which no art can imitate, to the marvelous intellectual capabilities of the many-chambered brain of a Shakespeare or Humboldt,—from the folded petals of a rosebud to the revolving movements of the solar system. If there be no personal, intelligent originator of all this harmonious system of things, then how came man, with his intellectual power, and how came animals with their cunning instincts? To talk of fortuity originating all this seemed a self-evident absurdity. Thus were the scientific opposers of religion overwhelmed with the evidence of their own senses and drifted from bank to bank of this turbulent stream of investigation, harrassed by the difficulties which beset their path and prevented any rational or satisfactory assurance concerning the problem of human life.

In all these years of struggle between christian philosphers and those intuitively skeptical investigators who doubted everything they could not see, hear, feel, taste or smell, religion had decidedly the best of the controversy, for it was only necessary for the Christian believer, or even the natural theist, to point to the fact that we exist, to silence the batteries and shut the mouths of the entire old school of atheists. Their scoffs at the Bible and its apparent contradictions, which were their principal stock in trade when driven to the wall on the question of God's existence, produced little effect upon the trained theological mind with its ever-ready resources of interpretation and biblical lore, by which apparent inconsistencies were transformed into harmonious truths not understood by the uninstructed; and thus chagrined at defeat they would recoil within themselves, gnashing their teeth at their own unsatisfactory solution of the problem of this two-fold mental and physical existence.

It was at this juncture of the irrepressible conflict between so-called science and religion that a new philosophic light burst upon the world—a light so intense that it dazed the skeptic for the moment and then caused his heart to leap for joy at the prospect of a new and unlooked-for triumph over religion and the Bible.

In 1858 that remarkable book by

Charles Darwin, called the Origin of Species, was announced in the English press. At first its full scope and object were not understood or appreciated either by the opponents or advocates of religion. It was not until the work had been quite extensively circulated and read among naturalists and free-thinkers in science and religion that the alarm began to be sounded among the clergy of both hemispheres and to be spread broadcast by the denunciation of the book in the pulpit and the religious press. Soon the students of our colleges seized upon the new departure, professional men of the liberal type, particularly of the medical fraternity, became imbued with this novel way of accounting for man's existence upon the earth as better than atheism and the impossible supposition of chance, till finally the intelligent laymen of all our religious denominations, asserting their rights to think for themselves, took up the Origin of Species, read its terrible concatenation of facts and inferences drawn from natural science, proving that man is but the lineal descendant of the ape, and commenced putting ugly questions to their respective pastors, urging upon them an attempt at reconciliation of these indisputable facts with the teachings of the Christian scriptures. This state of things forced the clergy to look seriously into this dangerous phase of opposition to the plain teachings of the Bible, and this new mode of attack upon the cherished hopes inspired by the Christian religion. For, evident it seemed to be to the most casual reader of Mr. Darwin's work, that unless his hypothesis, of man's origin by development from lower animals, could be met and fairly refuted, it was worse than futile to advocate the Bible account of creation or the miraculous introduction of Christianity, even under the most liberal rules of biblical interpretation.

For a time this excitement continued without signs of abatement, and without any definite result having been arrived at among the clergy. In the meantime steadily but surely the tables were turning favorably to Mr. Darwin's side of the controversy among advanced scientific thinkers throughout the world,—the revolutionary book, which had caused all this commotion was rapidly translated into many of the languages of modern Europe, —a few of the clergymen of the Church of England, who were also educated naturalists, had given in their adherence to the new hypothesis (subject, of course, to God's personal supervision of these organic changes), till matters had begun to assume such a dangerous look toward the cause of religion in general as to produce a widespread and profound sense of alarm throughout Christendom, particularly among the clergy who had given any special attention to modern scientific investigations. There seemed to them no middle ground possible to take, at this juncture, between the positive transmutation or development of the higher from the lower, of all species, including man, and the absolute rejection of the entire hypothesis as a misconception of the facts of natural science, and thus relegating the question of the origin of species back to the special acts of creation by the God of Nature as taught in the sacred record.

As was to have been expected in such a sifting controversy, a division soon commenced, even among the clergy, which has continued to increase in magnitude up to the present time, every year numbers of gospel ministers surrendering to Darwinism, till now it may be safely estimated that thousands of the best educated clergymen of Europe and America are outspoken advocates of evolution, not strictly as Darwin advocates it, but evolution nevertheless, with the proviso that God used it as His method of creating the species. Those who doubt the correctness of this statement have only to read the lectures of Rev. Joseph Cook, Rev. Dr. McCosh, President Seelye, and others who take the same position as Prof. Asa Gray, who claims to be a firm believer in the Christian religion, and holds that evolution as taught by Darwin (with the proviso of intelligent design in every change effected) is in no way inconsistent with a belief in the Bible account of creation properly interpreted. To me, however, a more monstrous inconsistency than a belief in Christianity while accepting the theory of evolution in any shape or under any restrictions of theism, can scarcely be conceived. I will try to give my reasons for this conclusion as the argument advances.

First, it is proper to know that those who claim to believe in the existence and providence of a personal God, and who are yet forced, from the scientific facts arrayed by Darwin, to accept evolution, have generally so far modified Darwin's pur-

poseless and designless views of development under natural selection, environment, survival of the fittest, etc., as to claim that God purposely adopted these laws as His method of creating the species thus developed, while a portion of these advocates also include man among the transmuted beings. Such believers in this theistic proviso excuse their acceptance of the doctrine by saying: "There can be no *evolution* without first *involution*;" "there can be no *evolution* without an *evolver*, or *involution* without an *involver*," and hence, if Darwin's theory should finally be established it would simply be shown by science to be God's method of carrying on creation through the action of laws over which and in the operation of which, through each transitional variation from a polyp up to the human form, He exercised efficient control and immanent supervision. This view, as they hope, differs so far from Darwin's outspoken theory of designless transmutation, as to take away the curse and make it consonant with Christian theism. But the truth is, it is substantially what is involved in Darwinism, not as its author interprets it, but as interpreted by some of his friends, including Prof. Asa Gray. For, according to Darwin's hypothesis, the *first few simple beings*, forming the basis of evolution, and out of which the myriad species up to man have been developed by natural selection, were the special work of creative intelligence, requiring the miraculous interposition of the Creator who "breathed" into them, not only the life and mental powers which made them living creatures, but who necessarily incorporated into such vital force and mental power the potentiality requisite to transfer the same to other beings with compound and complex interest. Thus, according to Darwin's view, logically and consistently carried out (not illogically as he describes the process of evolution), God, in breathing into one protozoan such living force and mental power, absolutely transferred a sufficient fraction of His own intelligence and vitality to stock the whole realm of living organisms which should afterwards arise as the lineal descendants of that first imperfectly developed animal. This being so, God must have *involved* himself in that first polyp, rhizopod, protozoan or moneron, embodied, so to speak, His own attributes within the vital and mental spark which animated its body, and by which, under the laws of development thus incorporated in this simple creature, it was enabled to become the primeval parent of all the other organisms through God's constant, ever-present supervision; and hence the first variation of that simple creature, by which it advanced to a form of life higher in the zoological scale, must have been the direct and efficient act of God himself as thus embodied in its vital and mental powers. The first animal therefore was made God's acting vicegerent in creating all other species, or else God continued personally to supervise every transmutation. So with each variation and every specific change, till the highest form of man-ape, by natural selection, diverged into the lowest type of man, thus perfecting the human form divine, and in this manner did God make man out of the dust of the earth in His own image, and breathe into him the breath of life, in one day, or as theistic evolutionists interpret it, in one epoch of 100,000,000 years, more or less.

This is a correct statement of theistic or purposive evolution as held by many of our prominent clergymen who, seeing no way of answering Mr. Darwin's facts, have tried in this manner to save a fraction of religion by almost getting down on their knees to modern science. Prior, however, to the appearance of the Origin of Species these same theologians believed firmly, and taught that, according to the Bible, God made man and the different animal species by direct acts of creation or spoke them into existence out of inorganic matter by his Almighty fiat. But when the scientific facts collected by Mr. Darwin were sent broadcast into the world, it became evident to these same thoughtful investigators that the Bible account, if not absolutely erroneous, must be greatly modified by interpretation, unless such acknowledged facts of science were susceptible of some other explanation than the one given them by Mr. Darwin and his colaborators. No other interpretation of Nature being conceivable, hence the effort to retain a respectable hold upon the religion of the Bible, while at the same time accepting evolution, by a license in the interpretation of God's work of creation as recorded in scripture, which amounted to an actual rejection of miraculous acts of Divine wisdom and power, and a substitution for them of God's indirect acts of develop-

ment through the processes known as natural selection and survival of the fittest. Being unable to explain these facts of natural history, except as teaching evolution in some form, or to answer the arguments of Darwin, Huxley and Haeckel, in favor of the transmutation of species, nothing seemed left to religious science but this resort to theistic evolution, rather than a total abandonment of the Bible. But really, to the mind of an impartial investigator it would seem more rational and consistent to reject the scriptures in toto as of human origin, if science actually teaches, as supposed, that all animals including man have descended from a polyp or protozoan; for certain it is that this whole conclusion is involved in the facts as presented, unless Mr. Darwin's interpretation can be shown to be without foundation in science. How a man can believe, as Prof. Asa Gray claims to do, that all species are developed from one "initial form of life" and at the same time believe in the Nicene creed and the New Testament, is more than I can imagine. Such a believer must hold that Jesus was the Son of God by being the son of an ape, at least on the side of His mother. But I forbear to carry out a thought so repugnant to the sensibilities of every Christian man.

One of the principal reasons urged by Mr. Darwin, Prof. Gray, and all evolution writers, against the probability of the direct creation of the different species, is the vast number of miracles throughout Nature which such a supposition would involve, while the theory of development, they claim, involves no miracle, save the one at the start necessary for the creation of the first simple being, out of which, as lineal descendants, all subsequent species are supposed to have been developed by natural selection. This was, doubtless, one of the principal difficulties which influenced Joseph Cook, Dr. McCosh and scores of the learned clergy, to adopt theistic evolution in combination with the Nicene creed, which they all claim still to believe with unshaken faith. Yet they seem never to have thought that the Nicene creed requires them to believe in the thousands, possibly, tens of thousands of miracles wrought by Christ and the apostles in confirmation of their divine mission, and which necessarily constitute a part of the Christian religion indorsed by that same Nicene creed. It is as much of a miracle to raise a Lazarus from the dead, after his body had undergone putrefaction, as to create an elephant out of a heap of sandstones. It is no more an effort of divine power to make a lion out of water, or out of a cake of ice, than to turn water into wine. If our theistic believers in the Nicene creed have adopted evolution to get rid of such a superabundance of miracles as would be involved in the direct creation of the different animal species, then in the name of consistency they should repudiate the Nicene creed and with it the entire mission of Christ and the apostles, since John the Divine tells us that if all the miraculous works wrought by Christ had been recorded, the world would not contain the books that might have been written, which would at least equal the number of miracles needed for all the different species from the moneron up to man! But what is still worse for this objection to miraculous creations, Mr. Darwin assures us, that it has taken myriads of slight but distinct spontaneous variations, each saved up by natural selection, to produce any important specific change in animal structure. Now if, as all advocates of theistic evolution maintain, God specially controls or directs each variation to this specific end, it is equivalent to a direct creative act, as much so as was the miraculous production of Darwin's first simple form out of inorganic matter. Hence instead of one miracle for each animal species as biblical science requires, it involves myriads of miracles or their exact equivalent, in so-called spontaneous variations specially supervised for each specific change. Theistic evolution, therefore, unless God's connection with the course of Nature is merely nominal and not immanently causal, in any effective sense, complicates the work of miraculous or creative intervention a thousand, possibly a million fold. And so far as Mr. Darwin himself, and his followers are concerned, they admit at least one miraculous intervention at the start, for the production of the first simple organism, on which to begin evolution; and as the God who "breathed" into that first form was infinite in power and resource, it is no more tax upon such unlimited facilities miraculously to create ten thousand different species than to create one. As such a God, moreover, is necessarily as immutable as He is infinite in power and wisdom, it is but consistency to suppose

that He pursued the uniform course of creating all species as He did the first one, and thus acted in harmony with the unchangeable nature and character of His being. There is, therefore, no reason why Mr. Darwin should not accept miraculous intervention for each separate species, throughout the entire zoological range, provided there is the least difficulty in the way of his theory of natural selection and survival of the fittest; and that there are such difficulties, and scores of them, absolutely insurmountable, will abundantly appear as this argument proceeds.

While upon this point, as no better place may present, I wish to refer to a remark made by Prof. Asa Gray, and which occurs many times in the works of Mr. Darwin, that while miracles explain and can explain nothing in science, they interfere with the uniformity of Nature. Let us explode this stereotyped argument at once and have done with it. Miracles do explain, according to the theory of Prof. Gray and Mr. Darwin, the most important scientific fact and phenomenon in the universe, namely, the origin of organic life. They both tell us that God was compelled miraculously to "breathe" into the first organism as a basis for this highly scientific theory of evolution! What an absurdity, therefore, to reiterate the assertion that miracles explain nothing in science, when they explain everything involved in evolution! How could Darwin, Huxley, and Gray have explained the start of evolution, but for this miraculous intervention of God in producing the first animal? Look at the self-contradiction of the theory. As miracles explain nothing in *science*, but still are necessary to explain the start of *evolution*, it follows that evolution, by the admission of its founder and ablest advocates, *is not scientific*. This is a clear illustration of evolution against itself.

But all evolutionists concede that any species, at its first appearance in the geological record, is always at its greatest perfection, and the uniform testimony of paleontology is that the same species occurring at a later geologic epoch is rather deteriorated in anatomical structure than improved by gradual development. Nothing but miraculous creation for each species can explain this state of facts; while the very similarity of anatomical structure of the different vertebrated species, "the hand of a man, foot of a dog, wing of a bat, and fin of a porpoise," regarded as so conclusive in favor of evolution by Darwin and Huxley, can only be explained satisfactorily as the work of an intelligent artificer carrying out that typical or family resemblance seen in the works of all great artists, as fully shown in chapter X. Hence Nature is full of scientific facts which nothing can explain so readily and satisfactorily as the assumption of direct creative acts.

But miraculous interventions, evolutionists tell us, "interfere with the uniformity of Nature," and therefore are inadmissible in science. This also proves too much for the theory. There was one miraculous intervention for one species, at the start, they admit. And as they have not been able to demonstrate the production of one single species since then by natural selection, it proves that Nature, in order to be *uniform, should produce all her species by miraculous intervention!* Hence evolution turns out to be *the only violation of the uniformity of Nature for the production of species*, these scientists themselves being judges, thus again turning the contradictory system against itself. The truth is, nothing but downright atheistic evolution, as taught by Professor Haeckel, which is supposed to be started by the spontaneous generation of the first form, and then carried on without God or any other intelligent power, can lay any claim either to consistency or to the above phraseology of the "uniformity of Nature" and miracles explaining nothing in science. And as for Prof. Haeckel's theory of manufacturing life and mental powers out of nothing, it will receive due attention in the seventh chapter.

But by this time the reader is ready to ask, have you any proof that the great clergymen you have named, the eminent Boston lecturer, and the learned President of Princeton College, have really gone over to evolution? as it is a serious matter to make such a charge as this without positive proof. I admit that it is a serious charge, since it is wholly incredible, without undoubted evidence, that ministers of the gospel should publicly, or even privately, adopt a system of so-called science or philosophy, which virtually contravenes everything taught in the scriptures concerning the creation of man and the lower animals. I am also aware that there are at this moment thousands of clergymen, and tens of thousands of intelligent laymen in the

United States, who would pronounce me a slanderer and a secret enemy to the Christian religion, should they hear me utter the charge of "evolution" against these popular and esteemed divines! I will therefore proceed to prove it from their own lips and pens, as uttered in lectures and published under their own supervision. Dr. McCosh says:

"Two great scientific truths have been established in this century. One is the doctrine of the conservation of energy. * * * * The other great doctrine is that of *development*, acknowledged as having an extent not dreamed of till the researches of Darwin were published." "We may discern a plan and purpose, means and end, in the way in which plants and animals are *evolved*, and in the forms they take, which are evidently not by chance."—Reply to Tyndall, pp. 15, 16.

This view, as here expressed, is what is known as "theistic evolution," simply Darwinism with its purposeless and designless features left out. In other words, Dr. McCosh holds that all species have been evolved, one from another, by natural selection, environment, struggle for existence, and survival of the fittest, precisely as does Mr. Darwin, only he claims that these are not blind laws or chance operations, but that God supervises by His providence, the various changes and natural selections by which a fish is transmuted into a reptile, a reptile into a bird or mammal, a marsupial into a jackal, a jackal into a monkey, and some form of ape into a man; and hence, that development is not a game of chance. Possibly this last transmutation of an ape into a man, may be going a step too far, and may prove altogether too consistent for Dr. McCosh, though Mr. Darwin and every logical believer in evolution, are forced by consistency to include man as among the lineal descendants of the tortoise and fish, if the monkey can have been thus transmuted. I will return, however, to this after a little.

Now, this "theistic" view of evolution is the same as Darwinism, to all intents and purposes, only Darwin takes no account of God in this entire system of development after the miraculous creation of the first simple form, as the start of evolution; while the hundreds of theistic evolutionists, represented by Prof. Asa Gray in his work called Natural Science and Religion, claim that every variation of one species which tends toward its transmutation into another, is produced and nurtured under the supervising direction of God's providence. Prof. Asa Gray is an avowed and acknowledged Christian, a firm believer, as he says, in the Nicene creed, and is regarded by Rev. Joseph Cook as one of the representative theistic evolutionists of New England. I now take his testimony.

"So the difference between pure Darwinism and more theistically expressed evolution is not so great as it seemed. Both agree in the opinion that *species are evolved from species.*" "You ask me if I maintain that the doctrine of evolution is compatible with this [Christianity]? I am bound to do so." "The inquiry, what attitude should we Christian theists present to this form of scientific belief, should not be a difficult one to answer. In my opinion, we should not denounce it as atheistical, or as practical atheism, or as *absurd.*" "I am unable to perceive that the idea of the evolution of one species from another, and *all from an initial form of life*, adds any new perplexity to theism."—Natural Science and Religion, pp. 64, 80, 83, 106.

This kind of evolution Joseph Cook calls "*a* theory of evolution," while Huxley's and Haeckel's godless plan of development, he calls "*the* theory of evolution." Let us now take the testimony of this eminent lecturer and writer.

"I have not criticised, *I have even defended, the theistic doctrine of evolution.* I have endeavored only to show that the *atheistic* and *agnostic forms of that doctrine are violently unscientific.*" "The position of this lectureship is that there is a use and abuse of the theory of evolution. I hold *a* theory of evolution, but not *the* theory. What do I mean by *the* theory of evolution? Precisely what Huxley means when he says, in so many words, that *if the theory of evolution is true, the living must have arisen from the not-living.*"—Lectures on Biology, pp. 111, 184.

This is plain and to the point. Joseph Cook thus accepts the evolution of the different animal species, on the condition that God controls the laws of development; but he rejects it only when it involves spontaneous generation, or the idea of evolving the "living from the not-living," as taught by Profs. Huxley and Haeckel.

In keeping with this outspoken acceptance of evolution, Joseph Cook says:

"The question of *chief interest to religious science* is, whether the new philosophy [evolution] is to be established in its *atheistic*, its *agnostic*, or its *theistic* form."—Lectures on Biology, p. 10.

I take issue with this eminent authority, and deny his conclusion most emphatically. On the contrary, I assert that "the question of *chief* interest to *religious* science is, whether the new philosophy is to be

established" *at all*, or in any "form." What the Christian world wants to know, and what investigators of *religious* science need to inquire into, is, not which "form" of evolution is to be accepted, but whether there is any necessity for accepting any of its forms,—or anything in the shape of evolution, either atheistic, agnostic, or theistic. This highly esteemed lecturer seems to have taken it for granted that evolution is a foregone conclusion, in some form, and his "chief interest" now is to determine which of the forms will come nearest leaving a modicum of the religion of the Bible,—enough to *swear* by in a court of law, if not enough to *pray* by. I assert that Joseph Cook, Dr. McCosh, and the hundreds of eminent clergymen who agree with them, and have followed their lead, if they have not shown the "white feather," have at least shown undue haste in thus pulling down their colors, without even having fired a gun or been asked to surrender. If they were not able, as they evidently were not, to explain the scientific facts of Darwin, Haeckel, & Co., upon which they claim to have established the theory of evolution, why should they have been in such a hurry to throw down their arms at the first boom of evolution artillery and sight of smoke, and conclude that the facts were inexplicable by anybody else? They seem to have concluded, judging by their action, that what *they* did not know upon this subject, was not worth knowing, or at least must be past finding out; and that problems they were not able to solve, could never be solved by man. Hence, this surrender without a struggle. Such weakening, in presence of these most virulent assailants of religion, whether under the disguise of this so-called theistic form of the "new philosophy," or Prof. Haeckel's outspoken atheism, is unbecoming the grand mission of the most prominent exponents of religious science in this country. Well may our leaders in this crusade against error, be admonished to add to their faith *courage*, and to courage *knowledge*. These two things would have carried them safely through the battle. It may not be too late, yet; for there is an opportunity even now to shout the rallying cry of victory or death, inspire courage in their demoralized and retreating forces by drawing from its dust-covered scabbard the sword of the Spirit, and renewing the battle, even through fire and blood, if need be, against these evolution giants who have defied the armies of the living God.

But even after thus surrendering to evolution, with its theistic proviso, there is a manifest indication of shakiness, a want of confidence, and a feeling of insecurity in the minds of the eminent theologians named, or they would not blanch as they so evidently do, when they come to face the legitimate consequences of their "new philosophy," and yield the last point in the controversy with Darwinism,—the evolution of man's animal organism from that of some extinct form of ape. Why do they hesitate here with trepidation and doubt? Prof. Gray, though not outspoken, virtually gives up all, and consistently claims that Darwin's view of the extent of evolution is either all right or all wrong, and that man is necessarily included in the lineal descent from that simple form of life first created, whether it be a polyp or an ascidian. But Joseph Cook and Dr. McCosh, confused and trembling, hesitate to accept this final and legitimate act of the evolution drama; and that, too, without one scintilla of reason for so doing, after conceding evolution up to the orang-outang, save the fact, as Joseph Cook elaborately argues, that the average brain of man is more than twice that of the highest ape in cubical contents. Hence, here there must have been a special miraculous leap. But why do they not listen to the teachings of their scientific master, Darwin, who explains all this most beautifully by the defects in the geologic and paleontologic records? Why do they not reason about this evident leap in cranial and cerebral structure, from the highest known ape to man, as they are obliged to reason in explaining the leap from the reptile to the bird, from the fish to the reptile, from the tortoise to the mammal, which are leaps vastly greater in anatomical structure and resemblance than the one to which they demur? If they can, with such alacrity, accept the development of the almost human form of the chimpanzee from the fish, and fill up the innumerable gaps in structure by imagining lost pages in the paleontologic record, why not be consistent and say with Huxley that the connecting fossil man-ape, which bridges the chasm between the small brain of the present anthropoid monkey and the immense brain of man, has not yet been found, but probably will be, just as the archeopteryx

has but recently been discovered which closes up the hiatus between the reptile and the bird? And since they have now the convenient "theistic" panacea for all the other lame joints in the "new philosophy," by which to harmonize it with "religious science," why argue so earnestly for this one exception to the rule, and that man must have been made as the scriptures teach, by a direct miracle, just as if it would detract from the glory of God to have made man as He condescended to make the orang-outang, by gradual development? If it was God's method of making a monkey, why not of making a man? What is the use of having "theism" mixed up in it at all, if it will not help us out of the whole difficulty and account for the formation of man's body on the same principle employed in constructing the body of the gorilla or chimpanzee?

By turning to the account of creation in Genesis, we will see the utter absurdity of believers in revelation thus playing fast and loose with "theistic" evolution, all to avoid the unpleasant charge of being consistent and teaching that the creation of man simply means his development from the ape, as the creation of the ape means its development from the dog, a conclusion to which Darwin and Huxley are forced to come, from their interpretation of the facts of science, and of which they profess not to be ashamed. Let us now examine this authentic record of creation:

In the first chapter of Genesis, verse 21, it is said that "God *created great whales;*" and right on at verse 27, it is said that "God *created man.*" Now, I ask these "theistic" advocates of the "new philosophy" if it is reasonable to suppose that God *created* a *whale* by supervising its evolution from a "hoofed animal" (see Haeckel's History of Creation, vol. ii, p. 251), after first evolving the hoofed animal from a fish through saving up millions of slight modifications; and that He then *created* man without the aid of evolution at all, by means of a direct miracle? Is it likely that "created," here, has two distinct meanings, for no philological reason on earth save to accommodate theistic evolutionists? Will the learned President of Princeton College tell us plainly whether the word here rendered "created," in verse 21, is the same word in the original Hebrew, as in verse 27? Or is it a different word, with an entirely different signification, but erroneously rendered "created" when it should have been *evolved?* I am not a Hebrew scholar, but I have taken the precaution to write to Dr. Epstein, of Tiffin, Ohio, one of the best Hebraists in this country, and for a year Professor of Hebrew in Heidelberg Theological Seminary, asking him if "*created*" in verses 21 and 27, is the same, and if it has the same meaning in the two instances? The following is his reply:

"TIFFIN, O., April 22, 1880.

"A. WILFORD HALL.

"Dear Sir:—In answer to your letter, inquiring whether the word '*created*' in the 21st and 27th verses of the first chapter of Genesis, is the same in the original Hebrew in both instances, I reply yes. The Hebrew word is בָּרָא pronounced Bārā. The meaning of the word, " in these two instances is and must be necessarily and unconditionally the same. Respectfully yours,

EPH. M. EPSTEIN, M. D."

Theistic evolutionists, thus driven to the wall of consistency, are forced to admit, however hard they may struggle against it, that if *whales* were "created" by development from other animals, *man* must have been "created" by the same process. Although the Rev. Joseph Cook evidently dreads the logical consequences of this conclusion,—the unavoidable outgrowth of the "new philosophy," whether theistic or atheistic in form,—yet he makes many statements in his lectures which unintentionally but plainly point to Darwin's unabridged views, that man, as well as the ape, the puppy, and the tortoise, is the lineal descendant of the fish. Take this one:

"It is a *physiological fact* that every human being once *breathed* by a membrane, *then by gills*, then by lungs."—Lectures on Biology, page 236.

This is a clearly expressed indorsement of Darwin's and Haeckel's embryological argument, that the embryonic infant, as well as puppy, chicken, tortoise, etc., at an early period of development, possesses the *gills* of the fish, which fact they triumphantly adduce as evidence that man, as well as the dog and other lower animals, descended by transmutation from some branchial ancestor,—a thing by the way totally fallacious and without even the foundation of one correctly understood scientific fact upon which to rest, as abundantly shown in the seventh chapter. But no matter for this. Joseph Cook does not even suspect that this "gill" argument of

the evolutionist is a deliberate fraud upon physiological science and the intelligence of mankind; and as a consequence the great Boston lecturer innocently falls into the trap set for him by Haeckel and Darwin, and announces it as an important "physiological fact," thus admitting that embryonic infants have actual *gills*, which, if it be a fact, can only be explained, says Darwin, on the hypothesis that man descended from the *fish*. And if man descended from the fish, his blood relationship to the monkey can hardly be doubted.

But the most remarkable phase of this "physiological fact," so positively announced by Joseph Cook, is, that these "gills," in the embryonic infant, are *functional*, that is, they are actually employed in *breathing*, as in a living fish! This defense of the "new philosophy" out-Haeckels even Haeckel himself, since the renowned professor of natural science in the University of Jena never dreamed of such thing as that these embryonic "gill-arches" were employed in any functional way, regarding them merely, to use his own expression, as the "ontogenetic record of man's phylogenetic or tribal descent from some fish-like ancestor." Now it is a fact, upon which, I believe, all well-informed physiologists are agreed, that an infant does not "breathe" at all, till its exposure to the external air, and that, during gestation, it depends entirely for nutrition upon the substance of the ovule and the umbilical circulation of the mother. Yet this important physiological announcement makes it *breathe* by two different processes prior to the functional use of its lungs. If it really be a "physiological fact," that the human embryo depends for its vitality upon *breathing* through these so-called "gills," it suggests a serious difficulty, which no one is more competent than the Boston lecturer to explain. As these "gills" *entirely disappear*, according to all authorities, including Prof. Haeckel, *at the eighth week of gestation, how does the embryo manage to put in the interim of twenty-six weeks till its birth without breathing at all?* It is a matter to be deplored that such nonsense as this gill-breathing process should be taught as "physiological" science in the very literary and scientific centre of this country, just because Draper, or some other authority, chances, inadvertently, to speak of such a stupid impossibility as a human embryo breathing through "gills," or through anything else, in fact, prior to its birth.

Not only do these distinguished theological exponents of the theory of development seek to harmonize the new philosophy with Christianity under the specious title of "theistic evolution," but they actually go further, and make the astounding announcement that there is nothing antagonistic between *spontaneous generation* and a religious belief in the existence of God! This culmination of obsequious absurdity in truckling to the claims of modern science, will be found in the following quotation from the pen of Dr. McCosh:

> "Suppose it proven that there is such a thing as *spontaneous generation; would religion thereby be overthrown*, either in its evidences, its doctrines, or its precepts? * * * * There is really no ground for the fears of the timid on the one hand, nor, on the other hand for the arrogant *expectation of the atheist*, that he will thereby be able to drive God from his work. * * * It [spontaneous generation] is a production out of preëxisting materials by means of powers in the materials —powers very much unknown, working only in certain circumstances, and *requiring, in order to their operation, favorable conditions assorted by Divine wisdom.*"—Christianity and Positivism, pp. 35, 36.

In order to see the self-annihilating character of this statement, it is only necessary to reflect that the production of an organic being out of inorganic matter, as here described, by the operation of "*favorable conditions assorted by Divine wisdom*," is simply *miraculous creation*, nothing more and nothing less, as all theists understand that term, and not spontaneous generation in any sense of the word, since it flatly contradicts the well-known and only meaning of that phrase. No one supposes that God does not act in accordance with laws already existing, or specially enacted for the occasion, even in the miraculous creation of an animal; that is to say,

He takes already existing materials, brings them together by the operation of laws, whether we are able to comprehend them or not, and causes all the necessary chemical and other changes of the inorganic matter to convert it into albumen, protoplasm, etc., and then, by other laws, infuses into it an infinitesimal atom of His own vitality and intelligence, according to the need of the creature and its place in Nature, all of which is embraced in the language of Dr. McCosh—"favorable conditions assorted by Divine wisdom." This is exactly the way in which Adam was created out of the dust of the earth. "God is a God of *order*, which is another name for *law*, and, in miraculously forming Adam, He proceeded according to law, even to the act of *breathing* into his nostrils the breath of life, and thus constituting him a living soul. We cannot doubt that He did all this by just what Dr. McCosh calls *spontaneous generation*,—"favorable conditions assorted by Divine wisdom." Should this learned theologian chance, on some Sunday, to preach from his pulpit that Adam came into existence by "spontaneous generation," he would, doubtless, be tried by his presbytery for publicly teaching a most dangerous heresy. But imagine, if you can, the looks of the solemn presbyters constituting the court, as the Doctor steps forward to answer the grave specification in the charge by explaining, with a broad smile upon his countenance, that "spontaneous generation" is the same thing precisely as miraculous creation, since it is simply the operation of "favorable conditions assorted by Divine wisdom," thus reconciling the extremest phase of modern materialistic philosophy with the religion of the Bible! Who would not be the president of a college, if the office carries with it such a sublime and unlimited license in the use of language?

But seriously, a college president has no more right to annihilate the universally accepted definitions of words than has the most obscure or humbleplebeianof his pastorate. To employ such a manifest contradiction in terms, as spontaneous generation produced under the assorting supervision of Divine wisdom, is like talking about a system of *atheism* with its leading article inculcating the existence of a personal God; or like an elaborate description of a self-acting perpetual motion driven by a steam-engine! It is the employment of well-known words, with well-understood definitions, in about as loose and reckless a manner as that of Prof. Haeckel, in *evolving* a fish into a hoofed-animal, and then *evolving* the same hoofed-animal back again into a porpoise or whale! (See History of Creation, Vol. 2., p. 251.)

While I protest against this slipshod mode of teaching science and using words without the slightest regard to their etymology, I cannot help congratulating Professor Haeckel upon his involuntary escape from atheism, as a brand plucked from the burning. He made a desperate effort, through the two large volumes of his History of Creation, to get rid of a God by proving the "spontaneous generation" of the first animal, as "the primeval parent of all other organisms," and as the origin of life upon this planet, knowing well that if such "coming into existence out of inorganic matter" could be established, there would be no use for a God, and no difficulty in proving the evolution of all other forms of organic being by the settled course of Nature, and without the intervention of any personal intelligence whatever. But here comes the most learned divine in the United States who by a single sweep of his pen, demonstrates that this godless professor in the University of Jena, is a *theist*, with the promise and potency of some day becoming a Christian, since spontaneous generation, "suppose it proven," is only another name for miraculous creation or the operation of "favorable conditions assorted by Divine wisdom!"

But "theistic" evolutionists do not harmonize among themselves any better than do agnostic and atheistic evolutionists.

While Dr. McCosh insists that spontaneous generation does not conflict with religion or a belief in God's existence and providence, Joseph Cook just as distinctly rejects the "form" of evolution taught by Huxley and Haeckel on the ground that it involves spontaneous generation or the development of "the living from the not-living" (see quotation page 20), which the eminent president of Princeton assures him is only another name for miraculous creation, being an operation which takes place under the supervising control of Divine wisdom! It is scarcely worth while for these high authorities to attempt a reconciliation of their conflicting views on the meaning and scope of "theistic evolution," as it would take much less time and labor for them to get rid of the whole theory and have done with it. All it requires is a thorough examination and comprehension of the facts of science relied upon by evolutionists, which seems, really, to have been a matter of secondary importance in the estimation of these theological advocates of the "new philosophy," as they appear, rather, to have cast about them almost the first thing, to determine which "form" of the theory was least objectionable, and which would leave most of the religion of the Bible, instead of doing as they should have done, rejecting the whole thing as unscriptural, irrational, and absurd, and then patiently waiting and assiduously laboring for a solution of the natural facts involved, in accordance with the plausible hypothesis of special acts of Divine intervention as taught by religious science.

In concluding this introduction, I appeal, in all candor, to the clergy of the country, who have not yet fallen victims to the fatal wiles of the "new philosophy," and ask them, in the name of religion, if this apologetic spirit of compromise with modern science, among christian ministers, has not gone about far enough; and if it is not about time to call a halt and seriously reconsider the whole question? Instead of adopting a temporizing policy of almost bending the knee to evolution, the worst phase of materialism ever promulgated by man,—instead of accepting one-half of the new philosophy under the specious disguise of "theistic evolution," at the expense of surrendering to the avowed enemies of religion one-half of the Bible,—would it not show more true courage and Christian dignity to take an uncompromising and even defiant stand against the theory in all its forms and phases, fight it out to the bitter end, if need be, and either win all or lose all, in this struggle for religious existence? If I am not mistaken in the signs of the times, it is certain that there is neither a thought of compromise nor a disposition to yield, even so far as to make overtures for a parley, on the part of evolutionists. Not one inch will they yield till the ground is wrenched from them by piece-meal. All the overtures or compromises, thus far, have come voluntarily from the advocates of religion. This is a burning shame, and it is time to change our tactics and swear by Him that liveth forever and ever, that temporising compromises with so-called science have come to an end; and that, from this time on, it is either an unconditional surrender to the materialistic and atheistic evolution of Huxley and Haeckel, or it is the triumph of religion and of the unadulterated word of God. There can be no drawn battle in this scientific and religious war. There can neither be a mutual division of the spoils, nor a compromise over a salmagundi of new philosophy, divinely assorted spontaneous generation, religious science, and theistic evolution. It must, in the end, be either a victory for evolution, pure and simple, as taught by Darwin, Huxley, and Haeckel, or, it must be its utter extermination. Which, then, shall it be?

Whatever confidence our Christian fervor may inspire in us, as to the ultimate triumph of religion over the defiant infidelity of such eloquent and critical unbelievers as Haeckel, Ingersoll, Underwood, & Co., it is well for us to keep in mind

the undeniable fact that the time of miracles is past, and that God now works, in fighting the battles of His church, alone through human agencies,—through the fidelity, the courage, the enthusiasm, and the intelligence of His ministers and people. And should these agencies fail to uphold the Christian standard, and vindicate the religion of the Bible against the assaults of materialistic unbelievers,—meeting their attacks with sounder logic and more invincible arguments,—then, inevitably, the decadence of the church, of whatever denomination, commences, the youth of the land will grow up into the prevailing infidelity, and the utter downfall of religion will only be a question of time,—that time limited, possibly, to the interval of a single generation. This sad and even terrible contingency is not an impossibility, on the above supposition of a failure to arrest the present tidal wave of materialism; and for this reason I regard it as deplorable in the extreme, that our young college students, who are to form the intellectual bone and sinew of the coming generation, and who are just now at the point of determining their mental status toward these new philosophic doctrines, should be confronted, at the very threshold of their decision, with these wholly gratuitous apologies, for evolution, and even spontaneous generation, by the most eminent divines in our land, including many presidents of our colleges and universities.

Yet, I am fully persuaded that Joseph Cook and Dr. McCosh, whom I have been forced, in all kindness, to criticise in this chapter, would have been the last men in the world thus willingly to cast a stumbling block in the way of young investigators, or put a weapon into the hands of the enemies of religion, had they seen any possible way out of the difficulty, or had they been able to devise any method of accounting for the facts of natural history, bearing on the subject in question, without making such humiliating concessions. And it is even now morally certain, if these sincere Christian workers could be convinced that their surrender to evolution had been made upon grounds which were wholly insufficient, and that the theory, even in its mildest form, has not one fairly understood class of scientific facts, such as *embryology, rudimentary organs, reversions, paleontology, comparative anatomy*, etc., upon which its claims can rest, that they would be only too glad to avail themselves of the opportunity of at once appealing to the court of heaven for an everlasting cancellation of their mistaken compact with Darwinism. I assert, without mental reservation, that such opportunity for a final and unconditional dissolution of co-partnership with evolutionists, fairly, logically, and scientifically demonstrated, will be afforded in the following chapters of this volume, the benefits of which are within the reach of all who may have a desire to avail themselves of them. May the guiding influence of that wisdom which cometh from above direct our feet into the paths of true knowledge!

CHAPTER II.

MATTER, SUBSTANCE, FORCE, LIFE, MIND, SOUL, SPIRIT, GOD.

[Synopsis of Contents.]

The Conservation of Force.—All the forces of Nature substantial.—A regular gradation in density and tenuity in all substances.—Air the intermediate substance.—Gravitation a substance.—Illustrated by a bucket of quick-silver.—Proved by Sir Isaac Newton.—Magnetic substance proved and illustrated.—Soul, Life, Mind, Spirit, substances.—God the Fountain of all substance, and from whom all the substances of the Universe have issued.—Man a dual being, constituted of a double organism.—By this view alone is the Immortality of the Soul made to harmonize with Reason or Science.—Criticisms upon Comte's Transcendentalism in metaphysics.—All animals possess dual organisms.—Difference between material and immaterial substances discussed.—Origin of mind, life, matter, and material forms.—One great mystery, God, unavoidable.—It solves all minor mysteries.—Origin of Life on earth illustrated.—The existence of Soul as an entity demonstrated by the action of magnetism.—Many analogies and illustrations of the soul's substantial nature given.—This wonderful force of magnetism never before used against materialism.—Life and soul illustrated by Odor.—Cause and effect examined.—Many illustrations given.—The pen with its transparent hand, the invisible musician, etc.—Haeckel's views of life analyzed.—The complete and satisfactory solution which the internal, vital and mental organism furnishes of the soul and its probable immortality.

The recently established theory of the persistence of energy,—otherwise termed the conservation of force,—proves, as certainly as it proves anything, that all *force is substantial.* Nothing can be conserved or preserved unless it be something that exists, and it seems to be an axiomatic truth that nothing can exist unless it be a substance of some kind. If force in one form is convertible into force of another form, as claimed by the advocates of this theory, then all force in whatever form it may be exerted, is substance, since it is impossible to conceive of the conversion of one thing into another thing and neither thing be anything substantial. Our inability to take cognizance of the constituents or corpuscles of a force, such as gravity or magnetism, for example, by the immediate action of our senses, as we are able to do of such substances as iron, water, air, or odor, is no valid reason to a thoughtful mind why such force should not be regarded as a real substance,—as literally and truly an entity as is the atmosphere we breathe. The air when quiescent is admittedly unrecognizable by any of the senses as a *substance.* It can neither be seen, heard, felt, tasted, nor smelt; and even in motion we only recognize it by the effects it produces in displacing heavy objects or pressing against our bodies. To the minds of many who have not reasoned themselves into the philosophy of atmospheric pressure, it seems even now irrational and impossible that the air we breathe, so transparent and impalpable, can be a real substance having an actual weight of fifteen pounds to the square inch upon all bodies at the earth's surface. It would almost seem that this wonderful entity was intended by the all-wise Author of Nature, among its other uses, to show us the marvelous amplification of substantial existences in God's universe, and thus lead us step by step from the visible and corporeal constituents of gross matter up to the invisible and incorporeal elements of substantial entities outside of the present recognition of our senses. I never think of the air, or intelligently draw a breath, but a thought of adoration to the God of Nature pervades my mind for so ordaining this intermediate but invisible substance as to teach us that it is but the connecting link in the chain of

entities from the gross earth up to the inconceivably attenuated existences outside of material forms, thus rationally and philosophically leading the mind from what we are, in relation to sense, to the possibilities of what we may be.

Because that mysterious something called gravitation, which pulls a weight toward the earth, can neither be seen, heard, felt, tasted, nor smelt, it is no proof that gravity is not a substance as really and truly as is water, iron, or even platinum, the heaviest of all known substances, only the substantial corpuscles or attenuated threads of gravity are of such a nature that we cannot recognize them except through our higher faculties of reason, by what they accomplish. The German laborer who placed his bucket beneath a dripping rock to catch water, was astonished when he undertook to carry it home. He could neither lift it nor stir it, with all the strength of his arm. Yet he saw nothing to cause such a result except the water the bucket contained. It could not have frozen to the ground for it was a hot summer's day. Yet something held it down with immovable but invisible power. The secret was soon revealed. The bucket was nearly full of quicksilver which had dripped from the rock with the water. Had this quicksilver still remained invisible, after the covering of water had been removed, and had it been even unobservable by any other of the senses, or could the hand have been passed through it without feeling it in the slightest degree, it would still have been none the less a real substance so long as its effects were the same in holding the bucket to the earth. We must therefore judge of the substantial or entitative nature of any thing of which the mind can form a concept, not by its recognizable or unrecognizable qualities through the direct evidence of our senses, but by its demonstrable effects upon other and known substances under the exercise of our rational faculties in judging, analyzing, comparing, etc. Thus gravity is a substance as really and truly as was the invisible mercury in the bucket, but its nature is such that it is hidden from all our senses. Our hands can pass through it without feeling it. It permeates and passes through all substances that may intervene between the earth and a suspended weight, and when the chord that supports the weight is severed, the invisible and intangible threads of this all-pervading substance seize each molecule of the weight and pull it to the earth.

We say, by a license in the use of words, that a block of iron, for example, when unsupported falls to the ground. It does not *fall*, literally, but gravity draws it to the earth. Were it possible that another planet the size of this earth could be kept the same distance above the iron weight as the earth is below it, the weight would be suspended in the air between the two without support, and would neither move one way nor the other, the two gravities neutralizing or counterbalancing each other. Then such a mass of iron would weigh absolutely nothing. Hence it could not fall, because in that condition there would relatively be neither up nor down.

The same would be true if another force should act upon the block of iron, in the place of the supposed planet. Place a magnet an inch above the iron weight and of sufficient power to outdraw the force of the earth's attraction, and the weight would "fall" upward to the magnet by the same license of language that we employ when we say it falls to the ground. It would be drawn to the magnet by analogous but intangible and invisible threads of substantial force,—a real entity that passes off from the magnetic poles, seizes the block of iron and lifts it bodily. And yet, as in the case of gravitation, this substance passes uninterruptedly through solid bodies. A sheet of glass or an impervious plate of platinum may be interposed between the weight and the magnetic poles without diminishing the power of the attrahent in lifting the iron mass the most minute fraction of a grain. It lifts it by the similar invisible and intangible threads of substantial force, twined about the molecules of the iron, just as gravity acts in pulling the same weight to the earth. The cases are not only analogous but almost precisely similar. Few, who have given special thought to the true and wonderful nature of these phenomena, now doubt the substantial nature of magnetism, in its action upon a distant bar of iron, called an armature, and in thus pulling it toward the magnetic poles. No one, in fact, can conceive, by any possibility of mental effort, the idea of a bar of iron moving from a state of rest and being forcibly drawn toward a distant magnet, without acknowledging the existence of some substance of a real

entitative nature passing between them. Those who are thus forced to admit the substantial nature of magnetic rays, have stepped into a new world, filled with new entities and verities. They are mentally and logically compelled at once to look upon gravity in the same light. Sir Isaac Newton caught a glimpse of this new world of incorporeal entities as he contemplated the law of gravitation. In a letter to Bentley he says:

"That gravity should be innate, inherent and essential to matter, *so that one body may act on another at a distance through a vacuum*, without the mediation of anything else by and through which their action and force may be conveyed from one to the other, *is to me so great an absurdity that I believe no man who has in philosophical matters a competent faculty of thinking, can ever fall into it.*"

The greatest of philosophical reasoners, though inspired with this brilliant dash of intellect, did not, however, take advantage of such a sparkling revelation, and by dint of logic, carry it out to magnetism, electricity, life, mind, spirit,—even up to the substantial throne of the Deity Himself. He entered the portals of the new dominion of philosophical thought, but unfortunately stopped there, and spent his life in contemplating and elucidating the substantial wonders and all-pervading effects of that mighty entitative force which his own genius had formulated, if it had not discovered. He even, illogically, fought against substances beyond the range of the senses, and denied their existence because they could not be demonstrated. When *ether* was suggested as an undulatory medium filling inter-stellar space, but almost infinitely attenuated, as a means to account for the phenomena of light, he rejected it, though he held to the corpuscular theory of light itself, making the sun's rays a real substance, preferring a supposition approved by one of the senses rather than an assumption outside of all. Had there been any real use for this hypothetic ether in accounting for these natural phenomena, or if they could not have been as well or better explained without, then this *etherial* substance, even if it were a thousand million times more attenuated than hydrogen gas, could have been rationally admitted to exist; for if even such a vastly attenuated substance were shown to be absolutely necessary to a given mechanical or demonstrated result, as are gravity and magnetism & their physical effects, its existence as a substantial entity would thus be demonstrated and admit of no further controversy.

If, then, substantial rays of force can thus pass from the poles of a magnet through the most impervious bodies, producing corporeal effects at a distance in overcoming the inertia of, and giving motion to, a bar of iron, thus demonstrating the absolute existence of a substance not limited by corporeal conditions, and beyond the range of any of our senses,—a substance which can only be recognized by our reason in analyzing its effects upon physical bodies,—it brings us at once and by a single step into the world of vital and mental substances, which just as demonstrably show their entitative natures by their effects in moving our corporeal bodies and operating them at will, as well as the bodies of all living and thinking beings.

Nine-tenths of the religious world, who profess, of course, to believe in the immortality of the soul, have no definite or thinkable conception of the soul as a substantial entity. If asked, what they really mean by the *soul*, their answer would be utterly vague and unsatisfactory, as much so to themselves as to the inquirer. They would probably talk about that living, spiritual *principle* in man, which distinguishes him from the brute. If, however, you ask one of these believers in the immortality of the soul what were his conceptions of man as a corporeal, visible and tangible being, he would be able to give a definite answer. There would be no vagueness or ambiguity in his expressions—no dreamy "principle" mixed up with his definition. Man would be described as an erect, substantial, intelligent being, of a certain form and possessing certain organs and parts through which the vital and spiritual *principle* of the *soul* manifested itself. To the philosopher, however, who has grasped the true nature of substance in its various conditions of existence from the tangible to the intangible, from the visible, ponderable, physical bodies around us,—such as platinum, iron, water, wood, flesh, air, gas, and odor, up to the intangible, invisible and incorporeal substances of electricity, magnetism, gravitation, etc.;—to such a student of Nature there would be no difficulty in comprehending the additional fact that the life, soul, mind, or spirit of a living man, constitutes an in-

terior substantial entity, an invisible and incorporeal organism ramifying the physical structure, as real as is the visible and tangible organism it animates;—the one the exact counterpart of the other, though the inner must be vastly the more important of the two, since it is the moving force or motive-power through which alone any physical body is enabled to live, move, or think. Whenever we are enabled thus to grasp and comprehend this radical fact that there are or may be invisible, intangible, and consequently incorporeal bodies all around us, possessing forms and organic structures, as literally and truly as do the physical bodies recognized by our corporeal senses, then, and not till then, will we begin to get the first glimpse into the true solution of the problem of human life, and that mysterious something so vaguely spoken of as the immortality of the soul. And whenever we can grasp the thought that man is a dual being, possessing a double organism, the one structure being corporeal, visible, tangible, the other incorporeal, invisible, and intangible; and when we can further recognize the fact that man, through the aid of his senses, can really and truly extend his personal presence to a limited distance beyond that of his corporeal form, we can then conceive of an infinite personality who may exist upon His throne in one part of the Universe, and whose all-pervading substantial or entitative attributes, analogous to our senses, but infinitely surpassing them, may make Him literally omnipresent, causing His actual being to extend through all extent.

This view of God and man gives a theist something in the former worthy of adoration, and something in himself worth trying to save, and upon which a sensible and satisfactory idea of immortality can be predicated. To suppose that the human soul is bodiless, formless, and organless, is a thought about as unsatisfactory as to try to conceive of the immortality of a rubber balloon. How can an immortality be predicated of man worth hoping for, if the soul is not to see, hear, feel, taste, and smell? And if these powers, even in our most exalted conception of them, are to exist in the eternal state of man, then he must possess the essential organs by which such faculties are to be exercised and enjoyed; and this implies that the soul, which is so vaguely talked about as a *principle* destined to immortality, is in reality the *inner man*—the internal, incorporeal organism, as perfect in form as the exterior structure, and alone the entity which animates our physical body.

The view thus imperfectly taken of the soul of man is applicable also to God himself, with His infinitely extended attributes. Call it anthropomorphism or what we like, it is nevertheless a conception absolutely unavoidable, unless we are to regard God as a myth—the mere embodiment of a vague thought—the dreamy, vapory nothing of those who deny an incorporeal organism to the human soul, or the unknowable, inconceivable nonentity of Herbert Spencer. Of what conceivable value would be the idea of a God devoid of personality? Aristotle's definition of life is good as far as it goes, but is not sufficiently broad or explicit. He defines life to be "the cause of form in organisms." But it is not only the *cause* of form, but is the *form* itself—the invisible entity that constitutes the living, moving, organic being, filling every organ, fibre, or molecule of the physical man or animal. In searching through works on biology, physiology, psychology, and metaphysics, I have found no definition by any scientific writer that was at all radical or satisfactory as to the fundamental nature of life and mind. The discovery by Dr. Beale of an almost infinite distribution of living, moving *bioplasts* in every nerve, muscle, vein, artery, or fiber of an animal organism, which can be seen under the microscope busy at work plying their shuttles and weaving new tissue or repairing old, does not help to solve the problem in the least. It gets down toward the solution, but does not reach it. What is there, Doctor, we might ask, within this material bioplast that gives it motion, since matter cannot move itself? I answer: it is life,—invisible but none the less substantial,—as much substance as the bioplast itself. How could an army of bioplasts weave a nerve, even after motion were given to them, unless there were at the same time a vital, invisible nerve passing along the organic part as the incorporeal pattern around which and through which the bioplasts might travel and thus be guided to do their specific work? But for this incorporeal pattern, a *vein* might be mistaken for a *nerve* by the workmen! But make life a veritable substance, an invisible and incorporeal organ-

ism filling every part of the physical structure as the guide to the working bioplasts, and the chief mystery of an organic being is dissipated, and nine-tenths of the problems met with in physiological and psychological science are rationally solved.

The view here taken of man's incorporeal, vital and mental being applied to God, possessed of infinitely extended attributes and presence, disrobes Him of much of that unknowable, inscrutable, unentitative character that modern hair-splitting philosophers and metaphysicists have woven about the idea of His existence. With Deity as here contemplated, we may rationally talk of going into His presence and assembling around His throne and yet believe Him to be omnipresent. But we cannot consistently believe that He either sees us or hears our prayers, if He is not a personality in the broadest as well as most definite sense of the word. "He that formed the eye shall He not see, and He that formed the ear shall He not hear?" But how shall He "see" without eyes, or "hear" without ears of His own? The sacred record answers this question. "The *eyes* of the Lord are over the righteous, and His *ears* are open to their prayers." By extending the above inquiries, we may further ask:—He that formed or gave the mind, shall He not *think?* and He that formed or gave the life to man and animals shall he not live? and he that endowed us with consciousness, and gave us our sensations, shall He be incapable of consciousness or deprived of corresponding senses, infinitely extended?

Thus the substantial nature of the soul involves the substantial nature of God. And as the substance of Deity must constitute an infinite and inexhaustible fountain of life and mentality, it is easily and rationally conceivable that our individual life and mentality came originally as drops from out the infinite fountain of God himself, constituted as He must be of mind and life and their various qualities and attributes.

Hence, there is no necessity for supposing that God created the life, mind, soul, or spirit of man and the mental powers of animals out of *nothing*, as some religionists maintain, thinking thereby to enhance the glory of God by exalting His power. It is more glorious to believe that all life and mind are an emanation from God himself. The very act of *breathing* the *breath of life* into the nostrils of Adam implies that the "living soul" is an effluence of God, rather than a creation from nothing.

It is further rationally conceivable that in thus giving the spark of life and mental power, as an infinitesimal drop of Himself, to the originally created pair of any animal species, thus constituting them living and thinking organisms, He at the same time endowed each specific pair with a capability of transferring a germ of their incorporeal being as well as physical being to their offspring, by which each descendant becomes a substantial duplicate of its progenitor, with equal powers of transmission and reproduction.

The internal organism of man is thus his more *real* entity, because it is the only part which is perpetuated or remains unchanged, and by which his identity as an individual is kept up. Metaphysicists such as Comte, Hume, and others of that class, have carried their self-contradictory philosophy so far as to deny in toto the *reality* of matter, or any other substance. They maintain that there is no evidence that a tree, for example, exists as a *reality*, and that even when we see and handle it, the only *real* thing is our mental *impression* that the tree exists! But this distinction, as usual in the writings of these transcendental metaphysicists,—is a species of wire-drawing, which invariably reduces every position assumed to self-negation. For we surely know that the tree exists, by the very same evidence that we know we have the mental *impression* of its existence! I wish I could have the opportunity of saying to Mr. Comte, Sir: Your *impression* of the tree's existence is not a *reality* at all, according to your own reasoning. You only have formed an *idea* that you had received such an *impression*. Hence the *idea* of the existence of the *impression*, is the only *real* thing in the premises! Should he admit this, as he would be forced to do by his own logic, I would then take him a step further and demonstrate that his *idea* of the mental *impression* of the tree could not be the real thing after all, since he only *fancied or imagined* that he had formed such an *idea* of an *impression* about a tree! Thus I might keep him going with this house-that-Jack-built logic in search of the *real reality*, till he would be totally lost in the labyrinths of his own metaphysical confusion, and be obliged to admit that both the *tree* and the

mental *impression* of it, as well as the *idea* of the *impression* and his *fancy* about the *idea*, were all real, or else were nothing at all.

The fact that these eminent metaphysical philosophers have finally reached the conclusion and set it down that the *mental impression* is more real than the corporeal tree which gave the impression, is all I can ask in favor of my present position, as it gives the mental entity the preference over the external material world, showing that the "inner man" is the only true reality of our existence in the higher sense, the body being but its physicial and external manifestation.

Thus every animal as well as man must be considered a dual organism, the life and mental powers (however limited their scope or circumscribed their sphere of action) constituting the interior and exact duplicate of the physical organism, and the true and only source of all inherited characteristics, by which the peculiarities of the species are perpetuated, all of which I claim to demonstrate in a subsequent chapter. I beg of the reader not to hastily jump to the conclusion that this similar duality of being in man and beast, involves the immortality of the lower animals, placing them on an equality with man. With life and mentality evidently possessed by all lower animals, and with certain cerebral phenomena observed the same as in man, modern biological and physiological investigators, as well as many former ones, have been forced to admit the probability of the immortality of the souls of all animals. Even that most careful and critical investigator, the Rev. Joseph Cook, in his Lectures on Biology, substantially accepts this conclusion, or at least is not prepared to oppose it. But there is a proper line of demarkation, when carefully surveyed, running between the human and the lower orders of animals, by which it can be rationally shown how the former shall live forever with a conscious identity of personal being, while the latter are neither subjects of individual immortality, nor are their vital and mental substance annihilated, or in any degree lost in the general economy of God's universe, all of which will be treated of in the proper place, toward the close of this volume.

It is certain that no substance in the universe can be annihilated, or cease to exist, however often it may change its form, and it is equally a settled and indisputable principle of science, that no substance, corporeal or incorporeal, can come into existence or be created out of nothing, even by the aid of infinite power. I am aware that this trenches upon one of the prominent articles of the Westminster Confession of Faith, held almost sacredly by large bodies of Christian believers in this country and Europe. But there are certain axiomatic truths so self-evidently settled even in the very roots of science, that to controvert them by any article of religious belief is to fly into the face of all science, and unnecessarily provoke disparagement of religion itself, in the minds of cultivated scientific investigators. Fortunately for religion, however, this article of faith, which so positively teaches that God created all things out of nothing, is not even claimed by its framers to be expressly taught in the sacred Scriptures, and, I may add my own opinion, not even by any fair or necessary inference. In opposing the false views of scientists, and their perversions of Nature's laws, nothing is more detrimental to success than incorporating into such opposing arguments, religious hypotheses utterly untenable and false in the very nature of things. Let us admit all that is rationally and necessarily true in science, and it gives us an infinitely firmer foothold to overthrow the temple of the Philistines, without killing ourselves in the operation, as did poor Sampson.

I am glad to agree here with the views of that radical and critical thinker—the Rev. Joseph Cook—as I do upon almost all questions;—though I have been forced to differ from him in a few instances which have been frankly pointed out, and which I trust will not offend that great scholar and Christian scientist. Upon the creation of the universe he distinctly takes issue with the Westminster Confession. I quote a single sentence :

> "*It is not my belief that every thing was created from nothing*, nor do the authors of 'The Unseen Universe,' perhaps the most suggestive book lately published on these intricate themes, affirm that." —*Lectures on Heredity*, p. 121.

Then, if something can not be created out of nothing, whence came this material universe? Is matter eternal? If so, there is something in the universe co-existent with, and consequently equal, in this re-

spect to, God himself. This would seem to be inadmissable by all sincere theists, and hence *matter*, in the grosser form of substance, as contradistinguished from the incorporeal substances before named, from which probably it was derived, need not to have been eternal. But wherein, asks the reader, would lie the difference, and how would it alter the case as to the substantial eternity of matter, if the incorporeal substance, from which matter in its grosser form has come, existed from eternity? It would not, I confess, relieve the hypothesis of its inconsistency in the slightest degree, except to resolve all matter, for example, first into Prof. Crooke's fourth state, or Dr. Lockyer's single elementary substance, then into the grosser incorporeal elements of nature, in their various forms, such as electricity, gravitation, magnetism and other forces; then into the higher plane of incorporeal substance such as constitutes the vital and mental powers of the organic world; finally into the substantial elements of God's own external being, so to speak, out of which, by His infinite power and wisdom He might have condensed the various grades of substance down to the material world itself. This would constitute God himself the source from whence has been derived universal Nature, and answer both the scientist and the Westminster Confession. I fancy, however, the reader is shocked at this idea, and exclaims: *Pantheism!* But I believe a cool and careful consideration of the whole question will not only relieve this supposition of its apparently shocking character of pantheism, but will show it to be the only possible or consistent method of harmonizing the settled and axiomatic truths of science with the fundamental truth of religion—the existence of a personal God independent of, and superior to, Nature, while also maintaining His immanence in Nature. The truth is, religious philosophers who have undertaken of late to break down the materialistic theories of advanced scientists, have been too much hampered by creed, or else too fearful of trenching upon some popular religious notions to grapple with these doctrines effectively, or without converting their own weapons into boomerangs. The hampered manner in which some recent attacks have been made upon evolution, for example, by our leading clergymen, is suggestive of the failure of the general who decided rather to lose the battle than to deviate from the tactics taught him in the military academy. But let the hands of every soldier be unhampered, and, without denominational dictation or restraint, let us use every weapon God has given us, as well as the artillery captured from the enemy himself, by which to break down his redoubts and demolish, if possible, even the very foundation-walls of his fortifications.

It seems to me irrational, as well as unnecessary, to talk of any essential or radical difference in the fundamental nature of *material* and *immaterial* substances, and I have never seen a basic distinction satisfactorily defined. When the heaviest metal can be converted into a gas, many times lighter than our atmosphere, after which the present power of the chemist and mechanician is defied to reconvert it into a solid form, it ought to teach us that this gaseous substance, under the manipulation of still higher wisdom and greater chemical resources might be made to reach a second state of attenuation or sublimation, almost if not quite justifying our conception of an "immaterial substance," and that, too, without a transition much greater than its first change from metal to gas. Such a transformation may yet be effected by chemistry and mechanics; and then this twice-attenuated gas, by other processes, might again be compressed into its original metal, as atmospheric air has already been condensed into a liquid of the density of water by the action of cold and mechanical pressure. The present apparent impossibility of such transformations may change to a simple and well-understood process with a higher advance in scientific knowledge. Picus says: "*Difficult* things always seem at first *impossible*, and even easy things appear impracticable to the unskilled and unknowing." The experimenters of the Rosicrucian school of philosophy taught much in their cryptic processes, which have proved practical anticipations of the recent and startling discoveries of modern science. The "invisible fire" of the Brothers of the Rosy Cross, which they held to be the soul-substance of all metals, and which formed the groundwork for their belief in the philosopher's stone, the transmutation of metals, the elixir of life, etc., seems now to be but the invisible currents of electricity and magnetism, the fourth or radiant state of mat-

ter of Prof. Crookes, or the single basic elemental substance from which all material bodies have been condensed, as recently announced by Prof. Lockyer. Thus the philosophical and religious vagaries of one age may become the established scientific theories of the next, just as the dim utterances of theosophy by a Zoroaster or Confucius may even be incorporated into the grandest of all religions, and become the profound maxims of the wisest of all law-givers. It is possible that the germs of great truths may yet be found wrapped up in the folds of pantheistic philosophy. A Christian student cannot afford, in his investigations of science, to reject a rational truth first found in the works of Grecian or Roman philosophers, lest some creed-bound religionist shall shake his head knowingly and sigh—*platoism—pantheism.*

"Let truth be seized wherever found,
On heathen or on Christian ground,"

is a couplet to which scientific investigators no less than religious philosophers should pay good heed.

The inconceivable leap from density to tenuity,—from the solid metals of commerce to Crookes' fourth state of matter, or Lockyer's single elementary substance,—need scarcely be exceeded in another leap to land us upon that higher plane of substance which we call *immaterial* or *incorporeal*, such as electricity or the substantial rays from the poles of a magnet, so attenuated that they will pass through solid plates of glass and move distant bodies without the slightest interruption of their progress. And by still another leap no greater, through the agency of a being capable of exerting the necessary attenuating power, we might possibly reach the topmost plane of all substance in the immaterial, vital, and mental elements of God himself, from the atoms of which have come the vital and mental powers of the organic universe, and from the condensation of a fraction of which must have come all the denser grades of substances, even those constituting the material world we inhabit. This view makes the entire concatenation, in the gradual attenuation of substance, a consistent and beautifully harmonious chain, from platinum—the heaviest known metal—up through lighter metals, wood, water, flesh, air, gas, odor, magnetism, electricity, gravitation, light, heat, sound, instinct, life, mind, spirit, ending with the great and universal fountain of all life and mentality —God Himself. This natural order of gradation in substance makes God the highest of all substances, and the self-existent, uncreated *I Am*, from whom, by whom, and of whom are *all things* visible and invisible in the universe.

Again I take pleasure in quoting with my full approval the emphatic testimony of Joseph Cook, that the material universe, as well as finite mind, life and instinct, has been *evolved*, or, as I have preferred to express it, *condensed*, from the essential elements of God's substantial being, while at the same time he just as emphatically denies that such view involves *pantheism*. Here are a few of his incisive declarations upon the subject:—

"Matter is an effluence of the Divine Nature, and so is all finite mind." "The body itself, and all other substance we call matter, are a revelation of Almighty God. All matter, as surely as all finite mind, originated in him." "So I suppose Almighty God *evolves* the seen universe of matter and the unseen of finite force from himself." "*My creed is the reverse of pantheistic.*" *Heredity*, pp. 120, 121. *Biology*, p. 270.

To assume, thus, that God made or "evolved" all things out of His own eternal self-existent substance is completely and forever to answer the scientific position, that as God could not have made the material world out of nothing, hence matter must have been eternal in the form of star-dust or some other grade of nebulosity. While it thus satisfactorily sets aside this otherwise unanswerable difficulty of the materialist, I have not the least mental hesitation in viewing the progress of this condensation of a mere atom, comparatively, of God's substantial but external being, downward through all the gradations and amplifications necessary to the creation of this solid, liquid and gaseous world, with its manifold and multiform grades of animal and vegetable organisms. All that is needed for our rational acceptance of such a consistent origin of the visible universe is first and foremost to concede the substantial existence of an infinite, primordial, personal intelligence armed with omnipotent power. Without this fundamental conception and concession of one infinite mystery, incomprehensible though it may be, and is, we are involved in the mazes of a million mysteries equally inexplicable, in every blade

of grass, grain of sand, or creeping thing, not one of which has any possible solution without the primary concession of this one infinite and fundamental mystery. Is it not therefore the part of wisdom and the exercise of a common rationality for every scientific investigator at once and forever to solve and get rid of the myriad mysteries of which Nature is so prolific, by accepting the one great mystery of an infinite, self-existent God? The mind can more easily rest upon the concession of one mystery which can never be solved or comprehended, than in undertaking to grapple with a million equally inexplicable. The mind of man needs rest, and must find a sure abiding-place somewhere from the harrassing plague of doubt and uncertainty, or else wear itself out in perpetual agitation. There is but one safe position, either in philosophy or religion, where the soul can find rest, from the conflict of harrowing doubt, and that is to merge all the mysteries of Nature back into the one mystery of Nature's God.

Let us then seek that resting place as the shadow of a great rock in a weary land,—accept the grand but single mystery of an infinite intelligence and omnipotent first cause, and thus, at a single stroke of policy and a single effort of the will, wipe out all the minor problems of the universe.

The origin of life and mind lies at the foundation of all other mysteries in the phenomena of Nature, because through life and mind are we alone capacitated to recognize natural phenomena or contemplate the vast realm of mysteries which spreads out around us, in every drop of water, or atom of dust, no less than in the invisible air, the imponderable odor, the indestructible rays of magnetism, the mysterious flashes of electricity, and those incomprehensible entities we call sound, light, and heat. So completely are we involved in mysteries and surrounded by problems, in whatever direction we turn, and whatever phase of natural phenomena we contemplate, that the mind intuitively seeks for solution,—for some solid resting place for that weary, anxious, dissatisfied desire to know something of ourselves, first, and then more of the complex problems around us. The philosopher who seeks in natural science and through physical causes alone, for a solution of the existence of life and mind,—these marvelous but veritable operations we call thought, voluntary motion, hope, fear, love, anger, memory, reflection,—who essays to account for such bewildering phenomena first by spontaneous generation, and then by the action of brain or nerve molecules, without recognizing a first or teleological cause over and above Nature, is as puerile in his conceptions, and as trivial in his efforts, as is the staring infant in reaching out its hand to grasp the moon, and striking its nurse angrily, because she will not pluck and bring down the shining and coveted bauble. Let us for a moment contemplate the origin of life, and try, if possible, to solve a portion of its mysterious problem.

There was a time in the distant past, according to geological research, when this earth was a molten mass, and when, consequently, no life existed upon it. In the lapse of ages its surface became cooled sufficiently to admit of the condensation of vapor into water, and finally to allow of the existence of animal and vegetable life, both upon the land and within the ocean. But notwithstanding these favorable conditions, still no life existed,—not even a blade of grass, or cryptogamic spore, had made its appearance; and upon the whole broad surface of the earth not a living thing was moving. All nature, however, was in readiness for the support and development of organisms,—the sun poured down his effulgent rays, the tepid ocean ebbed and flowed with inviting warmth, babbling brooks descended from the mountains, and mingled into flowing rivers, genial continents and islands lay smiling in readiness to welcome vegetation and animal life, while the early and the latter rains continually prepared the soil for its future living denizens. But still no life was there, save that all-pervading life of the universe, which was in time to move upon the face of the waters.

Here the curtain falls, and after the lapse of another age, behold! The earth is teeming with its countless forms of luxuriant vegetable existences, giving sustenance to myriads of animal organisms, of diverse form and habit, while the oceans, lakes, and rivers are swarming with innumerable species of fish, and other aquatic animals. Whence came they, and by what mysterious and ingenious workmanship were these complicated living machines fashioned, and their various

parts and organs framed together so that part answers to part with the utmost perfection, showing plan in the general structure, and evincing intelligent design in their most trifling details? And then, whence came and how operates that invisible motive-power which propels these organic engines? How originated this vital energy, this voluntary will-force, this instinctive power of choice, by which the living machine actually determines its course, turning to the right or left, by which it walks or runs, stops or moves on; and who planned that delicate and complex furnace within the organic body of this living engine, by means of which vegetable substances are converted into heat which in turn generates the vital force by whose motive-power this wonderful living, thinking, voluntary locomotive is propelled? Philosophers of the Haeckel and Huxley school assure us that these engines not only built themselves without the aid of a designer, or mechanician, but that they run themselves without steam or any other entitative force, analogous to such motive-power. Though food is consumed, generating heat, though this heat generates the moving energy which drives the living locomotive, yet this heat, this energy, this mental power, this vital motor-force are all nothing but the molecular play of the physical cells of protoplasmic albumen "placed together in a most varied manner," as Haeckel expresses it, within the brain and spinal cord, and within the muscles and nerves of the body.

Ask these learned savants what moves that railroad-locomotive with force sufficient to draw a train of cars at the rate of forty miles an hour, and they show no such stupid want of logic as to talk about all this being accomplished by the molecules of steel, iron, and brass, "placed together in a most varied manner," and constituting the engine and boiler! No such puerility as a lecture on the atomic structure of iron, the globularity of aqueous molecules, or the peculiar mode of ethereal motion called heat, resulting from the combustion of fuel, would enter into their answer. They would tell the inquiring student of science, in plain words, that this invisible force is *steam*,—water rarified into vapor by heat,—a veritable entity, and one which is none the less real or substantial from being invisible, but that it is as truly a substance as is the boiler itself.

Ask them what it is that whirls the armature in front of the electro-magnet at the rate of a thousand revolutions a minute, without any visible or tangible connection between the magnet and the armature, and they will not waste your time by talking about the atomic structure of the armature, or the metallic molecules of the magnet inter-commingling "in a most varied manner," as all there is of this motive-force. They will tell you that the energy, which takes hold of this ponderable wheel of soft iron and overcomes its inertia, and which acts even through intervening sheets of glass or platinum, is a real entity,—though for convenience we call it force,—a veritable substance, which passes in currents from the poles of the magnet, and seizes the bar of iron with the mechanical energy necessary to cause its physical motion, on the same principal that the invisible steam overcomes the inertia of the piston, and drives the ponderous locomotive. They will not hesitate to admit that this substantial current called magnetism is as truly entitative as is the metal constituting the magnet itself. Notwithstanding this magnetic fluid is intangible, being utterly beyond the recognition of any of our senses, except as we recognize it in its effects on the armature, yet this fact does not prevent even these great materialistic authorities from admitting it a veritable entity, as real as is any corporeal substance which we can see with our eyes or handle with our hands. Why are they obliged to admit this? Because, to say that the inertia of a ponderable body like a bar of iron can be overcome and its mass be caused to change places in opposition to the law of gravity, without contact with some other substantial body, is to utter an absurdity so ridiculous in itself, and so opposed to all reason, as to be at once repugnant to the mind of a child no less than to that of a philosopher. Hence magnetism is as veritable a substance as steam, each acting under its own peculiar laws on the same principle of mechanical energy, producing a corporeal effect only by actual and substantial contact with the body to be moved.

Yet with these well-known facts and considerations before them, the so-called philosophers of our day,—the greatest living authorities in physical and natural

science, do not hesitate to assure us that the moving, working, thinking, voluntary engines, first found upon this earth were not only constructed without the aid of mechanical skill or prior mentality, but that they moved off, overcoming the inertia of their own ponderosity and that of other bodies, without steam or any equivalent substantial force save the motion of the material atoms which constituted the engines themselves. What infinite nonsense! No engine ever moved without a substantial motive-force within and distinct from its own material structure. This is a truism no one will dispute. It is further true that no engine was ever directed in its movements, to the accomplishment of intelligent results, without a living and substantial engineer to superintend its operations. This is equally a truism. Man is such an engine. His muscles, bones, nerves, sinews, heart, lungs, etc., constitute its working parts. His vital entity, kept up by the consumption and assimilation of food, constitutes the steam-power or the substantial motive-force which propels the machinery, enabling it not only to overcome its own inertia but to accomplish additional work; while the mental organism, is the engineer of this vital and physical apparatus which directs its movements, guides it in the struggle for existence, and controls its complex operations for the purposes of life. This engineer of the human body, this rational faculty in man, which stands at the controlling-lever of its motive-force, and which gives direction to its guiding-wheels, must be an entitative power as much so as is the veritable engine-driver who controls the movements of the thundering locomotive, or the pilot who stands at the helm and gives direction to the flying yacht or ocean steamer. Should the engineer be accidentally thrown from his locomotive while the steam-power is at work with full force, the train would be surely driven to destruction unless some other competent hand should be near to seize its valve-lever and bring the now reckless energy of the boiler under restraint. So the human engine with its vital motive-force in full blast would inevitably rush to destruction, should its engineer, *reason*, become suddenly dethroned, as is often the case with maniacs, unless some other guiding intellect should chance to be near to seize the restraining-lever and bring the mad machinery of man's brain and muscles under control. These rational analogies, drawn from well-known mechanical operations and the phenomena of life all around us, vividly illustrate the utter weakness of materialistic philosophy in its idle attempts to prove that our corporeal organism is all there is substantial about us, that the soul is but a puff of air, and that its supposed conscious existence separate from the body is but a vision of the fancy originating in a poetic faith.

But it is urged by materialists that as the mind does not act when the brain is paralyzed, so when the physical organism wholly ceases to exercise its functions then life as well as mind must cease to exist or become extinct. How then, they ask, can a future state of being be inferred, since nothing like life or mentality is known to exist after the death of the body? This limited and negative view of the nature of life and mind results from our imperfect conception of the relations which exist between the mind, the life and the body, and which unavoidably must exist while the body survives as the habitation of the soul in order to produce the corporeal results of which we are all the time cognizant. Assuming that life and mind are substantial entities, constituting an interior organism, the exact counterpart of our outer personality or self, as here maintained, it is easily supposable, while thus so intimately associated and blended, that the internal entity must necessarily be dependent upon the external organism for its conscious activity the same as the external body is dependent upon the entity within for its movements. Thus inter-woven, and inter-dependent upon each other, it is not surprising that a blow upon the brain should temporarily paralyze the vital and mental structure in proportion to the physical injury received, and should such injury prove sufficient to result in a complete dissolution or separation of the two organisms, it is not inpresumable but that the mental and vital entity might remain for some time in a state of entire unconsciousness, or until the effects of the dissolving shock should have sufficient time to subside. I say this is a reasonable supposition on the view that we are really dual, substantial beings; and then it is equally rational that our interior, incorporeal entity after recovering consciousness may actually continue on

forever in a state of personal activity, as all religionists must hold if their religion is to be of any practical value in this world or the next.

But does all this temporary paralysis of mind and body by a blow upon the brain constitute proof that the mind is nothing but molecular motion which then ceases to exist, and, as soon as the physical brain is restored to its normal condition, then *again comes into existence?* Does it follow, from the absence of cognizance by any of our senses of the presence of such a substantial entity, that the life and mind are annihilated even when the physical body is wholly destroyed or reduced to that condition which we call death? Let us look at this question for a moment, in the light of science.

The natural world is full of scientific and philosophical analogies going to show the reasonableness of the soul's substantial and conscious existence after death, even though not manifest to physical sense,—analogies which no materialist can set aside or explain, and some of the most important of which have never been used by the opponents of materialism. Take this simple example of the iron armature already referred to, which is observed to revolve with great rapidity near the poles of a magnet. No spring is wound upon its axle or connected with it by gear-wheels. No belt or other device, communicating mechanical power to its shaft, can be seen extending to a steam-engine or other motive-power. It is simply a naked mass of iron revolving in space. Something must move it since no material body can move itself or be moved without sufficient physical cause. But as nothing visible or tangible touches it, by which to cause such motion, there must be some invisible, intangible, and consequently incorporeal substance acting upon the iron mass to produce its rapid rotation. We peer intently between the revolving armature and the magnet, and, though the armature is pulled past the poles with great force and velocity, we can see nothing passing between them by which the one could possibly influence the other to cause such rotation. Yet, indisputably, something must pass from the magnet to seize upon this heavy block of iron and thus overcome its inertia, or else we have a distinct mechanical effect without a cause.

Let us now try to intercept this substance, whatever it may be, and thus stop the rotation of the wheel; for surely if it be a substance at all, according to all our physical or materialistic ideas of substance, it ought to be cut off from the armature by interposing a barrier between it and the magnet. We place a sheet of *glass* in front of the poles, but, to our surprise, it produces no effect whatever in lessening the force of this invisible something darting from the magnet, passing through this dense body, and producing such a marked effect upon another ponderable body at a distance. We substitute for the glass a plate of the most impervious of all known metals, *platinum;* but still no reduction of the rotary movement is produced—not a millionth of a grain of the power is intercepted. Yet, that it is an *entitative something,* having a truly *substantial character,* no physicist or materialist will venture to deny, though it is a substance *so independent of corporeal bodies as to pass through them unimpeded while it is so related to other corporeal bodies as to seize them, throw them into rapid motion, and thus perform mechanical labor.* Let materialists, who deny the substantial nature of life and mind, try to explain this analogical mystery of magnetism, and they will deduce therefrom a rational probability that the soul may be immortal. They flippantly deny that life and mind are substantial, that they are anything in fact, though they witness the effects produced by them upon corporeal bodies in ten thousand different ways, and hence, to be consistent, they should deny the substantial nature of these magnetic rays because they are intangible to chemical analysis, and elude the most careful scientific tests to prove their existence, and because they are unrecognizable by any of our senses, and can only be known to exist at all by the corporeal effects they produce, precisely as we judge of the substantial existence of life and mind.

Now, observe, still further, the beautiful analogy wrapped up in this well-known experiment, to which I have just alluded, and its illustrative bearing upon the substantial nature of life and mind. The invisible but substantial current of electricity coursing along the insulated copper nerve, which encircles the magnet, may fitly represent the bounding life-substance which permeates our physical organism in every

nerve, tendon, artery, and muscle; while the magnetism thus generated, and intimately correlated with the electric fluid, may well represent our mental powers, which, sending their mandates to the utmost extremities of the body, directly cause the movements of the organism, just as the attrahent reaches out its invisible, incorporeal fingers, and thus draws the massive armature from its state of rest, forcing it to obey mechanical laws in the performance of labor. Thus two correlated substances coalesce in both cases to produce physical motion, while in neither case are these substances recognizable by our senses.

But the analogy does not end here. I strike the *armature* (the moving part of the organism) with a hammer, and instantly the apparatus stops. It has ceased even to show the signs of life. You turn the damaged wheel with your hand, but it refuses to continue the motion. It is utterly paralyzed. Dr. Haeckel, at the suggestion of his friends, Huxley, Comte, and Spencer, examines the disabled machine. He feels for the magnetic pulse, but can observe no throbs of that wonderful life-current which a moment before had thrilled the whole apparatus, producing corporeal activity by whirling the now fractured armature. He pronounces it *dead*, and, as a consequence, declares that the electric *life* and magnetic *intellect*, which had caused all these physical manifestations of power, have ceased to exist, because, as he assures his friends, since they could only be manifested to us through the apparatus, they necessarily can have no existence without it! Besides this, he claims that electricity and magnetism, like life and mind, are "*nothing* but a connected chain of very complicated material phenomena of motion . . . . *of atoms placed together in a most varied manner*" (History of Creation, vol. i, p. 199); and as no molecular motion can be observed in the homogeneous substance of the magnet or insulated wire, even under the most powerful microscope, it is certain this "connected chain of very complicated material phenomena of motion," called electricity and magnetism has ceased to exist, because it is *non est inventus*.

But the intelligent electrician steps in and interrupts the Doctor by remarking that the electric apparatus *is not dead but sleepeth:* that notwithstanding the machine is broken and its bodily organism injured, the magnetism still lives and exists in all its energy, though we can not observe it, since we only recognize the fact of its existence by its manifestations in moving physical objects. Hence, this temporary injury is no proof, to a rational mind, that it does not still exist. To demonstrate the correctness of his view, he diverts the invisible current to another apparatus by shifting the wires, and behold! this identical electric life, with its magnetic intellect, which Dr. Haeckel declared had ceased to exist, seizes the new armature and makes it hum as before, by the speed of its physical rotation! The doctor, it may be well supposed, stands amazed and confounded at this demonstration, while his scientific friends are dumb at such a signal breakdown of their meterialistic philosophy. For here is an actual substance which defies our physical senses, and eludes every test known to science, yet is so independent of material conditions as to be capable of passing through plates of physically impervious glass and platinum as if nothing were present, while at the same time so related to matter as to grasp with physical force and move other inert bodies at a distance! Was there ever a clearer illustration and confirmation of a scientific fact or philosophical principle than this, that the vital and mental force which animates and moves our corporeal organisms, must be a substantial entity, and may be immortal? Materialists can not reply to this analogical argument, since they are here forced to recognize phenomena, just as mysterious and inexplicable, as those resulting from the life and mind of an animal, and which can be explained in no other way than by admitting electricity and magnetism to be substantial.

It really would seem that the God of Nature, in establishing the laws controlling electricity and magnetism, had purposely designed them for the benefit of materialists, so that they might be left without excuse as they stand upon the border-land between time and eternity, and survey the problems of the human soul. Because it would seem absolutely impossible that a philosophical mind can contemplate these correlated and wonderful substances, so analogous to life and mentality, and still doubt the substantial or entitative nature of the soul and life of man, which moves the physical body, as the intangible

magnetism moves the ponderous armature. And what is more wonderful, is the fact that this argument of arguments against materialism—this crowning, culminating, crushing consideration in favor of the substantial nature of life and mind—should never have been so much as alluded to in any work against materialistic philosophy up to the present time. But let it now be used unsparingly by every believer in the immortality of the soul, to stop the mouths of those who, like Haeckel and Huxley, contend that life and mind are nothing but the molecular motion of corporeal particles, since we fail to recognize them as substance by any of our senses or by the most refined chemical tests, or because we cannot trace their corporeal effects after the death of the body.

And here, let me say in passing, is where the much derided, much doubted, and much believed-in physical phenomena of spiritualism—the tipping of tables and chairs—would come in and prove useful and even invaluable in demonstrably crushing out materialism, could these physical manifestations be absolutely established, without the possibility of collusion or trickery. I have never feared these so-called mediumistic demonstrations as works of the devil or of bad spirits. Good, bad, or indifferent, so they are only actual spirits separated from corporeal organisms, let them tip and rap. Such visible and sensible manifestations would be demonstrative of the substantial nature of man's vital and mental being, and would utterly wipe out materialism by physical tests, the thing so much courted by advanced scientists. I also court these demonstrations, if they are possible, though, judging from my poor success hitherto, I scarcely expect to witness them.

Returning to our illustration of the disabled armature, we have seen that as the moving corporeal wheel may be broken while the invisible entity which gave it motion still exists in all its energy, and, when properly diverted is still capable of giving motion to another body; may we not believe, when our wheel shall be broken at the cistern, the earthly house of our tabernacle be dissolved, and our physical apparatus shall be crushed, that the Father of our spirits will connect the vital wires of our being with another body as it may please Him by which the substantial soul may exhibit every faculty and power it possessed on earth, and even to greater perfection, in that city which hath foundations whose maker and builder is God?

But the objector may say, that the analogy is incomplete, since the *magnet* itself was not broken in the illustration. Let it be destroyed and the magnetism will cease to exist. Not at all, for after the magnetism is once admitted to be a substance, which it must be, it matters not how tenuous or intangible, its destruction is impossible; for it is one of the best-established principles of science that no substance in the universe can be annihilated. The very doctrine of the conservation of *force* proves this. Magnetic substance may become so diffused through space as to cease to manifest itself to our senses, or lack the concentration necessary to move physical bodies; but not a particle of it is lost. This is beautifully illustrated by odor. A grain of musk, as I will show in the fifth chapter, will fill cubic miles of space with its peculiar substantial corpuscles, called odor, without reducing its weight perceptibly, tested by the most delicate balance, yet this fragance is a real and even corporeal substance, as admitted by all authorities on the subject. Prof. Tyndal says:

> "In the sense of touch the senses are moved by the contact of the body felt; in the sense of *smell, they are stirred by the infinitesimal particles of the odorous body;* in the sense of hearing they are shaken by the vibrations of the air."—*Tyndall on Light*, p. 57.

Now when cubic miles of odor have thus passed off from a mass of musk no larger than an acorn, as the magnetic corpuscles pass away from the poles of a magnet, will any scientific investigator for a single moment contend that these "infinitesimal particles of the odorous body" are annihilated because it is impossible to gather them up or even recognize them after they have subsided? No; a fair-minded materialist will freely admit that these odorous "particles" can never cease to exist, however widely diffused through space; and it is certain that the Author of Nature could, did it so please him, and by a law of His own ordaining, instantly collect into a single pellet all the odorous particles that ever issued from the flower-gardens of earth, or all the scattered corpuscles of magnetism that ever radiated from magnetic poles; just as He can, and I believe will, ultimately gather unto Himself every scattered corpuscle of our vital

and mental entities through the guardian power which numbers even the hairs of our heads.

But for the sense of smell (not at all necessary to our intellectual advancement) such a substance as odor would never have been known to exist, since it is impossible to prove its existence by any philosophical or chemical test whatever. Or had one-half of the world, including Prof. Haeckel, been born without the olfactory nerve, this eminent naturalist would probably now be protesting against such poetical nonsense as the supposed existence of odor, and would ridicule the testimony of one-half of the world just because of the defect in his own olfactory nerves and those of his friends,—pronouncing the pretended sensation of smell but the result of a diseased imagination, just as he now denies and denounces the religious intuitions and experiences of mankind because he chances personally to be incapable of them. And he would actually be able to prove that no such sense as *smell* could possibly exist in man with ten-fold more reason and plausibility than he now urges against the entitative nature of the soul, life, or mind. He could refer to the well-known fact that the nose was developed to *breathe* with,—not to *smell* with,—and could prove that no single organ can be used for two distinct functions by the "indisputable" fact that the *eye* is for *seeing* and nothing else,—the *ear* for *hearing* and nothing else! Why, he could ask, should the nose, then, be for *smelling* as well as *breathing?* He could further demonstrate that the so-called "infinitesimal particles of the odorous body" could by no possibility produce a sensation in coming in contact with the nose, since the undulatory theory of *sound* and *light* demonstrates that this is not the manner of producing exactly analogous sensations in the *ear* and *eye!* He could thus rap Prof. Tyndall over the knuckles about his "infinitesimal *particles* of the *odorous body*," and say: if the sensations of *hearing* and *seeing* are not the result of *sonorous* and *luminous* "particles" coming in contact with the *ear* and *eye*, but simply of the wave-motion of air and ether, as your great works on the undulatory theory of sound and light prove, then *away goes your nonsense about odorous "particles" producing a sensation, and with it the sense of smell?* Prof. Tyndall could only reply to this argument by giving up the wave-theory of sound and light, which there is little doubt he will be obliged to do before many more years have passed over his head.

Thus as odor, though an absolute substance, could never have been known to exist but for the sense of smell in man or beast, we might, nevertheless, have been able to demonstrate its existence by reason alone (if man alone had been thus deprived of olfactories) by watching the dog as he follows the direction of the fox with the most unfailing precision hours after it has passed a given point. Even a materialist might, with such logical data at his command, rationally demonstrate that an odorous substance must actually exist beyond the range of man's senses, alone by its observed effects upon the dog. But how obtuse his reasoning powers become when befogged by his materialistic philosophy as he reasons about the life and mind of man! He witnesses vital and mental phenomena even in his own consciousness and mental working, which, as every principle of logic and reason should convince him, could only result from an invisible vital and mental entity within the physical organism. Yet he turns a deaf ear to the voice of rationality and rather than admit such an invisible substance as life and mind, *he attributes these wonderful results to the equally invisible action of the equally unobservable molecules of his physical brain* "placed together in a most varied manner"! Why should he not reason the same way about the dog's wonderful ability to follow the direction of the fox, and insist that it is simply the result of molecular action in the dog's brain, its material atoms being "placed together in a most varied manner," thus enabling it to pursue the fox with such accuracy? And hence, he might insist, that a substantial odor, composed of absolute "particles," which neither our senses nor science can demonstrate, can have nothing to do with this astonishing performance. Yet, after all such materialistic reasoning has expended itself, it remains an incontrovertible fact that the invisible, imponderable, intangible odor external to the dog's brain was the veritable substance which gave direction to the pursuit, but no more so than the invisible, incorporeal, and intangible instinct within the dog's brain which analyzed the odor-

ous particles emanating from the fox's feet and, by a process of reasoning the most marvelous in Nature, *determined* the *fox's direction!* In the light of these startling analogies culled from nature, how beautifully consistent and satisfactory is this substantial view of the life and mental powers of all animate beings! And how pitiably insufficient and unsatisfactory is the materialistic view that consigns man's destiny to this earth alone, and makes the life and mind—even the intellectual powers of a Newton or Humboldt—nothing but the action of the ultimate molecules of the brain (which no eye has ever seen or can see) "placed together in a most varied manner."

No effect can be produced without a cause, nor can a movement occur without an adequate motive-power. Inert matter cannot move itself. These are truths as axiomatic in science as that something cannot be made out of nothing. If any material body is seen to move, we know, with the same certainty that we know of our own existence, that some force besides such body must have acted upon it to cause its motion. Should we see a heavy block of iron move up an incline, and at the same time see a rope attached to it, and a man at the end of the rope above, turning a windlass, the cause of the iron's movement is apparent, and we pass on without surprise. But should we see the block move in the same way without a rope attached, or any other visible moveing device, our curiosity would be excited to know the cause, for cause there must be, we would necessarily conclude, since this law of cause and effect is a principle so well established in the mind, that a little child as well as a savant recognizes it. If on critical and thorough examination no cause could be detected, and the block should still continue to move on as before, our curiosity would change to surprise, and finally end in astonishment, for we would feel that we were in the presence of a substantial power above Nature, or at least beyond the reach of our senses, that was purposely being exerted upon the block to produce this effect; and Prof. Haeckel would be among the first to join in search for invisible wires, secret springs connected with hidden wheels, or some other unobserved mechanical contrivances which were accomplishing this physical result; because, as he would positively assert, this block of iron cannot move itself or be thus moved without actual contact with some other substantial body producing the required force. But when he should finally be compelled to give up the search, and admit that no device of man was connected with the iron to cause its motion, he would be forced to admit that some invisible substance beyond the observation of our senses must either push or pull this block of iron up the incline, since (clinging to the physical truism) *inert matter cannot move itself.*

Startling as such a demonstration would be in favor of the existence of invisible, intangible, and incorporeal substances in Nature, it is nothing more than is before our eyes every minute we live, and in ten thousand forms just as inexplicable as this moving block. Every motion of our bodies, or breath we draw, involves just such a mystery, and one that equally defies solution by man, except by the admission of powers and substances,—active and intelligent entities,—beyond the range of our senses. The difference is, the one being unusal would be pronounced a miracle, the other being common is nothing but a natural process. Both, however, are equally inexplicable, resting as they do upon the same principle, that inert matter cannot move itself, and we know that our bodies are as inert as a block of iron, since a dead man cannot move himself. Then what moves a living man's body? This question places the two problems on precisely the same footing, and to the mind of a true philosopher they must be answered in the same way, and be regarded as equally demonstrable proof against materialism, showing that life is an entitative substance, though intangible and incorporeal.

No better illustration is needed than the movement of this inert bit of steel connected with a stick of wood with which I am forming these letters into words, words into sentences, sentences into arguments, and upon which the reader's attention is, I trust, now riveted. The pen evidently cannot move itself, neither can the pen-holder. But you say this case is plain, because you hold the pen in your fingers, and they are the moving cause of the pen's action. But what moves the fingers? You answer, the hand; the hand is moved by the arm; the arm by the body, and so on. True; but all these are

only inert matter, and neither of them can move itself any more than can the pen; and since only the actual contact of one substantial body can displace another body when at rest, there must be within my body a substantial, intelligent entity superior to corporeal matter, which not only plans the words and sentences I am now writing, but which by actual contact moves upon the nerves, muscles, ligaments, joints and bones, of my arm, even to the tips of my fingers, and which, finally, culminates in these orderly motions of the pen, leaving marks upon the paper which the reader translates into thoughts. This long list of connected parts through which the action can be traced from the pen backward to the moving, substantial cause or motive-force, is no reason for ignoring such cause entirely, by concluding that the last joint of a mile of shafting before reaching the engine necessarily moves itself, as does Prof. Haeckel, by positively attributing the motions of my pen, finally, to the motions of the material atoms of my body, the result of which he calls *life*. He does not even try to tell us how these material atoms get their motion, so as to cause life and thus move the nerves, muscles, ligaments, joints, bones, arm, hand, fingers, and finally the pen. He simply assures us that life is the *effect* of these *motions* of the material atoms. Then, in the name of science, I ask, what is the *cause* of these motions whose *effect* is life? Is this *cause* of life the *effect* of itself, or is the *effect* of life the *cause* of itself? Does the *motion* of the molecules precede life, and thus act as its *cause?* If so, what started the motion? Or did it start itself? Or if life precedes the motion of the molecules in order to start them, then Haeckel's definition of life breaks down, as life cannot be the *effect* of molecular motion and at the same time *precede* it and be its cause. If, to avoid this, it should be claimed that both life and molecular motion start at the same time, then I ask, what started them both together? I protest against this whole incoherent jumble of self-contradictory thought which in courtesy we dignify by the name of advanced German philosophy.

Reverting to our illustration of the pen, should a company of ladies and gentlemen, sitting around a table, but some distance from it, see a common steel pen raise itself, dip into the inkstand and then write out an intelligent communication, without any visible hand touching it, this would involve another problem similar to that of the iron block, and one well calculated to astonish the lookers-on. But suppose, upon closer examination, they should discover that some ingenious inventor had arranged a transparent artificial hand capable of taking hold of the pen, and doing the work of a ready writer by means of chords, levers, pulleys, etc., passing from the fingers through a transparent arm into the body of a wooden *automaton*, sitting upon one end of the table, by which this writing was accomplished; would this complex connection of parts make it any less a mystery, if the true cause were still hidden, and if no intelligent being could be discovered secreted within the automaton to produce the necessary manipulation of its mechanical parts? Surely not. But it might all be done by a spring, you say, concealed within this inert wooden man. If so, some one must be there to wind up the spring when it runs down, and some one must have been there originally to construct the spring and form and adjust its connecting devices for the accomplishment of such complex and intelligent work. And thus, when we reach the very inside of the human body and examine its last link in the chain of connecting tendons, muscles, nerves, fibres, even down to the blood-corpuscles and bioplasts, we shall find them all nothing but a connected chain of inert matter, which can no more move themselves than can the fingers, chords, levers, and pulleys of the wooden automaton. Man's body is but a delicate and complex machine, with its parts "*placed* together in a most varied manner," as Prof. Haeckel truly says. But this learned scientist never thinks to tell us who "placed" them thus "together," and gave them the power to move themselves in such manner as to perform intelligent labor! He satisfies the demands of his own intellect no doubt, and the intellects of materialists generally, by practically teaching that the different parts of this wonderful living, thinking machine not only "placed" themselves together in this "most varied manner," but that they afterward voluntarily *move* themselves and at the same time *give intelligent directions* as to their own movements without the aid or contact of any substantial agency save

that of the inert matter of the machine itself! If the scientific ambition and philosophical thirst for knowledge of modern materialists are really satisfied with this wretched solution of the problem of human life, we certainly ought not to complain. But they can rest assured that they are destined to be outstripped and beaten by the intellectual grasp of the rising generation as signally as have been the lumbering freight-wagons of our ancestors by the lightning-express trains of the present day.

But we have not yet seen the culmination of this logical method of tracing links in the chain of connected parts from a sensible effect back to its hidden cause. For example: we hear the music of a piano by our side. On turning to observe the cause of this music, we see a player sitting by the keyboard, and observe his fingers rapidly manipulating the keys in response to which we see the hammers striking the strings in rapid succession. Of course the cause of this musical effect is solved, so far as concerns our immediate inquiry. But suppose, instead of this, we stand by the same piano and hear the same delightful strains of music, but on turning to look for the cause of such exquisite harmony of sounds, we behold nothing but the naked piano! No musician is visible! And to our further surprise the keys move in correspondence to the ringing notes, and the hammers rise and fall, hitting the strings in response to these movements of the keys. Now what conclusion would we come to? We certainly would not decide that this piano, constituted entirely of inert matter—wood, iron, steel, ivory, etc.—played itself; and that the music was nothing but a "connected chain of very complicated material phenomena of motion . . . . of atoms placed together in a most varied manner," as Prof. Haeckel describes *life* to be, and hence that no musician was really necessary. The fact that no musician was visible would surely not be sufficient evidence to satisfy us (unless we happened to be materialists) that a player did not exist. Though we necessarily and logically recognize the great mystery in the case of such music without a musician, yet we certainly would not, like mere children of the Haeckel and Huxley type, jump to the conclusion, that this audible and visible effect could by any possibility take place without an intelligent and personal cause, even though that cause were wholly hidden, defying every effort of our physical senses or scientific tests to find it out. We know there must be a substantial, intelligent musician somewhere if there is music, as surely as we know there must be a substantial, vital, and mental being within the corporeal man as the moving and directing player upon the inert physical organs of our body. The mystery which such a conclusion involves is no bar to the fact that every effect must have a cause. The invisibility of the player can have no weight upon an intelligent mind as against his existence, so long as the music is heard and the keys are seen to move, and which we know can only be the work of a personal, intelligent musician.

We seek to unravel this mystery, and on searching carefully beneath the instrument we discover, passing up one of the legs of the piano, what appears to be a small rope, within which, upon closer inspection, we find a large number of small insulated copper wires. What can this chord of wires have to do with the hidden cause of the grand concerto issuing from this piano without a visible musician? We search further. On raising the keyboard we observe that the under-surface of each key is lined with a thin plate of soft iron, and beneath each key, carefully imbedded in the wood, we discover an electro-magnet, its wires being connected with suitable copper threads in the insulated chord. The mystery begins to unravel; but where is the player? Our faith is still unshaken that there can not be music without a musician, any more than there can be a moving, thinking, voluntary man or animal without life and mind. Those musical strains are the work of mind, the result of intelligent skill, the embodiment of artistic culture. The musician must be somewhere, possibly in an adjoining room. In one corner of this piano, on lifting its lid, we discover a *telephone*, and observing that its copper threads pass down the same insulated chord that conveys the wires to the magnets, we take the hint and venture the usual call: "Halloo, there!" And behold! the answer is returned from Philadelphia! There sits the musician in his private study, a hundred miles from New York, playing upon his grand piano, each key of which is connected with a corresponding key of the piano in New York by one of

the wires in the insulated chord. The story is now told and the mystery is solved. Sure enough, the piano was not without a player, nor the music without a musician! Each depression of a key by the musician's finger closes the electric current for its counterpart and congener in the other instrument, and though a hundred miles away, the response is almost instantaneous. But, what is more wonderful still, the artist, with a receiving telephone at his ear, becomes a combined dual musician and listener;—every note is not only reproduced upon the distant piano, but is actually returned to himself in Philadelphia and repeated in synchronous harmony with his own instrument, and with compe and delight.

Let us now try to gain a little instruction by taking advantage of the facts brought to light in this illustration. The assumption of materialism, that the life or soul in man is but as the music to the piano, and that when the body dies the life ceases to exist, as does the music when the piano is destroyed, is thus demonstrated to be incorrect; and instead thereof, we prove that the soul or life of man is as the *musician* to the *instrument*, while the music itself, issuing from the sonorous qualities of the piano and the skill of the performer's fingers, represents the outflowing thoughts, affections and noble works of the soul, manifested through the living corporeal organism. And as the musician in the illustration could not play upon the keys of the piano a hundred miles away, without some actual and substantial connection between his fingers and the instrument, even though that substance had to be, as it was, the invisible, intangible and incorporeal current of electricity and substantial rays of magnetic force, in like manner the performer within every organic being can only manipulate the inert organs of the corporeal body by substantial contact through that entitative substance, the life, soul, or mind, which I designate the *vital and mental organism*, and which has been shown in many ways in this chapter to be so wonderfully analogous to electricity and magnetism.

Our organism is thus a musical instrument of a thousand strings. The intelligent and artistic soul sitting at the keyboard in the brain is the invisible musician who plays upon the chords of our physical structure, sending vital dispatches and intellectual mandates to the extremities of our body, causing us to raise a hand, move a foot, or bend a finger. The vital nerve-threads which convey this life-fluid are the conducting wires which permeate our physical system, and ramify it in all directions, along whose beaten paths the errand-boys of the will run with messages of love or hate, hope or fear, joy or sorrow, pleasure or pain, causing corresponding actions in the different organic parts of the body, or peculiar expressions in the countenance.

To say, as do materialists, that this life-current and soul-essence are nothing but a very complicated motion of the material atoms of the corporeal body, is to assert that the electric current which courses along the wire is nothing but the molecular tremor of the conductor itself, and that the magnetic rays which seize and manipulate the piano keys are nothing but the molecular motion of the substance of the magnet; both of which have been fully shown in this chapter to be incorrect, as the reader no doubt has already become convinced. How satisfying, then, is the view here taken, that life and mind are substantial entities as veritable as are electricity and magnetism. How rational and scientific the thought, that this real life-substance permeates every part of the physical body, giving motion not only to the molecules, but to the organs themselves! How consistent and ennobling the conception that the soul thus animates and enables its servants, the bioplasts, to carry nutriment to every fiber of the system, while it forms the architectural or anatomical guide and outline of the physical frame-work, as an *incorporeal organism*, by which these bioplasmic artisans are enabled to do their work in the formation of new tissues, nerves, veins, arteries, even to the construction of the complete body of the embryo, or to the reproduction of lost parts under suitable conditions, to the repair of old and injured tissue, the healing of wounds, etc.

While this view so satisfactorily accounts for all these vital phenomena (as will be more fully seen in a subsequent chapter), we observe with regret that some of our ablest opposers of materialism have wholly missed this central truth in psychological physiology, in their attempts to solve the problem of human life—namely, this vital and mental organism within the

physical structure, filling every part of it and constituting its exact but invisible and incorporeal counterpart. They speak of the substantial soul vaguely, as a "non-atomic" animating "principle," just as if any real substance could exist without *atoms*. They dwell ably upon Dr. Beale's bioplasts, those living specks of protoplasm seen under the microscope in every cell or fibre of organic tissue, and occasionally, as if of secondary importance, speak about the force behind these bioplasts, which causes them to act, under th indefinite name of an "etherial enswathement," term borrowed from the transcendental, anti-materialistic German philosophy of Lotze and Ulrici who are opposing Haeckelism. They correctly note the fact that such bioplasts are always busy at work in building up new tissue or repairing old, and that they can be seen under a powerful glass, moving hither and thither as things of life, picking up and distributing atoms of nutrition to strengthen muscle, tendon, vein, nerve, etc., and then these great authorities apparently conclude that they have struck the keynote to the solution, and have reached the lowest or basic stratum of life-substance in the human organism, thus framing an impregnable breast-work and barrier, as they suppose, to the onslaughts of materialism. How vain is this hope! Not a bioplast leaves the body at death. These atoms of so-called life-substance are but a part of the physical structure, and cease to move at dissolution, the same as do the larger organs of the body, and consequently have nothing more to do with the true solution of our problem than have the veins and arteries, with their myriad blood-corpuscles, which also cease to act at death. Bioplasts, with all the useful knowledge they have furnished us, as to the formation of organic tissue, do not touch the question of life itself,—what it is, how it exists, or what becomes of it,—and no more meet the objections urged by the materialist than would the anylysis of the outer cuticle of our flesh. Hence every argument employed in illustrating the work of the bioplasts, as a refutation of materialism, is so much labor lost. The whole trouble lies in seeking to solve the problem of life by the *microscope* instead of the *magnet*. Not one step toward the true solution can be made without first drawing a distinct line of demarkation between the *corporeal* and *incorporeal* substances of Nature,—the one *tangible*, the other *intangible* to sense, the latter only recognizable by our reason in analyzing their demonstrable effects upon known and visible corporeal bodies, as so clearly illustrated by the action of the substantial but incorporeal rays of the *magnet*.

Then what is it that moves the *bioplasts*, these smallest active atoms of a living organism, causing them to work like so many infinitesimal ants? I answer it is *life*. What forms the invisible pattern (for *pattern* there must be) around which and through which the bioplasts are guided in their work of constructing nerves, muscles, bones, ligaments, etc., and by which they are thus prevented from making mistakes, substituting a nerve for an artery, a ligament for a muscle, etc.? I answer again, it is *life*, which, could we see it after the body dies, would stand out a transparent *manikin*—with every outline of the the human body intact—a perfect representation of our organic form in all its parts, as would a manikin of the arteries, veins and nerves, could they alone be lifted from the body without disturbing their relative positions. Without the aid of this substantial but invisible organism, the working bioplasts of Dr. Beale can no more touch the problem of life, than can Prof. Haeckel's material atoms "placed together in a most varied manner." Without this view, every effort of modern science and philosophy will fail to satisfy the longing, craving wants of honest but doubting souls, as to a rational solution of what life is, and how it is related to an organic structure, so as to be viewed scientifically, philosophically, and religiously, as a substantial basis for immortality and personal identity in another life. I have tried in this chapter to furnish such a solution of man's dual organism, with such analogical proofs drawn from Nature and illustrations so framed upon the principles of science, philosophy and art, as may give a reasonable ground of hope to the candid inquirer that death does not end all, but that though we die yet shall we live;—that though the "outer *man*" perish, the "inner *man*" shall surely survive; and that though our *earthly house* of this tabernacle shall be dissolved, we may still hope for a building of God, an house not made with hands, eternal in the heavens.

CHAPTER III.

CORRESPONDENCE—CHARGES OF MATERIALISM AND PANTHEISM ANSWERED.

[Synopsis of Contents.]

What led to writing this Book.—The Key to the solution of Darwinism.—The vital and mental organism or duality of structure the pivotal feature of the work.—The Author forced to account for the origin of life and of material bodies.—Dangers of Materialism and Pantheism feared by friends of the book.—Numerous Correspondents and their Inquiries.—Letter from Dr. Barr, of Philadelphia.—Notice of the Book in *The Evangelical Repository* that led to the Correspondence.—Dr. Barr's arguments in favor of the Westminster Confession of Faith.—Scripture proofs to support the view that God made all things out of nothing.—Reply to Dr. Barr.—The Scripture proofs examined.—Many reasons given for rejecting the Doctrine of the Confession of Faith.—Reënforced by quoting from a *Presbyterian Quarterly Review*.—Letter from Rev. Mr. Sheldrake against the Author's view of an Incorporeal Organism.—Many difficulties suggested.—Charges the Author with a tendency toward Materialism and Pantheism.—Reply to this Letter and the difficulties explained.—Charges of Materialism and Pantheism answered.—Second Letter of Mr. Sheldrake.—Many additional difficulties suggested against the Incorporeal Organism.—Many reasons why the tendency of the Book is toward Pantheism.—Reply to the Second Letter.—The difficulties taken up by piece-meal and answered.—The folly of the Pantheistic charges shown.—The absurdity involved, if the Soul is not an Organism, pointed out.—Variously Illustrated.

In the metrical form in which a part of this work appeared in the early editions some obscurity necessarily existed in the manner of stating the religio-philosophical views of the writer, as his aim, in many instances, was to *hint* rather than elaborate ideas. Some expressions may thus have lent coloring to the fears of many warm friends of the book, as a whole, who thought they saw faint tendencies toward a disguised form of pantheistic materialism. A part of the ground of this fear, may also have arisen from a misconception of his frank acceptance of certain broad, axiomatic, and necessary truths of science and philosophy which had hitherto carried along with them, and wrapped up in their secret folds, distinct pantheistic and materialistic notions, but which only needed the proper philosophical thrashing and winnowing to separate the grains of golden truth from the chaff of error. This I have tried, partly, to do in the preceding chapter, but will here try more fully to elucidate.

As an investigator of science and philosophy in the interests of religion, and in opposition to materialism in all its phases, it became necessary to meet and explain certain self-evident or well-authenticated facts and phenomena in Nature, as well as to harmonize with religion certain axiomatic truths of philosophy, claimed by materialistic evolutionists as utterly opposed to, and irreconcilable with, the teleological teachings of the Bible. It became clear to me that glossing over these facts of science and truths of philosophy, or entirely ignoring their force, as had been so often done in works claiming to refute the views of Darwin, Huxley, Haeckel and Tyndall, would no longer answer the purposes of religion or meet the rigid demands of this age of close and critical thought. Hence, I resolved, as far as lay in my power, to enter the very innermost temple of philosophical materialism, and grapple with the main objections there met with, even at the risk of exposing my own hypotheses to unfavorable criticism, waiting for the future to justify my course.

Among the problems thus encountered were the origin and nature of life and mental power in man and the lower animals, the origin of matter and material forms, the nature of God, the philosophy

of man's possible existence after death and the nature of such existence, the true difference between man and beast and how that difference first originated, and finally a philosophical view of the line of demarkation between the spirit of man that goeth upward and the spirit of a beast that goeth downward to the earth. All these problems with their various elaborations, and many more of analogous character, I have tried frankly to discuss, not as a theologian or adherent of any creed, but purely from a scientific and philosophical point of view. The novel and partly-elaborated solutions and hypotheses which followed have called forth numerous friendly letters of inquiry from different parts of the country, to which I have frequently replied during the past two years, and which, in a few instances, have led to quite spirited and extended correspondence, a sample or two of which will be copied into this chapter, that the reader may have not alone my own *ex parte* arguments, but those also of able critics, which will be reproduced in their own words, with my replies.

Upon the charge of pantheistic materialism made by some of these writers, I have a few words to say, though it would seem entirely superfluous to any one who had paid the slightest attention to the arguments, as a whole, of the former editions. If to teach that we are possessed of an incorporeal yet substantial soul within the the human form, and which can never die, as contradistinguished from the physical organism, be an inculcation of materialism, then am I a materialist. To call Prof. Haeckel a Christian theist would be no more absurd and false. Every argument of this book is directly the opposite of materialism, and those who make the charge are either reckless or ignorant of the use of words as generally employed in the discussion of these subjects. Because I have been disposed to view the soul as a real entity, and have not been satisfied to look upon our future existence as a vague, shadowy mist, or anything less real and practical than the present life, I am regarded as teaching doctrines materialistic in their tendency!

When I first undertook the examination and review of evolution as taught in the writings of Darwin, Huxley, and Haeckel, it became evident at a glance that the key to its overthrow lay in a single fundamental biological and psychological fact or law of Nature which had been totally overlooked by writers against the theory as well as for it, and that this oversight was the true cause of the general failure to break through and satisfactorily explain the leading classes of arguments and facts relied upon in support of evolution. This fundamental law of Nature, susceptible of the clearest scientific demonstration, as shown in the eighth, ninth and tenth chapters, is that every animate being, including man, is a dual organism or double entity, the outer or physical structure being the visible and tangible half, while the incorporeal, though invisible and intagible, constitutes the other half, the one being the exact counterpart of the other. I saw that the moment this law of duality—this universal fact of biology—was recognized, every difficulty encountered by Mr. Darwin in regard to the inheritance of mental and physical peculiarities and the development of diverse specific forms from ovules exactly alike (some of which problems were so overwhelming to this scientist that he implored any explanation however imperfect, agreeing in advance to be satisfied with it) could be instantly and beautifully solved and harmonized with all other observed phenomena. And because I was forced to emphasize and dwell upon this pivotal law of organic life by showing that the vital and mental organism, though invisible and intangible, was as really *substance*, constituted of vital and mental corpuscles, as was the physical body itself, some of my critics hastily concluded that I had reduced the soul to a material basis and given it the characteristics of a physical structure.

Further, in attempting the solution of the origin of the material universe as the creative work of the Almighty, I was forced to admit the truth of the scientific axiom that "from nothing nothing comes" since it was impossible successfully to attack materialism unless the self-evident principles of science it contained were first frankly admitted and logically accounted for upon the general basis of religious philosophy and the existence of a personal God. I was obliged, therefore, to agree with science that the physical universe was not, and could not have been, created out of nothing; and as the eternity of matter, in its gross sense and form, could not rationally be admitted by Christian theists, I was unavoidably driven to the view

taken in the preceding chapter, and fully sustained by the Rev. Joseph Cook as there quoted, that material forms are an efflu-ence of God himself, or immediately the result of a succession of gradual condensations from the more attenuated conditions of physical substance—these from the still rarer elements and forces of substantial Nature, and these, finally, including the vital and mental powers of the organic world, from the omnipresent substantial entity of the Deity himself. One of these three positions seemed to be unavoidable: either that God created all things out of His own substantial nature as here assumed, or that matter is eternal, thus making two self-existent and co-eternal substances, or else the impossible conception of the creation of all things out of nothing. I chose the first as the only rational view, consistent alike with science and with all religious conceptions of God's character and attributes as an omnipresent and personal Deity. This has been objected to as "ill-disguised pantheism," but a more unjustifiable inference could scarcely be framed into words; and when this charge was made against Joseph Cook for taking the same view of the origin of matter, he curtly replied that as well might we call Wendell Phillips a pro-slavery demagogue! And I may add: as well might we call the doctrine of the existence of a personal God independent of, and superior to, Nature, as argued all through this book, pure *atheism!*

Pantheism, as clearly defined and understood, teaches that Nature itself, constituted of its laws and forces, its organic and inorganic forms, is God, and all the God there is in the universe, and no more recognizes a personal, intelligent Deity, independent of, and superior to, Nature, than does the designless system of atheistic evolution as taught by Prof. Haeckel. Then what an absurdity to charge my arguments in favor of an intelligent personal God as being but ill-disguised pantheism! As an illustration of this mistaken charge, and to give the reader the benefit of a correspondence involving both sides of the question, I will quote the entire article which led to it, from "The Evangelical Repository," edited by Rev. Dr. W. W. Barr, Philadelphia, Pa., after which we will give the conclusion of the correspondence. The article, as will be observed, is fairly commendatory of the book, with this single exception of charging the author with pantheism and materialism:

Messrs. Hall & Co., Publishers, No. 234 Broadway, N. Y., send us "The Problem of Human Life," embracing the "Evolution of Sound" and "Evolution Evolved," with a Review of the Six Great Modern Scientists—Darwin, Huxley, Tyndall, Haeckel, Helmholtz and Mayer.—By Wilford. The part of the work entitled "Evolution Evolved," we noticed last month, and expressed a favorable opinion of it. Its treatment of the doctrines of the Evolutionists was apparently so original and incontrovertible that we were interested in seeing the entire work of the author. The handsome volume now before us contains this. It is in three distinct parts—"The Problem of Human Life," "The Evolution of Sound," and "Evolution Evolved." These are distinct monograms, and are published separately. Yet they bear a relation to each other. The teachings in the first pave the way for the second and third. A part of each of the treatises is printed in rhythmical prose, evidently a conceit of the author, which he ought to have gotten rid of before publishing. It is his opinion that he has thus expressed certain arguments more forcibly than he could have done in plain prose. Few, we think, will agree with him in this opinion. His meaning, however, whether he employs rhythm or prose, is generally, if not always quite clear. His style is unusually vigorous, his arguments at times overwhelming, and his power of sarcasm seemingly unlimited.

In his doctrine relating to human life, the author assumes that life in man and all living creatures is a substantial entity—a part of an interior and invisible organism consisting of real substance, of which the outward and corporeal structure is but the tangible counterpart. Connected with this, he assumes that all forces in nature, such as gravitation, magnetism, electricity, heat and even sound, are substantial corpuscles emanating from their respective sources. This assumption leads him to take the position, that there is really no difference, except in degree of density, between what we call matter and spirit. Everything in existence is substance, from platinum, the densest of all, up through the metals—wood, water, gases, odor—and the incorporeal—heat, light, electricity, magnetism, sound, gravitation, life, instinct, spirit, and last of all, the Supreme Spirit, God himself. Of course, with this assumption the necessary conclusion is, that matter is eternal, and that creation is nothing but the concentration, in its various parts of the substance of the Creator himself. We cannot but regard this, notwithstanding the author's disclaimer or apology, as being simply sublimated materialism and ill-disguised pantheism.

With this pivotal proposition in relation to substance, the author proceeds, in two lengthy chapters, to attack and refute the wave-theory of sound, and to establish the corpuscular theory. He is guided in this, of course, by his fundamental position assumed in regard to substance. Light he regards as composed of incorporeal emanations from the body which is its source,

and the same is true of sound. We confess that we do not feel competent to decide as to the correctness of the author's positions in this part of his argument. He is revolutionary in science, and, if he be correct, much that has passed in the scientific world as true must be utterly discarded. This much may be safely said: The author has here troubled the scientists; and to command and retain confidence, they must fairly refute his arguments, and show that his positions cannot be maintained.

The author's special object in demolishing, as he confidently believes he has done, the wave theory of sound, is to throw, by this means, discredit upon the conclusions of the scientists, and especially upon Mr. Darwin [Tyndall], the most prominent exponent in our day of the wave-theory of light and sound. If it can be shown that he has made almost incredible blunders in these matters, then his arguments and conclusions relating to evolution may well be suspected. This leads the author to what may be called the third part of his work, "Evolution Evolved." This we have already noticed, and need not now further refer to it.

On the whole, this volume must produce something of a sensation in the scientific world. A long and elaborate review of it appears in the *Scientific Reporter* for October. The reviewer is disposed to regard the main positions taken by the author as demonstrated. This judgment may be partial, but the scientists must show that it is not well-founded. For our own part, with the exception above noted, we have gone over these chapters with great interest. The volume is very handsomely printed and bound.

On receiving a copy of the above notice, I wrote a friendly note to Dr. Barr explaining briefly the difference between my views and those of the pantheist and materialist, and requested a reply. He politely declined entering into a correspondence with a *nom de plume*, upon which hint the publishers, at my suggestion and under my prompting, commenced a correspondence with the Doctor, the last two letters of which I will now copy, and which will speak for themselves:

PHILADELPHIA, PA., Dec. 25, 1878.

MESSRS. HALL & CO.

Gentlemen: A few words in reply to yours of the 23d inst. seem to be necessary. In reference to the Westminster Confession of Faith, I may say that there is certainly a way to amend it, or revise it at any time, but so far as I know in relation to the matter referred to in my former letter, namely, the teaching of the Confession on the subject of creation, there is no demand for a change or amendment. It is believed by Presbyterians, I think almost without exception, that God did in the beginning make all things out of nothing. Dr. Charles Hodge may be fairly taken as expressing the views of Presbyterians generally in relation to this matter. In his great work on Theology he strenuously maintains the doctrine of the Confession, and what is of far more importance proves, as I think clearly, that the doctrine of the Confession is the doctrine of the Bible. Believing, therefore, that the Bible teaches that God did make all things out of nothing, Presbyterians are not likely to "amend" their confession of faith in this particular.

You ask me to give you an explicit declaration of scripture that God made all things out of nothing. I think I did this in my former letter. To present the proof fully would require more time and space than I can command. I must limit myself to an outline. The first verse in Genesis declares that God did in the beginning *create* the heavens and the earth. Now it is true that the word rendered *create* does not always, nor does it in itself mean, absolutely, to make something out of nothing, but it is the very best word afforded by any human language anterior to revelation to express the idea of absolute making. Remember, too, that it was in the beginning, in the absolute beginning, that God created the heavens and the earth. Afterward there was chaos, and if the object of the inspired writer had been to declare that God did make all things out of nothing, he could not have employed language that would have better expressed that idea. Then Christ speaks of the glory which he "had with the Father before the world *was*"—existed. "Before thou hadst formed the earth and the world, from everlasting to everlasting thou art God." How could this be said if the matter of the world was everlasting? Besides the scriptures attribute the *existence* of things purely to the "*will*," "*word*," "*breath*" of God, and never *even indirectly* imply the presence of any other element or condition of their being such as *pre-existing matter*. "By faith we understand that the worlds were framed by the word of God, so that *things which are seen were not made of things which do appear*."—See Heb. xi. 3., Psalm 33. 6; 148. 5. Your mistake and that of "Wilford" in relation to this matter arises out of your confusion of mind in relation to substance, or substantive being. You seem to teach that if we admit the substantive being of God,

that then all difficulty is removed in relation to his imparting his substance to the things which we see, and which are properly called material. In other words you identify substance with material. You certainly ought to know that the term substance is applied to existences whether they are spiritual or material. But there may be a wide difference between what is substance and what is material. Christ's person is divine, but that divine person exists in two natures, the nature of God which is substance and *spiritual*, and the nature of man which is also substance, but is *material*. To say that the substance is in both cases identical, the one only more refined or sublimated than the other, is to ignore the essential difference between spirit and matter. This is exactly what "Wilford" does, as we understand him in his book, and this is exactly wherein lies his materialism, or else his pantheism. Christ has a human nature as truly as you have. If that human nature is of the same substance with God himself, you are essentially the same in substance with God, you are a part of God, and so may be worshiped.

Your saying that God breathed life into man is true, but did he by so doing breathe a part of his own substance into man? He made man in his image and likeness, but this does not say that he made him of his substance.

You say that a drop from the ocean is not the ocean. True, but it is of the same substance as the ocean. Is the material universe the same in substance as God?

You say that air has been condensed into water. So it has, but is not that a change in *form*, not in *substance?* As I understand "Wilford's" teaching, the universe is simply a change of the substance of God himself in form, not any change in essence. How that can be different from pantheism I cannot possibly conceive.

I would be as anxious as you or "Wilford" to meet the objections of the scientists. But to do this by running into greater error, and by going in the face of the belief and teachings of orthodox Christendom is certainly not gain, but unspeakable loss.

I must insist upon it that the scientists who would "scout the idea that God made all things out of nothing," are only the scientists that scout the Bible, the atonement made by Christ and every distinctive doctrine of our holy religion. "Wilford" need not be anxious to conciliate these men. They will, as soon as it suits them, scout him, professing to teach Christianity and at the same time teaching pantheism. Glad would they be if the Christian Church would adopt "Wilford's" views. Their victory would be about complete.

But I must stop this. It is gratifying to know that you are going to inquire into this matter. I am certain that if you go to the prominent theologians in this country, and take their advice, your second edition will be revised.

Yours very truly,
W. W. Barr.

New York, Dec. 30th.

Dear Dr. Barr:—

We are glad to receive your carefully written letter of the 25th inst., and we feel sure that this friendly correspondence can not do either you or us anything but good. We are pleased also that you have taken the time and trouble to point out definitely your reasons for believing in the general principle involved in that article of the Westminster Confession of Faith, namely, the *Creation of all things out of nothing.* Will you pardon us if we still are not fully satisfied, and suggest a few reasons for our doubts? We intend, however, that these letters shall not prejudice a careful investigation of the entire question in the future.

First, as to *matter* and *substance.* You say there may be a wide difference between what is substance and what is material. Certainly this is true; but not necessarily involving a contradiction of the idea taught by Wilford, that gross matter and substance of the most attenuated nature, imperceptibly blend into each other, so that we cannot tell where one ends and the other begins,—from platinum, up through iron, water, air, hydrogen gas, odor, electricity, light, heat, sound, life, mind, spirit, to the fountain of all life and mind, God himself, the embodiment of all substance, and from whom, and of whom, all forms in nature, whether visible or invisible, exist. There is as much difference, surely, between platinum and odor, both corporeal substances, as between odor and magnetic currents, or between electricity and life substance, or between life and spirit.

There is a regular gradation of substance, from the lowest gross material, up to the most refined spiritual essence of God himself, or the highest qualities of the Divine nature. Webster defines substance and matter, that of which anything is made, though matter generally relates to the corporeal substances of physical forms. God's nature can easily be conceived of, as composed of more than one grade of substance, from the highest spirit essence to the elemental essence of which all material forms are constituted, just as man possesses a body and a soul, and just as the Saviour possessed a Divine and human nature.

You say if the forms of nature were created out of a portion of God's substantial being we would be worshiping God in worshiping a stone. Not at all, any more than in admiring or revering a great man we would necessarily be admiring and revering the substance of which his feet and hands were constituted! Even our mental organism has grades of substance from the highest spiritual qualities to the lowest animal passions and instincts. So may the Omnipresent God possess, for ought we know, a dual organism or nature, the higher elements of His being, or His wisdom and goodness, being that which is worshiped. You catch our idea, though we cannot clearly express it in appropriate words.

Secondly, the creation of the heavens and earth described in the first of Genesis, you think, is expressed in the strongest language in reach of the inspired writer to convey the idea of making the world out of nothing. This implies that the framers of the Westminster Confession had more power than Moses in selecting words, Now the word *nothing* and the phrase *not anything* occur all through the Bible, and surely could have been selected, or the original from which they are translated, had the inspired writers wished to convey such an idea as that in the Westminster Confession. In the first chapter of John it was easy: "All things were made by him, and without him was *not anything* made that was made." It would have been just as easy for Moses to have said:—"In the beginning God created" of *not anything* or *nothing*, "the heavens and the earth." No: instead of this the same words and forms of language are used in speaking of the *creation* of the heavens and the earth, as are subsequently used in speaking of the creation of Adam and Eve, while we know that they were not made out of nothing, but the former out of *dust*, and the latter out of a *rib*. This, then, defines the meaning of the word *creation*, or *create*, or *make*, as applied to the work of God, and proves that it means the employment of pre-existing substance.

You quote Heb. 11, 3: "By faith we understand that the worlds were framed by the word of God, so that things which are seen were not made out of things which do appear." To our mind this clearly implies that they were made of *things which do not appear*. If I say this chair was not made of oak, I imply that it was made of some other kind of wood. I surely do not wish to convey the idea that it was made out of *nothing*. The apostles frequently speak of *things visible* and *things invisible*. The worlds, then, were framed of things invisible, or things which do not appear. "He knows our frame that it is *dust*." The very word "*framed*," in Hebrews, proves that the worlds were made of pre-existing substance of some kind. No man *frames* a house or anything else out of nothing. The fact that Christ was with the Father before the world was, no more proves that the world was made out of nothing, than His being with the Father before man was, proves that man was made out of nothing. We hope this is clear. "Before thou hadst *formed* the earth and the world, from everlasting to everlasting, thou art God." You ask how could this be said if the matter of the world was everlasting. We have not supposed that matter, in its gross form, existed from eternity, but the elements of which gross matter was created, could have existed co-eternal with God, and as already explained, as the exterior nature of God Himself. To deny God a dual being, as Christ really possessed, would seem to limit Him.

We take it that God's *breath*, as when He *breathed* into Adam the breath of life, is figurative, and simply signifies His *word* of which Adam's life was constituted, when he became a living soul. Hence, this figurative *breath*, or the *word*, by which, and of which, all things were made, was really a part of God Himself.

You made no reply to the strong point of our two previous letters which is here again made pertinent: "The *word* was *made flesh*." It is distinctly stated that the

word, as here used, and in this exact connection, "*was God*," and yet it was "*made flesh*." This seems positive proof that a part of God's substance or word became the flesh of Christ's body, which you state in your present letter to be as physical and material as any man's body. Unless this text is met, "and we see no way to meet it," it follows that God could just as well condense a part of his word or substance into a world as into a human body, and hence, Wilford is clearly correct in assuming that God may have created the universe out of the exterior substance of His own being.*

Wilford, it is evident, could not see how it was possible to meet atheistical scientists and show the reasonableness of creation only on the basis here explained. It is true, as you say, that the scientists who scout the idea of God's creating all things out of nothing, are only the scientists who scout the Bible. But they scout the Bible because they have been always taught just such things, as a part of the Scriptures, which conflict with their reason, and supposing these things to be according to the true interpretation of the Bible, they are thereby led to scout the Bible itself, as absurd and unworthy of belief. These scientists are no worse than they were in Paul's day, when they laughed at the idea of the resurrection. Paul did not abandon them, but, appealing to their reason, tried to save them from their error, by asking, "why should it be taught *a thing incredible* with you that God should raise the dead?" So Wilford reasons with mocking scientists by trying to convince them that the creation of the universe by an intelligent and all-wise God, was not "a thing incredible," but one every way in accordance with reason.

Science claims to have demonstrated that no substance can be annihilated, or, in other words, changed from *something* into *nothing*. We presume you admit this. It is not the annihilation of wood, or one particle of it, to burn it up, but simply the change of its substance into other forms. Hence, these scientific investigators logically argue, that as *something* cannot be changed into *nothing*, so *nothing* could not have been converted into *something* in the work of creation. Wilford, accepting these axioms, proceeded to answer the scientists and meet their atheism, which he never could have done, as we remarked in the previous letter, had he been confined to the Westminster Confession of Faith.

These reflections are offered, not in the spirit of controversy, but for the sake of truth, and we sincerely hope that good may come of this correspondence.

Yours Fraternally,

HALL & Co.

It appears that Dr. Barr did not object to the substantial view of life, mind, soul and spirit maintained throughout this work, and took no exceptions to the hypothesis of an internal vital and mental organism within every animate being as constituting the exact form and outline of the physical structure, and as the true entity by which its specific corporeal form is originally developed from the ovule and maintained intact through all the organic changes and mutations of life. He even quotes approvingly this view of life and mind, notwithstanding the hypothesis had

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*As an evidence that these views are not a dangerous form of pantheistical heresy tending toward materialism, we find the same sentiments precisely, published approvingly in the July number (1879) of the *Reformed Presbyterian Quarterly Review*, Philadelphia, Pa., formerly *Mercersburg Review*, from the pen of "A Presbyter of the Diocese of Ohio," whom we have ascertained to be the Rev. A. R. Kieffer, of Warren, Ohio, in a masterly paper on "The Kingdom of God," a single paragraph of which we here copy:—

"Our earth was not made out of nothing. The Bible no where says so. * * * Let a spiritual standpoint be occupied in studying the Bible, and it will not appear antagonistic to human reason or science. Thus it teaches that the world was not made out of *nothing*, any more than it was made out of pre-existing *material* things. St. Paul declares that "the things that are *seen* were not made of things which *do appear;*" that is to say, they were made out of *invisible* things, the *real* though *invisible substances* of the spirit-world, which *proceeded from God as the first cause*, by numberless spiritual intermediates, which were, in their turn, the instrumental causes of *material creations as their effects*. Each *visible, material form must be the effect* of its invisible spiritual cause. The spirit world, with its mineral, vegetable, and animal kingdoms, is *materialized*—is embodied in the mineral, vegetable, and animal kingdoms of the *material world*. And as there is an unbroken development downward on the spiritual side, so there appears on the visible side an unbroken development upward. Thus do we see the spiritual and material universe to be one; and the only way to understand the material is to look first and chiefly at the spiritual side where we find the causes which appear as effects on this side."

never before been mooted as a strictly scientific one by which to explain the physiological mysteries of procreation, growth, inheritance, transmission of parental likeness, and the wonders of vital and mental phenomena generally. I may regard this indorsement of the fundamental and pivotal law upon which the entire book is based, and by a theological authority so eminent, as one of the pleasantest episodes in my struggles with evolution and materialism.

But this great underlying principle of organic duality, this universal but hitherto unrecognized law of biological science, was not destined to ride into popular favor on flowery beds of ease, as many friends of the book had predicted, but was doomed rather to meet with sharp opposition and somewhat severe criticism at the hands of another clergyman, the Rev. Dr. Sheldrake of Winchester, Tennessee, who suggests various difficulties, wise and otherwise, all of which, with my answers, will be found in the following four letters which began and ended our correspondence. I copy these criticisms and the replies as the best possible means of stating and answering the objections raised, many of which might possibly have occurred to the reader:—

WINCHESTER, TENNESSEE,
July 3d, 1879.

Dear Sir:—Having read your book with deep interest, I write to ask as to your willingness to meet the difficulties that suggest themselves to the mind when reading your book. I would say that your exposition of Tyndall's Lectures on Sound (which I had the privilege of hearing at the Royal Museum of Mines), is simply crushing, and as to the "wave-theory," I have no doubts.

As an exponent of the gospel, I should like to receive your hypothesis of an incorporeal entity, but see some grave difficulties in the way.

First: Is there not danger that your theory will result in the very worst form of materialism.

Those [materialists] that I have met hold that will, reason, sensation, etc., are properties of matter very *highly refined.* With a very little modification in their definition of matter, your arguments would sustain them.

Second: After some years of close study, I am fully satisfied that the word of God presents man as a triune being, "spirit, soul, and body."—1 Thess. v. 23.

Soul and spirit are separate and distinct in God's word, one the seat of the appetites and affections, the other of the reason or judgment,—animals possessing souls, but not spirits. I think this can be plainly shown from God's word, the soul being the connecting link between the spirit and the body. If inertia is a property of matter, it must be in all its forms, however attenuated. But your theory seems to me to be open to the objection that it makes "attenuated matter" to acquire new properties, if, as your work seems to teach, this incorporeal entity is such attenuated matter. Intelligence, freedom, moral sensibilities, are not properties of matter, but spirit; and can never be acquired by matter, however attenuated.

I could accept the theory of an incorporeal organism, provided that the existence of spirit is still allowed, and such organism be regarded as the connecting link between; then my difficulties would be met.

Third: Without going into detail as to spirit, I have another difficulty. You use the reproduction of the leg of the salamander, and of supernumerary fingers, together with the consciousness of the presence of the leg, after it has been cut off, as arguments.

1. If the reproduction of the supernumerary finger is due to the presence of this organism, why are not ordinary fingers reproduced in the same way?

2. If the consciousness that some have of the presence of the leg after it is cut off is due to this organism, why do not all have it? and why does it not exist always?

3. If this consciousness is owing to this organism, then it must be the seat of sensation; if so, how comes it that when a man is partly paralyzed, sensation is gone from one-half the body? Is the organism partly destroyed?

4. If you reply that it is owing to the connection between this organism and part of the body being broken, then how comes it that the organism can be conscious of the presence of the leg after its connection with the leg is broken?

Fourth: According to Maudsley and others, insanity is due to physical causes. How would you harmonize your theory

with the accepted theories of insanity, and if you reject them, how would you account on your theory for insanity?

Fifth: Making God also such an organism, seems to open the door for the strongest pantheism, and your application of this to the souls of animals, would be open to the objection that it would make many incarnations of the Deity, and also that the essence of substance that would thus be God, could lose its perfection when thus separated, and made the inner organism of an animal.

It would be open to a still greater objection. Your theory of *inheritance* requires that in the animal the soul should be propagated as well as the body, and if this organism is a part of the organism of God, to be reabsorbed at death, then God can in small measure become imperfect, and this imperfect organism be re-absorbed by the Divine again. Along this line of thought a host of difficulties spring up.

Believing with Paul in the wisdom of "Proving all things, and holding fast that which is good;" having a desire that your theory should be established if true, or more fully developed if defective; having these difficulties, and knowing no other way, I have taken the liberty of writing to you direct. Possibly to you, having thought out so thoroughly your theory, these objections may seem trivial, but you must remember that, to those of us who have only, as it were, just been led into this region by means of your book, it is otherwise.

Whether all it contains be established or not, your book will do great good, and I can thank God for it.

With much respect,
Yours in Christ,
G. H. Sheldrake.

New York, July 9th, 1879,
234 Broadway.

Rev. Mr. Sheldrake.—

Dear Sir: Your kind letter came duly to hand, and though I am receiving scores of letters making somewhat similar inquiries, to most of which I have no time to reply, I will make yours also an exception, as the plausibility of your difficulties is such as to require an answer.

Still, there is not the least difficulty to my mind in any of the objections you name, if we can first arrive at a correct comprehension of the principles of science and truths of philosophy involved. In the first place, there is either an invisible, incorporeal organism, as the vital and mental principle which we call *soul* and *spirit*, or else the mind, life, soul, and spirit, are but the insubstantial effects of the interaction of the molecules of the brain, nerves, etc., as Haeckel and other materialists teach. In the eighth and ninth chapters of the "Problem," I have given positive scientific proofs of the existence of such an incorporeal entity corresponding to the physical structure in all its parts. In some parts of the work I may have inadvertently spoken of such intangible organism as constituted of highly attenuated "matter," when I should have said *substance*, since "matter" is usually applicable to corporeal substances, such as possess the properties of inertia, tangibility, etc., and of which it is truly said that they cannot move themselves, and no two of them can occupy the same space at the same time. But incorporeal substances, such as light, heat, magnetism, electricity, sound, gravitation, life, mind, instinct, spirit, etc., do not possess the distinctive properties of gross matter at all, are not subject to its laws, since many of them can not only move themselves and other bodies, but can occupy not only the same place at one instant of time, but can occupy the densest of material bodies—platinum, glass, water, etc., without the displacement of their particles in the slightest degree. I need not enlarge upon this, as you no doubt admit that the soul is *substantial*, or else it is absolutely nothing, and all talk about the immortality of the soul is nonsense.

If, then, the soul is substantial, there is no conception of its existence (separate from the body) but as an incorporeal organism, having entity of being and identity of person. If it is not this, it is nothing. As an incorporeal organism, it is easily comprehended. For example: As the physical organism has its finer and coarser materials, such as brain, nerves, muscles, blood, bones, cuticle, nails, hair, etc., so the incorporeal but substantial organism, which will live after separation from the body, must, by the laws of analogy, be of different grades of fineness—having qualities of constituents corresponding to those of the corporeal structure. It is easy, then, to conceive of the

finer part of this inner organism,—this incorporeal *brain*,—as what we call *spirit*, in contradiction to the mere life or instinct. So it is with God. He is an intelligent, powerful, acting, speaking being. Christ was the express image of His *person*. He was seen by Moses. His word is himself. He is substantial, because His *word* became *flesh* and dwelt among us. If this *word* could become *flesh*, it could become *wood*, or *rock*, or *iron*, as well. Hence, I assume that, instead of God's making all things out of nothing, as the Westminster Confession of Faith teaches, He condensed them out of His own all-pervading substance—His *word*—the same as His word was changed into corporeal *flesh*. This is not materialism or pantheism, but reason, science, and common sense, since all science and reason teach us that something cannot be made out of *nothing* any more than something can be annihilated or turned into nothing, which reason and philosophy assure us is impossible. Hence, as gross matter, even in its finest conceivable atoms, was created, and consequently could not have been eternal, there is no other conclusion possible save the one here assumed, that he spake all material objects into existence—made them of His word, just as he condensed the "*flesh*" of Christ from the word of His power. Then, having this basis, it is no more difficult to conceive of God's being or personality consisting of different grades of substance than to conceive of Christ's personal entity, condensed out of the word of God, consisting of flesh, blood, bone, nerve, brain, life, passion, appetite, spirit, etc. It is, therefore, easily understood that physical organisms were condensed and framed out of that portion of God's omnipresent substance suited to such material existences; their vital parts out of a higher or finer grade of God's substantial nature, while the mental faculties and powers, including that highest of all the substances constituting man's dual organism—*spirit*—were but drops out of the higher qualities of God's intellectual or spiritual essence. In this way man, receiving his higher spiritual substance as an atom of God's Divine intelligence and higher spirit-essence, was made in the "image of God."

Your objection, therefore, that this view smacks of materialism and pantheism, has no foundation in fact. All Nature is but an atom, so to speak, of God's substantial being, while He still exists over and above Nature, and independent of this drop of His entitative being—out of which the universe has been framed. Pantheism teaches that Nature is God and all there is of God. My theory teaches that the material universe is but a small fraction of God's entity, and no more constitutes God Himself than the new-born infant constitutes the mother herself, because its organism came from a part of her own. I sympathize with any man who cannot distinguish between this sublime conception of the origin of Nature and organic beings, and the godless theory of pantheism.

Neither does my view involve materialism, which teaches that life, soul, spirit, is nothing but a mode of molecular motion—a changing of position of the brain and nerve particles—and hence is insubstantial, having no entitative character or existence separate from material organisms. Surely I need not spend time to point out the difference between this purely physical and materialistic conception of man, and the beautiful hypothesis forming the basis of my entire volume, namely, that within every living creature there exists a vital and mental organism—the counterpart of the physical structure—the source of all vital and physiological phenomena, originally contributed by the Creative Will as atoms out of His own being, and which must, at the dissolution of organic life, return to the vital and mental fountain whence they emanated, there to mingle by reabsorption into the original source, or, as in the case of those lives which have received the spiritual impress of God's image, live forever with the self-conscious ego inherited through their higher organic nature.

This temporary relation between these two organisms, or while they co-exist as in the body, causes an interdependence of one upon the other. The physical is under the control of the incorporeal, and *vice versa*, to a large extent. While thus interblended, any serious derangement of the bodily functions disturbs the harmonious operations of the vital and mental faculties. In case of insanity the physical brain becomes diseased, and the incorporeal brain, which has its seat in the corresponding part of the physical structure, loses its balance from sympathy; and though the vital functions of this inner man may retain their full vigor, or even an increase of

energy, the mental part of the inner organism has temporarily lost its footing in the physical organ where it has been accustomed to reign supreme.

So the physical nerves of sensation can only cause feeling by means of the incorporeal vital nerves within those physical threads. The relations of the two are thus interdependent, the same as just described with reference to the brain. If the whole nervous system of one side of the body becomes inoperative in consequence of the ganglionic centre becoming diseased, the vital and incorporeal nerve-system, out of sympathy with the physical, ceases to act. If the disease were not in the brain, and if the ganglionic throne of the nerve-system were not disturbed, but if, instead, the physical thread of sensation should be severed below this centre, as when a limb is amputated, then the effect is different. Though the absence of a portion of the physical nerve may weaken and disturb the operation of the vital nerve above, it does not wholly paralyze its operation so long as its upper portion and seat within the brain remain in a healthy condition. In time, however, this isolated portion of the vital nerve of an amputated limb will contract itself within the stump of the physical structure, and cease to recognize the lost limb, on the principles of vital adaptation to changed physical conditions, which, undoubtedly, we do not and may never fully understand. If you will read my work attentively, that portion particularly where the amputation of the salamander's leg and supernumerary digits is discussed, you will see the reason why all fingers, when amputated, are not reproduced, namely: the want of *vital density* in the part removed. The infant may and does possess that vital density, as instances of regrowth have been often demonstrated; but as age advances and the corporeal structure increases in size, the vital organism expands and becomes more attenuated till it has not the solidity, so to speak, or in strictness, *density of substance*, to support the physical particles as they essay to climb into position for the regrowth of an amputated organ, though it still possesses sufficient organic density to restore flesh for the healing of wounds, even in old age. I submit these explanatory suggestions, written hastily, in hopes that with the aid of your own mental effort to solve the problems raised, you may assist me and everything may become clear. I do not pretend that every shade of difficulty which may suggest itself to an inquiring mind, can be clearly and satisfactorily answered. This is not absolutely necessary to useful scientific knowledge, or we could never come to a settled conviction on any subject, as there are inexplicable mysteries involved in every aspect of religion, science, or philosophy. I have recorded in the "Problem" abundance of proofs showing that no solution can be given of the phenomena of growth, reproduction of lost parts, transmission of characters and diseases, healing of wounds, or the inheritance of ancestral peculiarities and resemblances, without the scientific recognition of this vital and mental organism within the physical structure. I again refer you to those scientific demonstrations in the eighth and ninth chapters. If this be so, it is your place, it is every reader's place, as well as mine, to answer the objections you have raised, and not, in effect, array apparent difficulties against stubborn facts, and then leave the facts as if they had been annihilated and the difficulties established. I have had a score of correspondents who have raised the objection of *pantheism* and *materialism*, without giving a thought to the true signification of those words, all because I have undertaken to prove scientifically that the vital and mental nature of man is a substantial entity, that can be happy or miserable, and because I have framed a scientific hypothesis, explaining how the soul can exist forever as a conscious, personal ego or selfhood. I am charged with pantheism because I point out a scientific basis for the origin of life and mind, as well as of corporeal bodies, without flying into the face of axiomatic scientific truths—without even assuming the eternity of matter, or the position of the false theology of the day which teaches that all things were made out of nothing, and thus invite the sneering ridicule of every scientific or thoughtful mind. After showing, as I have done, that life, in every organic being, must be substantial, I am charged with detracting from God's perfection, because I assume that this entitative vitality was originally a part of God's vital fountain, and in the case of lower organisms would again return to it and be reabsorbed into it, instead of assuming, as I would otherwise have been obliged to do, the scientific absurdity that this vital

and mental substance in lower animals is utterly annihilated at death; or else that brutes will be individually immortal, and will thus be placed on an equality with man in the future life.

Yours very truly,
WILFORD.

WINCHESTER, TENNESSEE,
July 25, 1879.

DEAR SIR: Yours of the 9th inst. came duly to hand. Possibly I did not make myself fully understood, and in seeking *brevity*, sacrificed *clearness*. I wish therefore to define my position, and then the bearing of my difficulties will be fully perceived.

First.—All who are not materialists, agree in teaching that the soul is an "immaterial substance;" in fact, that is the definition of soul as given by Webster, and others. None of my objections therefore apply to this.

Second.—That this substance, soul or spirit, pervades the whole body conforming to its shape is not a new idea. Swedenborg brings it out clearly in his "Heaven and Hell." A German writer, I forget his name, Ulrici I think it is, advances the idea of a spiritual body, which is the same thing with the exception of the word *body* for *soul*.

To my mind there has been an objection to this theory of the spiritual "*body*," drawn from its bearing on the resurrection, and the question of materialism.

Yet it sets forth what I believe, if the word *soul* be substituted for "*spiritual body.*" Then beyond this I also believe in another entity distinct from either soul or body, which the word of God calls *spirit;* the soul being the connecting link between this higher entity and the body. 1 Thess. v. 23, and Heb. iv. 12, teach the separate character of soul and spirit. As to the distinction between them, the soul is the seat of the affections and appetites.

It loves,—1 Sam. xviii. 1. Cant. i. 7, etc.

It hates,—2, Sam. v. 8, etc.

It pities,—Ez. xxiv. 21, etc.

It is the seat of the appetites,—Sam. i. 11, Luke xii. 19, etc.

The derived meanings grow out of this; hence, "appetite," "pleasure," and "desire" are used to translate the Hebrew of soul.

The spirit is the seat of the intelligence and judgment.—1 Cor. ii. 11, etc. Hence it is translated (the Heb.) "mind" in Ez. xi. 5, and other places. This distinction runs through the whole Bible; hence, "it is sown a natural [i. e. a soul led] body, it is raised a spiritual [i. e. a spirit led] body." Spirit and matter having such opposite properties, they cannot, so it seems to me, act together without some connecting link; this I find in the soul, an entity which touches matter on the one side, and spirit on the other. Thus man is tri-unity, a trinity.

Third.—We now come to what I conceive to be *the* position of your book, viz, that the soul is an "*incorporeal organism*" (the question of heat, light, sound, etc., not being considered here). Now an organism is that which has organic structure. If I understand your book aright, it is not upon the existence of an incorporeal *substance*, but of an *organism*, that its arguments depend.

To illustrate: Physical peculiarities are inherited. This you explain by your hypothesis of an *organism*. Thus the soul (or organism) is received from the parents, a part of whose souls is imparted to the child. It is against *this* theory, of the soul as an *organism*, not as a substantial entity, that my objections are urged.

Your theory requires that the soul like the body should be a structure built of atoms or molecules, because how otherwise could it be divided so as to be imparted to the child. It could be only a small portion of the soul of the father that could be imparted to the child, and allowing that one-half of this is imparted to the grandchild, and so on, your figures as against the physical cause of "reversions," "rudimentary structures," etc., would apply with equal force against your own theory, with this advantage only on your side, that you take the question into the regions of the unknown and invisible.

The portion of this organism imparted by the parent, must, equally with the physical germ, be *developed*, assuming the various forms of the embryo, and that, too, before the material change, as that (on your theory) is the result of the change of this organism increasing in *size*, as well as developing in *shape*.

How is this development effected? Your theory of "vital density," answers by *expansion*. But expansion is caused by the particles composing any body being removed further and further from each other.

There can be no expansion in any substance not composed of atoms; at least no such can be conceived of by us. Given, however, the idea of an atomic or molecular structure, as characterizing your organism, and reasoning from analogy (to which also we are impelled by the facts), and your theory of "vital density" cannot be maintained. We know that physical development is the result of the division and sub-division of the cells, and this can not go on, only as a stream of nutrient matter enters the cell-wall, and comes in contact with the living matter or bioplasm within. Analogy requires that a similar process take place in reference to the soul, if your theory is true. Then the objections urged by you against the physical theory by which the phenomena mentioned are accounted for, apply with equal force to your own. "Vital density" does not meet the difficulty, as I will try and show.

You say, "as the incorporeal structure *increases in size*, the vital organism *expands*, and becomes more attenuated, till it has not the solidity, so to speak, or in strictness, density of substance." Then, a man in years imparts a portion (and a very small portion at that) of his attenuated organism, to his child. If it gains size by expansion, this small portion of attenuated soul must with each generation become more attenuated, and it will not be long before the race is without soul. More,—in three generations, the lack of "*density* of substance," would be the destruction of the race, as the body built upon such a frame-work could not hold together. There must therefore be nourishment, an addition of new material or substance, to the organism to perpetuate the race. But once admit nourishment as a fact in the growth and development of this organism, and "vital density" loses its force, as accounting for the facts. All analogy would require that we should regard the nourishment of the "organism" as being similar to that of the body. Nay, more, as the condition of growth in the body is that the cells manufactured should be in excess of those destroyed, so we ought to expect (on account of interdependence) that something analogous should occur in this organism. But given that the soul is an organism made up of atoms or molecules, and given the fact of nourishment, then, followed out logically, the objections used by you to the physical theory, apply to your own. More, the unity of consciousness, and its testimony as to identity, remain unexplained.

I think your exposition of the text that "the word was made flesh," is open to grave objection. You give to the words the sense that the word was made *into* flesh, which is not a Bible idea. John says the Word was *with* God, the Word *was* God. Word here does not mean speech, for we cannot say of words that they are God.

It is of the Logos, a *person* so called, that John is speaking, a very intelligent idea, when we remember that the Jews believed in the Logos as a person. In the Chaldee paraphrases of Jonathan and Oukelos, in the writings of Philo and others, it is so used.

In 1 Kings, xix. 9-11, the Word of God is spoken of as a person appearing to Elijah. John's words are therefore equivalent to teaching that God became incarnate as a man, which is the testimony of other Scriptures. Your exegesis is in conflict with the testimony of other Scriptures; for instance, "of whom [we the Jews] as *concerning the flesh, Christ came.*" His human body was received by natural descent from Abraham; hence the promises to *the* seed. But in that body "all the fullness of the Godhead dwelt."

In saying that there was danger of your book leading to materialism, I did not mean to charge you with it. Yet our arguments sometimes lead in a direction we did not intend, when followed out logically. Your using the term "attenuated matter" was plainly materialism; not extreme materialism in its gross infidel form, but still materialism in that it made spirit matter. And the objection I urged that matter could not acquire new properties by being attenuated, was clearly to the point. In your reply you withdraw the expression, "attenuated matter," which largely removes the objection that it tends to materialism. Still your reply is open to the same objections urged in my letter. If matter cannot by attenuation acquire new properties, how can spirit by *condensation*, which is simply reversing the process. And if material bodies are simply condensations of God's spiritual substance, then re-absorption must be by attenuation, so that while withdrawing the words, you retain the thing itself.

As to pantheism, I certainly did not

confound your theory with the *godless theory* of Pantheism. But there are different schools of Pantheists, and all I meant to convey was that your theory tended *in that direction*. And in so far as you make the universe *a part of God*, this is true. Of course there is a wide difference between this and the *grosser forms* of Pantheism, or possibly what you might call Pantheism proper, although the term is now used with more extended application.

To my mind the idea that an immaterial substance can be transformed into a material body, is as unscientific and irrational as that something was created out of nothing. We have no scientific evidence of such transformation, and it is as inconceivable as the one you assail,—hence rests on a frailer foundation, as the so-called "false theology" has at least this plea, that the Hebrew word for create, expresses the idea of bringing something out of nothing. Your position that it was by a condensation of God's substance, logically implies that that substance is material; and further, the act of condensing implies a condenser, and that the condenser and the thing condensed are one and the same, is inconceivable. Just as well might we say that the Creator and the thing created are identical. In the name of science I must protest againts such unscientific statements. If the universe is a part of God, it would be conceivable that in the formation of many worlds, God's substance would be condensed away, and God as God cease to be.

Your statement that this was done (condensing worlds out of His own substance) "just as He condensed the flesh of Christ from the word of His power," is not to the point, as Christ was "born of a woman." The only difference between His birth and ours being, in the manner of *generation*. And when we remember "that throughout the whole series of living beings, we have *agamo genesis*, or not sexual generation," we need no such extraordinary theory to account for His birth.

I have written thus fully, because I believe that your work is a valuable one, marking an era in the history of science, and because, having invited criticism, it seems to me you have erred by attempting to define what lies beyond the reach of one's senses, beyond, therefore, the limits of the conceivable. I think the idea of an *organism* open to this objection, while the essential arguments prove the existence of an incorporeal substance.

Rev. G. Mitchell will forward you a book, containing the history of interesting phenomena, to me inexplicable.

With much respect,

Yours,

G. H. Sheldrake.

New York, August 4th, 1879,
234 Broadway.

Rev. Mr. Sheldrake.—

Dear Sir: I am in receipt of your letter of the 25th ult., in reply to mine. I cannot help feeling a degree of disappointment in reading this letter, as it fails to sustain the spirit of candor which I thought I saw so clearly evinced in your first letter, particularly in view of your remark. "As an exponent of the gospel, *I should like to receive your hypothesis of an incorporeal entity*, but see some grave difficulties in the way." I tried to answer those difficulties, and called upon you to aid me in my attempt, since you wished the hypothesis to be sustained, if possible. Instead of doing this, you reply with other difficulties, many of them positively trivial, and some of them amounting to mere quibbles, and, I might add, misrepresentations of my views, rather than valid objections. I regret to feel obliged to say this, but will try to convince you that it does not do injustice to the literal reading of your letter, when carefully examined.

For example, you say: "We now come to what I conceive to be the position of your book, namely, that the soul is an *incorporeal organism*. Now, an organism is that which has organic structure. If I understand your book aright, it is not upon the existence of an *incorporeal substance*, but of an organism that its arguments depend." You then proceed actually to ridicule this idea that the soul is an "incorporeal organism," by supposing it to be received from the parents, "*a part of whose souls is imparted to the child.*" You further add: "It could be only a *small part of the soul of the father* that could be imparted to the child, and allowing that *one-half of this* is imparted to the grand-child, and so on, your figures, as against the physical cause of reversions, rudimentary organs, etc., would apply with equal force against your own theory," etc.

Now, this apparently forcible criticism is a complete misapprehension of my views, and applies, to all intents, against your own position whatever that may finally turn out to be. You admit that the child has a soul, obtained from some source—that even "animals possess souls,"—and, "that the soul is an *incorporeal substance.*" You even go further. In your first letter you say: "I could accept the theory of an *incorporeal organism*, if the existence of *spirit* is still allowed." Yet, after I had fully "*allowed*" of *spirit* in my reply, all that you required, you proceed to ridicule your own conditionally accepted theory of an "incorporeal organism," raising difficulties in regard to its transmission from the parents by taking away a part of their attenuated souls, till finally you suppose it to run out

in the course of descent and become extinct, on my view, like Darwin's "gemmules" in his theory of "pangenesis," or his hypothesis of corporeal reversions, never thinking that it must run out on your own view just the same. And yet you do not reflect that there is no parallel between Darwin's physical theory of reversions and my theory of an incorporeal organism, the one based upon a purely physical substance, liable, as all science teaches, to constant mutation, displacement and substitution, while the other is based upon a purely "incorporeal substance," as you still admit the soul to be, constituting an interior or "incorporeal organism," as I claim, and which your first letter clearly conceded after I should allow of the "existence of spirit." Yet the opportunity seemed so favorable that you could not resist the temptation of positively making fun at the expense of your own accepted theory, all of which I will fully meet at the close of this letter, though I will remark here: Suppose I allow of the "existence of spirit," which I do, and suppose you "accept the theory of an incorporeal organism," which you say you could do "if the existence of spirit is still allowed," then pray tell me how you would, in such event, meet your own criticism about the father transmitting a part of his attenuated soul to the child, half of which would go to the grandchild, and finally in a few generations run out, leaving children to be born without souls? If you accept an "incorporeal organism," which you positively have done, as above, then how do you account, according to your own objection, for the expansion of this organism in the infant to keep pace with the growing man? This is no child's play. You are as much bound to explain these difficulties as I am on your own conditionally accepted "theory of an incorporeal organism." But if you are sincere in raising your objections, you cannot of course be expected to answer them. It will, therefore, devolve upon me, which I will try fully to do in this letter.

You say: "It is against the theory of the soul as an *organism*, not as a *substantial entity, that my objections are urged.*" But in your first letter you say that this "entity" is the very thing you would like to accept but for the "*grave difficulties* in the way." Now, there seem to be no "difficulties in the way" of this "entity." It is only the "incorporeal *organism*" against which your "objections are urged," while in your first letter you were perfectly willing to accept this "organism" if I would still allow of "the existence of spirit."

Let me now try to analyze your latest position in regard to this impossible "incorporeal organism" against which your "objections are urged," though you fully admit it since I have allowed of the existence of spirit. In the first place, as the soul is to be immortal, and is to exist after death in a conscious condition, but not as an "organism," then pray tell me how such a "substantial entity" can be *conscious, think, love, feel, see, hear, sing*, etc., in that disembodied condition, without possessing either *brain, heart, nerves, senses, eyes, ears, tongue, mouth*, etc? As you admit the soul, when separate from the body, to be a substantial and conscious "entity," and must admit it unless the "immortality of the soul" is a hollow sham, then it is your bounden duty to tell how a soul is to *sing* without a *mouth, think* without a *brain, see* without *eyes*, or *feel* and *love* without *heart, nerves*, and other *organs* of *sensation?* Your ideal human souls, though you admit them to be "substantial entities" are absolutely organless, since you object to the "incorporeal organism," and hence they must see without eyes, hear without ears, and think without brains. This is an anomalous condition of affairs in the spirit world. Christ referred to certain persons who had ears but heard not, and eyes but saw not, but your kind of souls is the first specimen of a conscious, living thing that could see or hear without the organs corresponding to those senses. My idea of this substantial entity agrees with that of the apostle. It is the "inner man" which has stepped out of its "earthly house" but retains its manhood, selfhood, and identity the same as when it inhabited the "outer man." "Reasoning from analogy," as you say, how could Paul thus speak of the "outer man" and "inner man" and of the latter leaving its "earthly house," if this "inner man" possesses none of the organs, senses and parts which belong to the outer man? There can be no *man*hood without a human organism, though to gross conceptions it may seem impossible that a spirit should possess organs, such as eyes, ears, brain, nerves, tongue, heart, etc., because these organs, as well as the body of a soul-entity, are incorporeal and consequently intangible and invisible to the physical senses.

I should be very sorry and even sad to entertain your conception of the human soul, which, as soon as it starts on its journey to heaven, becomes deaf, dumb, blind, and idiotic, since it is not an "organism," and therefore lacks the very organs or parts by which, "reasoning from analogy," it is possible for it to hear, speak, see, or think. When a human soul arrives in heaven, my theory teaches that this "entity" can clasp *hands* with the angels, can *play* upon a *harp*, can *shout* hosannas, can *hear* the welcome of the Saviour, and "*see* Him as He is." Your ideal soul can do none of these things, because, not being an organism, it possesses none of the parts necessary for such celestial employment. To speak the candid truth, I should prefer the impersonal immortality of the *positivist* to an existence in such a crude soul as your ideal involves, which can neither see, hear, feel nor think. Such an "entity" I can compare to nothing so much as to Haeckel's spontaneously generated moneron—an "organism without organs" as he calls it; yet even this "simple lump of pure albumen" vastly surpasses your model human soul, for it can and does *feel*, and therefore must possess sense-nerves, though they are invisible under the most powerful microscope.

There is one other point touching this inquiry I must refer to before turning to other matters. As a soul has no *organs*, does it possess a body? If so, of what shape is this *body* of the human soul? Or has it no form? It surely has neither *legs, arms*, nor *head*, as that would constitute it an organism, but it ought to have some form nevertheless. Did you ever try to imagine this characteristic of your organless "entity?" Is it round, long, flat, oblong, square or three-cor-

nered? You ought to answer something, if it is only a guess. Possibly you will try to be consistent and say it has no shape at all, as *shape* is a property of *matter* which cannot, as you have told us, be predicated of an "incorporeal entity." So far you are safe. But let us pursue the inquiry a little further. If the soul is without *form*, is it also without *size?* According to your vague notions of this organless "entity," and in harmony with your safe policy of not venturing to touch upon anything "*beyond the reach of one's senses*," you dare not, of course, even venture a provisional hypothesis as to whether your ideal soul, after it leaves the body, will be as large as an ox or as small as a mouse,—as tiny as a monad or big as Mount Chimborazo. Consistency again comes to your aid. *Size* is a property of matter, and therefore a human soul is of *no size at all*—neither big nor little. Now it is my turn to "protest" that a pretended candidate for immortality which is destitute of either body, organs, or senses, and, consequently, which can neither see, hear, feel, nor think, and which is without form or size, is about as poor an excuse for a "substantial entity," that is to retain its personal identity and unity of consciousness, as we can well imagine.

You say it is not constituted of atoms, and even ridicule this idea. Hence, it must be all *one atom*, or else it is nothing. If it consist of one atom, then such an entitative atom ought to be limited in size, or otherwise its *extension* must be unlimited, and if unlimited it is omnipresent, and therefore equal to God in one of His grandest attributes. But again, you are safe. *Extension* is a property of matter, and incorporeal substance is so essentially unlike matter that it can possess none of its properties. But God is omnipresent, or, as Pope expresses it, "extends through all extent,"—and, as you admit, is "substantial." Hence another tangle. Though God is a "person," of which Christ is "the express image," though "His *eyes* are over the righteous and His *ears* are open to their prayers," yet God, according to your view, has no organs, and can therefore neither hear, see, feel, nor think, because an incorporeal entity cannot be an "organism."

But a word in regard to my view of the degrees of *density* in life-substance, by which to account for the expansion of the incorporeal "organism," which you so severely criticise. You reject the idea that the soul, though a substance, is constituted of *atoms*, and therefore insist that it cannot decrease in density by expansion, since the only way a body expands is by its *atoms separating more widely apart.* This, perhaps, involves one of the most serious and profound problems in the whole range of science, and contains wrapped up within this single question of "ultimate molecules" and the "molecular theory" one of the most mischievous errors of modern times, and I am surprised that you have fallen into it. But as much of your trouble seems to grow out of this molecular theory of expansion, and as no writer has ever yet attempted to explain observed phenomena on any other principle, I submit the following for your careful consideration. In the first place, it is inconceivable that any substance can exist without being constituted of atoms or particles, whether corporeal or incorporeal. As all the substances that come within the reach of our analytical powers are thus constituted, it is illogical, "reasoning from analogy," to assume that other substances "beyond the reach of our senses" have no constituent elements or particles. A scientific mind is therefore compelled to reject your view of non-atomic incorporeal substance as paralleled only by that of *something* being made out of *nothing.*

In the second place, I deny in toto this whole molecular or atomic theory, in regard to the expansion of bodies by the separation of their atoms more widely apart, as unscientific and absurb, and I challenge any physicist to answer my objections to it. If a body expands, as in a compressed piece of rubber when released, by the separation of its molecules more widely apart, then they do not touch each other, and consequently, by every principle of philosophy and reason, the connection between the particles of such a substance must be destroyed, and with it the *cohesion* of the body itself, and the mass should fall to pieces like a rope of sand. This alone destroys the molecular theory, which teaches that the molecules of all bodies are nominally separated by absolute spaces of many times the diameters of the molecules themselves, that these spaces are filled with "luminiferous ether," so that these "ultimate atoms" have plenty of room to circulate, and that they are in continual motion to and fro, bombarding each other and keeping up a rattling fusilade in all directions against the surface of the body or against the wall of the vessel containing any confined substance, such as air for example. If such motion or bombardment of the molecules really takes place in a body not confined, such as a stone or piece of metal, why do not these atoms escape beyond the surface? What is to hinder their flying away, when they come to this jumping-off place, and the mass thus dissipating itself and disappearing in space by the continual loss of its molecules. The theory is a weak attempt to solve that which needs no solution whatever. In regard to this question of expansion, we have only to assume in the atoms of a body the very thing which we see taking place in the body itself. The mass expands by *swelling*, does it not? But what causes it to *swell?* You say the separation of its atoms more widely apart. I deny this and answer that the atoms, constituting it, *swell.* If you ask how can these constituent atoms swell, I answer, again, by the swelling of their atoms, or smaller constituent parts, and so on, as far as any physicist dare follow me. If you say this is unreasonable, and that we must stop somewhere at the "ultimate atoms" of a body, I answer by denying most emphatically the existence of any such things as the "ultimate atoms" of a body, and maintain, instead, the infinite divisibility of matter or substance of any kind, as the only rational solution of these phenomena of *compression* and *expansion* and their resultant *heat* and *cold.* Take what histologists now regard as one of the "ultimate atoms" of a body. Suppose a microscope could be invented as far exceeding in magnifying power our best present instruments as they exceed the power of the naked eye, such "ultimate atoms" would then seem to be as large as cannon balls, and would be distinctly composed

of clusters of still smaller "ultimate atoms." These again magnified by still more powerful lenses, would present the same appearance; and so on with each increase of magnifying power, with no term capable of expressing the concept save that of the *infinite divisibility* of matter. This view, simple and beautiful as it is, renders the molecular theory wholly unnecessary, and though such a solution may be finally incomprehensible, it is no more so than the "ultimate" limits of space, of which it is the opposite infinity. Thus by answering and, as I believe, setting aside the atomic or molecular theory, and rationally solving this problem of the expansion or rarefaction of a body without its atoms separating more widely apart, your principal "difficulty" in the way of an "incorporeal organism" has been met.

But you seem to scout the idea that the child gets its soul from its parents. Then you must believe that it receives it at some period of embryonic development, or at some later period, as a special or miraculous gift from God, since you now admit the soul to be a "substantial entity." Please name the probable date of this miraculous event in the development of the child, the puppy or the chicken; and as it is not communicated by the parents at the time of fecundation, please give some solution of the fact, that the child partakes of the *vital* and *mental* qualities of the father and mother? I ask you, as a favor, to stop raising objections long enough to solve some of these knotty problems yourself, which your own view involves equally with mine, and in some respects more so. Whatever difficulties may be involved in my hypothesis of a vital and mental organism, and I acknowledge, as remarked in my reply to your first letter, that no hypothesis in biological research is free from difficulties, yet it seems to me to be the only conceivable explanation of observed physiological and psychological phenomena, as so fully shown in the eighth and ninth chapters of the *Problem of Human Life*. It at least has the merit of being a frank and outspoken hypothesis, which is surely preferable to no hypothesis at all, so conspicuously illustrated by your two letters, with the bare exception of "agamo genesis" to explain the birth of Christ. And as there seems to be no likelihood that you will venture a physiological solution of the difficulties you suggest about how an infant gets its soul, I see no way but for you either to adopt Haeckel's view, that the soul and life are nothing but a mode of motion of the molecules of the brain and nerves placed together in a complex and "most varied manner," or else come back to the beautiful hypothesis which you conditionally accepted in your first letter, and thus take the only rational and scientific position within reach, namely, that the incorporeal life-germ of the child is conveyed to the ovule by the father and mother jointly at the time of fecundation,—that this vital and mental organism thus formed, is perfect at the start and expands with the growth of the child by the expansion of its atoms, and that, though invisible and intangible, yet it contains within it the perfect life-form of the species represented even at the commencement of organic life, and thus furnishes a substantial pattern or outline of structure for the deposition of the molecules of bioplasm from the mother's circulation, and by which the physical cells are fed and caused to subdivide and multiply, till not only the embryo is complete, but the organism, of whatever animal species, has attained mature growth. Such a solution is consistent with reason, as a basis for physiological research; while it scientifically explains the phenomena of growth, healing of wounds, reproduction of lost parts, the transmission of characters by inheritance, etc., etc., which are wholly inexplicable on any other supposition.

Your admonition, touching my "attempting to define what lies *beyond the reach of one's senses*," and beyond, therefore, "*the limits of the conceivable*," is clearly in harmony with the non-committal policy of your letters, in objecting to my views, but not defining your own; yet it is hardly in keeping with this age of advanced scientific research. A man who seeks to conceive of, or define, nothing "beyond the reach of one's senses," in the realms of science and philosophy, or even of religion, is better adapted to a cloister than to the modern duties of a progressive "exponent of the gospel." As you have thus abandoned every thing lying "beyond the reach of one's senses," as equivalent to lying beyond "the limits of the *conceivable*," of course you have abandoned the existence of the soul, the existence of God, and of a future life, since evidently they all lie "beyond the reach of one's senses," and of which, therefore, you can form no conception! The result is, in attempting to oppose my beautiful view of an incorporeal organism, you carry yourself right into atheistic materialism, by a strict application of your own words. I would rather, however, a hundred-fold, venture even a questionable hypothesis, in explanation of the recondite phenomena of science,—one which might tend to aid in their ultimate solution,—than to fold my hands like a scientific coward, and say nothing lest I might render myself amenable to criticism. A man who rejects everything that lies "beyond the reach of one's senses," should scarcely teach that something can be made out of nothing, unless he has had personal experience and observation to that effect!

The statement in your letter, "that the Hebrew word rendered *create* expresses the idea of *bringing something out of nothing*," is clearly erroneous, as any Hebrew scholar is aware, since the same word is frequently used in the Scriptures to record, or to refer to, the making of things out of known pre-existing materials, as in the case of Adam's body. As if to define God's mode of *making* anything, we are especially informed, in the literal reading of the word, that Adam was made of the *dust*, and Eve of a *rib*. This ought therefore, to stand as a Bible definition of God's manner of creating anything,—not out of nothing, but out of something having a previous *existence*. As God made Adam's body of dust which already existed, it is but rational and logical to infer that, when He breathed into him the breath of life, and he became a "living soul," that He simply transferred to Adam a drop of pre existing life, and as God is life itself and the only primordial life of the universe, it becomes clear that Adam's life consisted of an atom

of God's own living substance, moulded into a vital organism corresponding to his physical structure. You admit Adam's "living soul" to be a "substantial entity." Which, then, I ask you, is the more rational view to take, that God's figurative *breath* communicated to Adam a drop of His own vitality, or that He "breathed" into him for no purpose whatever, and then made Adam's soul or "substantial entity," as you call it, out of *nothing*, by an independent effort of His power? In other words, did God make one-half of Adam (his body) out of *something*, and the other half (his soul) out of *nothing?*

It is inconceivable that all things should have been made of nothing, a thing so contrary to reason and all the possibilities of science, and that not once, in the Bible, should it have been so intimated by the inspired writers, especially in view of the fact that the word "nothing" is such a common word in the Scriptures. To conclude that these writers, while familiar with this word and constantly using it, should not have thought to employ so expressive a term in a connection, of all others the most necessary, while trying to record the very fact that God made the world out of *nothing*, is absurd in the highest degree, provided that such really was their aim. No; it seems to have remained for the framers of a certain modern Confession of Faith to correct this mistake of the Bible, and to remind the inspired writers of their unaccountable obtuseness or absent-mindedness, in neglecting the employment of this familiar word which so appositely might have expressed the idea they were trying to communicate.

In view of this argument, how corroborative, and to the point, is the unvarnished statement in the first chapter of John, that "*The word was God*" and "*The word was made flesh*, and dwelt among us!" This asseveration of the inspired evangelist, without note or comment, outweighs a whole library of such questionable exigesis as your letter contains on the peculiar manner of Christ's incarnation by "*agamo genesis*," thus tacitly denying the miraculous conception of the Saviour by quoting the words of Huxley. As His birth was not miraculous, possibly you might aid Huxley in disposing of His life, resurrection, and ascension in the same way.

In maintaining my position that the universe was made of God's all-pervading substance, it does not seem to me unscientific or irrational to assert that even a substance so highly attenuated might be condensed into a solid body, like this earth, since the great scientific investigator, Dr. Lockyer, has given reasons for believing that all tangible substances, from platinum up to the most tenuous gases, are resolvable into one single elemental substance, vastly more attenuated than that of hydrogen gas. Would it not, therefore, beautifully complete the scientific chain of continuity to assume this sub-element of which all worlds are constituted, as the first condensation of a fraction of the substance of God's exterior nature, and as His initial act in the process of framing the corporeal universe? If all material substances are absolutely traceable to a single element, far beyond the reach of our senses, may we not assume that all substances, whether material or immaterial, might be rationally traced one step further and resolved into the one primordial substance of the Deity Himself, from an atom of which, in the first place, this sub-element was condensed, and then out of which all other substances and forms were made.

Though I verbally distinguish between *material* and *immaterial*, between *corporeal* and *incorporeal* substances, one being generally applied to tangible, and the other to intangible things, yet that does not preclude the idea that the corporeal may have been condensed from the incorporeal substances of Nature. The marvelous discoveries of modern science, under the investigations of such physicists as Lockyer, Crookes, Fairfield, and others, are clearly pointing to results as wonderful as this, while they all tend to confirm the broad position first announced in my treatise on Sound, that even sonorous pulses may consist of absolute substance, in opposition to the universally accepted theory of the undulating motion of air-waves. In view of the discovery of this single sub-element announced by Lockyer, out of which all the grosser physical elements and substances have been evolved, does not such a grasp of the almost intangible render the hypothesis probable, aside from proof, that Electricity, Magnetism, Light, Heat, Gravitation, and even *Sound* are but other forms of the same primordial substance out of which this sub-element was probably condensed? The bold position assumed recently by Count Du Moncel, before the French Academy, that the generation of sound, as well as the observed action in the telephone, is clearly molecular, in opposition to the vibratory or wave-theory, is a step in the same general direction, and must culminate in the corpuscular hypothesis as the solution of all the so-called modes of motion and forces of Nature.

While it may, therefore, be rationally assumed that an incorporeal substance might be condensed into a material form, by the application of Almighty power, yet to assert that *something can be made out of nothing*, even by God Himself, is irrational and unscientific, not to use a stronger adjective. You unintentionally admit as much in your letter before me. I quote your words: "To my mind the idea that an immaterial substance can be transformed into a material body, is *as unscientific* and *irrational* as that *something can be created* out of nothing!"

Since *air* has been condensed by the skill and power of puny man, into a permanent liquid of the gravity of water, and through the limited appliances within his reach, does it seem "irrational" to believe that an infinite God might also condense an incorporeal substance, such as electricity, for instance, into granite rock, or something equally dense? And if this be not irrational nor insupposable, does it exceed the bounds of reason and probability that the same infinite Artificer might condense a mere atom of His own omnipresent but exterior substance into a world like this, and if into one world, might He not thus have created the universe?

You seem really to have wrought yourself up to a pitch of alarm on the supposition that my pantheistical theory might, if true, possibly involve the ultimate extinction of God! "It would be conceivable," you say, "in the formation

of many worlds, that God's substance should be *condensed away*, and God, as God, *cease to be.*" I fear you are becoming too sensitive on the possible obliteration of God from the universe, even if He has done, and continues to do, all that my hypothesis involves. Did you ever reflect upon what *omnipresence* signifies? Have you ever thought of the meaning of *unlimited space?* and then reflected that this vast illimitation is filled with the substantial and personal presence of God? Why, my dear brother, if God's substantial essence were a million times more attenuated than hydrogen gas, and had all the suns, visible by the aid of the telescope, just been condensed out of His exterior substance, they would altogether amount to less, compared to the whole of His essential being, than the diminutive substance of a pin's head contrasted with the myriads of suns and systems of worlds thus condensed! There is not the slightest ground, therefore, for such apprehension on your part, as there is not the least danger of the omnipresent Author of the universe condensing Himself away, or sensibly reducing even the outer cuticle, so to speak, of His substantial entity, should He continue on to eternity condensing worlds, as He has been doing in the past. Besides, it is reasonable to assume that an intelligent God would know enough to cease the work of condensing worlds before the danger you have supposed should become imminent!

You thus observe that my "pantheism" is of a very mild type, and even should it become epidemic there is no danger of its proving fatal to anybody or anything except to one very unnecessary article of the Westminster Confession of Faith, though I was reared to believe in it by as devoted and pious a father and mother as ever a boy had, and never thought of doubting it till I was recently forced to it by the stubborn facts of science.

I will now point out one of your misrepresentations (unintentional, I am willing to believe) of my teaching, as a fair specimen of others in your letter, and as I promised to do at the commencement of this reply. You argue, if the incorporeal organism expands and possesses less vital density with development, that when a man has grown old he must impart an "attenuated organism to the child," and you add, as if to show the absurdity of the whole thing,—"If *it* gains size by expansion, *this small portion of attenuated soul must, with each generation, become more attenuated, and it will not be long before the race is without soul.*"

Now I have no doubt, when you penned this sentence, you fancied you had struck a powerful blow at my position of an "incorporeal organism." Let us see. In my book, pages 426, 427, and in other places, in discussing the difference between human knowledge and animal instinct, I carefully show that the Creator, in forming each original species, delegated to the parents the power of imparting to the ovule an incorporeal "life-germ" embodying their joint specific vital and mental organism, but so condensed that it might expand to keep pace with the growth of the embryo, and thus form the invisible outline or structural guide for the deposition of the physical molecules from the mother's blood. I urged that each of the offspring also received with this life-germ the *same power* of imparting *similar germs*,—not *small portions of their own "organism"* or *"attenuated soul,"* as you so gratuitously assert, but a complete and condensed *life-form*, capable of expanding into that of the mature specific being; and hence that the father and mother, instead of imparting a "small portion" of their own vital structure, transfer to the ovule the *perfect germ* without any reference to their own age or vitally attenuated condition, so long as they are capable of procreation at all. I never intimated, or intended to intimate, such a stupid thing as that the father and mother transferred a portion of their own vital *organisms* or a fraction of their *souls*, to the ovule, and if anything in my book bears that construction it is an inadvertency of language. I hold and teach that the parents of all species are the *natural vicegerents* and *custodians* of the Creator for the impartation of these specific and perfect incorporeal germs to offspring. Hence the crude conception in your letter, that this "small portion" of the father's "attenuated soul" is given to the child, according to my view, as the capital stock for all future generations, and that this *fraction of soul* would be subdivided at each step of descent *till it would finally run out and become exhausted*, like Darwin's physical stock of "dormant germules," is a statement for which I am unable to frame any justifiable excuse. How could such a formless fragment of soul serve as a guide to the developing embryo? As I said in my first letter, in regard to the unjust and almost ridiculous charge of pantheism, I can sympathize with any man who could honestly mistake such a fragment of "attenuated soul," as the equivalent of this delegated power in nature of transferring a perfect "life-germ" to offspring by parents, so explicitly set forth in my published views.

Your objection to my theory, that it fails to explain "the unity of consciousness and its testimony as to *identity*," is singular to say the least. According to my view there is something to perpetuate consciousness of identity in the man or woman; for, when the immortal part leaves the "earthly house of its tabernacle," it goes into the spirit-world with an exact counterpart of its personal existence here,—its organs, shape, size, countenance, etc., and is the same essential, entitative being that it was on earth, and as it will be observed by spirit-eyes in that world. Hence mine is the only conceivable position in religious psychology upon which conscious and personal identity can be predicated of man in the next life. On the contrary, your view that the soul has neither atoms, constituent elements, parts, organs, senses, size, shape, countenance, nor anything else by which personal identity is recognizable here, since it is not an "organism," utterly excludes the possibility of the soul's identification in another life, by an intimate friend on earth, even should such friend happen to possess an extraordinary soul endowed with eyes and other sense-organs with which to make the examination. As we would scarcely be able to identify a friend here who had lost all his organs and senses, including head, arms, legs, etc., then, "reasoning

from analogy," I am at a loss to comprehend how a conscious, personal "identity," can have anything to do with another state of existence, or how John the Revelator could have *seen* "the *souls* of them that were *beheaded* for the witness of Jesus," since they must have been "*organless*," and as "headless" as were their bodies, if your view be correct.

As an illustration of the unreliability of your letter in matters of science, I need only refer to one of your twice-repeated statements. You say: "The objection I urged, *that matter could not acquire new properties by being attenuated*, was clearly to the point." Yet a more manifestly erroneous doctrine could hardly be condensed into so short a sentence. Among the distinctive properties of the *diamond*, for example, may be named its *hardness* and *brilliancy*, both of which are totally lost when this gem is attenuated by heat and converted into gas, though not a particle of the substance of the diamond ceases to exist. The same is true when we invert the illustration. For example, one of the characteristic properties of steam is its remarkable *elasticity*, yet, when condensed into *water*, this property of matter entirely disappears and is substituted by its exact opposite property called *incompressibility*. I could give a thousand illustrations, as there is not a solid or liquid body in Nature that would not, if attenuated, contradict your "science," while there is not a normally rarefied substance in existence which, if condensed to a solid or liquid form, would not take on "new properties" not possessed in its natural condition.

But I cannot now take time to follow you through all your misconceptions of my theory of creation, or to correct all your unscientific reasoning in regard to my hypothesis of an incorporeal vital and mental organism. I must, however, attend to one other matter on which you seem to lay special stress, before bidding you adieu. You appear to have discovered, near the close of your letter, a prodigious inconsistency in my supposition that God might condense a world or anything else out of an atom, so to speak, of His own substance. You present to me the fact that "the act of *condensing* implies a *condenser*." Yes; why not? Who would ever think of disputing this proposition? You then add, with your usual logical discrimination: "That the *condenser* and the *thing condensed* are *one and the same*, is inconceivable. Just as well might we say that the Creator and the thing created are identical. *In the name of science* [!] *I must protest against such unscientific statements.*" Yet even after this formal protest, I think you would admit that you might, if you should try, *pare your own finger nails, pulverize the fragments*, and then *condense them into a pellet*, and while you would readily understand how this act of condensing "implies a condenser," I doubt if even your own logic would lead you far enough to conclude that "the *condenser* and the *thing condensed*," in such a case, would necessarily be "*one and the same!*" "In the name of science I must protest," etc. It is only about a week ago that I saw a lady clip from her head a tress of hair, out of which she made a beautiful and artistic watch-chain; but it never occurred to me, that "the *creator* and the *thing created*," in that case, were necessarily "*indentical*,"— that this *lady*, in other words, and the *watch-chain* were necessarily "*one and the same*" because a part of her own exterior stucture was used in making this ornament! No; it did not occur to me till I was fortunate enough to receive your interesting communication. Possibly I may have been laboring under a pantheistical delusion in supposing that God possesses as much power as a finite human being. If I am mistaken in this estimate of the attributes of the omnipotent and omnipresent Author of the universe, I shall wait patiently to be set right in your next letter.

Very truly yours,

WILFORD.

NOTE.—In the preceding correspondence I have been compelled to differ from the Westminster Confession of Faith, concerning the creation of all things out of nothing, contrary to my former prejudices, and in opposition to most of my brethren of the Presbyterian branch of the church. Dr. Barr, as will be seen, admits that the Confession can be amended should a majority of Presbyterians consider its teachings upon this subject erroneous. Then I appeal to the clergy and laity of that influential denomination to take action at once, looking to the change of the first section of Chapter IV., since it is manifestly on its face contrary to the Bible, as will appear by the following quotation:

"It pleased the Father, Son, and Holy Ghost, for the manifestation of the glory of His eternal power, wisdom, and goodness, in the beginning to create or make of *nothing* the world and *all things therein*, whether visible or invisible, in the space of six days, and all very good."

Now it is perfectly plain that *man* and *woman* are included in "*all things therein*," and it is just as plainly evident that *man* was created out of the *dust* and *woman* out of a *rib*. Hence, the Confession is clearly in error in thus teaching that Adam and Eve were made of "nothing." I beg of the progressive ministers of this church, therefore, that they insist upon the immediate elimination of this erroneous section and thus free their hands for the impending conflict with atheistical scientists. If this section were of any real use either for the glory of God or the consistent vindication of religion, I should not insist so earnestly upon its elimination. But it is both unnecessary and untrue; and must cripple the efforts of religious philosophers in their contest with materialism. Should it be thus voluntarily expunged from the Confession, as here suggested, such a progressive step would tend to convince the world that the church is as ready and willing to make advances in the elimination of error and the adoption of new truths as scientists themselves; while such a willingness on the part of all denominations would tend ultimately to bring them together in the bonds of a real Christian union, whereby the battle against the enemies of religion might be successfully waged under one flag and to the glory of God.

CHAPTER IV.

WILL, MOTIVES, CIRCUMSTANCES, CHOICE, SOUL-EYES, EARS, BRAIN, ETC.

[Synopsis of Contents.]

The radical view, that Will is under the control of circumstances, examined.—This view prominently maintained by the late Robert Owen in his debate with Alexander Campbell.—The radical argument given in its strongest aspect.—Reasons why this view of Will, motives and circumstances cannot be correct.—The necessary and legitimate fruits of the doctrine, if universally taught and believed, prove it to be false.—The argument illustrated.—New definitions and distinctions in psychology and metaphysics growing out of the view of an incorporeal organism here maintained.—Size, form, etc., applies to the vital and mental entity, but not to its qualities or properties.—The errors of Metaphysicists pointed out.—Illustrated by quotations from Joseph Cook.—The soul must have eyes, ears, and brain.—Proved by the inventor and musical composer.—The analogy of Joseph Cook and Herman Lotze in favor of the soul's immortality examined.—It is shown to favor Materialism.—The true analogy given.

That man is a volitional being, capable of choosing his course in life,—that, in other words, he possesses a *will* which makes him the arbiter of his own destiny, at least to a considerable extent,—is just as self-evident a proposition as that he is an intelligent being, capable of thinking, reflecting, reasoning or judging about matters which come under his observation. Yet there are thousands of the more "radical" thinkers, as they call themselves, of the advanced class of scientific investigators, who have formed themselves into clubs in different cities of this country and Europe, the first article of whose creed is that *will* is a chimera, that the power of voluntary choice is a fallacy of psychology, and a mental delusion, and that man intrinsically is a puppet, a mere automaton operated by the wires and levers of circumstances over which his so-called will or volitional power of choice has no control whatever, and, that when he thinks that he acts freely he is in reality self-deceived, being forced to do just as he does by the irresistible power of some controlling motive which impels him. They insist that what we suppose to be voluntary choice, is no more free agency than the movement of a water-wheel in response to the weight of water acting with the stronger force upon one side of its periphery.

This was the position assumed by the great Scotch atheist, Robert Owen, in his debate with Alexander Campbell, at Cincinnati, about forty years ago, and it has been used ever since unsparingly by the "Liberal Clubs" all over the land, to the discomfiture of religionists who would happen to drop into these gatherings and essay to take part in their "liberal" discussions.

Now the line of demarkation between voluntary action and the coercive force of motives and circumstances is a very narrow one, I admit, and I do not hesitate to grant that it is exceedingly difficult, if not impossible, to determine in all cases just where freedom of choice begins and the force of motive ends. And I doubt if any mind is fully capable of analyzing, or even comprehending all the ingredients and influences of circumstances and motives on the one hand, and on the other hand of voluntary will-power and choice which go to make up the moral and spiritual qualities of an act, even when we make a certain act an absolute mental test to assist such analytical conclusion. If, for example, I make the lifting of my hand from the table a test of my power of choice, and then try to analyze metaphysically its relation to the motive which leads to the mental decision, and which determines the final act of raising my hand, it is seen

that we at once become involved in psychological distinctions and a blending of the confused overlapping of choice and motive-force which the mind utterly fails to untangle satisfactorily. I say I can raise my hand if I choose to do so. Certainly I can. But it requires some circumstance or motive to make me choose to lift it, rather than let it remain, such as a purpose to convince the one with whom I am conversing, or to convince myself that I have such power of choice. This circumstance then acts as the controlling motive which coerces my volition and forces my will to issue its command to the muscles of my arm, which finally proceed to lift my hand from the table in obedience to my will. But had the motives and circumstances been the other way, holding out the stronger inducement to allow my hand to remain upon the table, then evidently the *will* would have dictated to my muscles accordingly, and volition would have acquiesced, and, in a sense, my hand would have been *voluntarily forced*, if I may be allowed the paradox, to remain upon the table instead of being lifted from it.

I have thus admitted all that the most radical member of a "Radical Club" can ask, and have tried to state his case in its strongest possible light. And yet, when I have done all this, and after freely confessing that my mind is not capable of disentangling the interlacing fringes of this motive-force and volitional power of choice as they brush into each other, there is yet somehow a something that stands out clear and distinct above all this tangle, as conspicuously self-evident as that the mind has the power of thought, going to demonstrate the freedom of the will and the absolute power of choice somewhere in the midst of motives and circumstances as an independent prerogative of the mind over and above all these controlling influences. This, it must be admitted, seems self-contradictory, but I will now try to make it appear and prove that it must be so, and in doing this to settle, if possible, the most intricate problem in metaphysics that can be conceived of.

In the first place, no radical thinker of the Robert Owen type, let him philosophize and metaphysicize as he may, does believe or can believe any such doctrine as he teaches in regard to the absolute force of circumstances and motives, and by which the will is coerced and all choice is but the result of force. The very consitution of the human mind revolts at such a doctrine of coercion in defiance of our logic, and I may challenge any man to reason himself into it far enough to wipe out this intuitive, inborn testimony of consciousness that man has a free will, a power of choice, an ability to select between two motives and determine upon one or the other by what the soul recognizes as a voluntary act of choice.

In the next place, if man cannot thus decide, by choosing voluntarily between a number of motives set before him, then how can we account for this inbred lie of conscience, and why these punitory horrors which continually dog us for errors which we really have never committed but were rather forced by the strongest motive, like simple automata, to perform? Why this self-condemnation which frightens us with a false arraignment before conscience, when we were forced merely to act the crime by the influence of resistless circumstances, as a Punch and Judy are forced to slap each other in their mimic spats? If freedom of the will be really a chimera, and our power of choice a mental delusion, then evidently man is not responsible for his acts at all, any more than is a clock for stopping when its weights have run down. To say that there is a difference in the two cases, since man is an intelligent machine, and the clock is not, is to teach that just so far as there is a difference is there responsibility, and just so far is man free to act under the guidance of his will in his choice among motives and circumstances, which is all that constitutes human responsibility. Raise man just one slight degree above the water-wheel, and to the extent of that degree does he become responsible as a volitional being, and the arbiter of his own fortune. But make him, as this system of radicalism teaches, a mere creature of circumstances, absolutely chained to obey the behests of the strongest motives which he has no hand in originating, and that moment we obliterate all distinction in his actions between right and wrong, vice and virtue, and in so doing wipe out the social system and civil government. Carry out this doctrine legitimately, and all words making a distinction between acts good and bad, such as crime, wickedness, sin, wrong, right, good, bad, justice, injustice, virtue, vice, etc., have no use in the vocab-

ulary of life, and should be expunged from our dictionaries. If man really cannot act only as he is acted upon by circumstances, and cannot do a voluntary deed only as coerced by a motive which he has no hand in framing (except as some other motive or circumstance induced him to frame it), then he cannot be justly punished as a criminal, and our prisons and penitentiaries are but institutions of torture, and any ostracism by society of the criminal who has been thus innocently convicted, and who has served a term in prison as a felon, is simple cruelty, for the reason that the most flagitious crime, so-called, is in reality the most innocent act, since the victim of this legal torture and cruel ostracism could no more help doing as he did, according to this doctrine of Robert Owen, than could the water-wheel avoid turning under the weight of water, or than could the supposed criminal have prevented the circumstances in which he found himself placed.

But, in the third place, the worst feature of this doctrine, and that which, more conclusively than anything else, goes to show its fallacy as a law of ethics, and hence, its impossibility as a fact, is its necessary fruits, should it be everywhere taught and become the universal guiding law of our actions. It is only because the advocates of this doctrine do not believe it, nor act upon it; in other words, because they are superior to their philosophy, that they are not all in the State-prison. The truth is, they neither believe that they are without the power of voluntary choice in determining their course in life, nor do they teach such a blighting and ruinous doctrine to their children. They are very careful to impress upon their sons, whatever they may argue in their club-meetings, that their success in life depends upon the choice they make of their studies, their books, their habits, their recreations, their associates, their use of language, etc. No father who has the least regard for the future welfare of his son would dare to teach him that he is the absolute creature of circumstances, that he can only act as he is acted upon, or as he shall be influenced by the strongest motive, and that should he commit a crime, he is nevertheless as innocent in the eyes of all just and educated men as if he had done the noblest act, since all acts, good and bad, are alike, and equally the result of the strongest motive, and which we can no more resist than can a water-wheel fight against the weight of water in its buckets. But even should a father become so crazed by his radical fanaticism as to teach this doctrine in his family, it might still not work out its legitimate tendency and fruits in the lives of his sons, since the ineradicable sense of a free will and power of volition in the mental constitution of every sane person would shield such minds from the baneful effects of this abominable doctrine, whatever metaphysical difficulties or psychological complexity may stand in the way of our analyzing the hidden springs of thought and action as relates to the true influence of motives.

We can, however, readily imagine a state of society in which this radical view of ethical law is universally taught in schools and in the family circle, and that an entire community might be thus educated for generations, and taught to believe that man cannot help his actions, good or bad, and that, whatever he does, he is innocently coerced thereto by motives and circumstances over which he has no control. We have only, then, to suppose this people wholly isolated from the rest of the world, and under the exclusive influence of this doctrine, socially, politically, civilly, and in all the business relations of life, to imagine them sunken to the lowest depths of self-gratification (provided such a community could exist at all), the strong overpowering the weak, every man devoted to his own selfish ends, without regard to the wants or wishes of others, believing each act to be innocent whatever its turpitude, till finally chaos would take the place of all law and order, and worse than the worst phase of savage barbarity would usurp the place of all government and of all true ideas of civilization. We have supposed this case, though it is, perhaps, an impossible supposition, so long as the human mind is constituted as it now is, with an inbred consciousness of right and wrong, which can only grow out of the innate power of choice which every human being must feel that he possesses, and upon which alone the issues of life depend. There is not, therefore, the least danger that this radical doctrine of the overpowering mastery of circumstances and motives, however involved in mystery, will ever spread sufficiently to subvert society, based as it is upon the intuitive sense in

every man and woman that we are endowed with a free will by which, in the proper exercise of the power of volition, we may reject the evil and choose the good.

Assuming as I have been compelled to do in attempting to solve the problem of human life, that the living entity within our material bodies, —life, soul, mind and spirit,—constitutes an organism which is the complete counterpart of the physical structure, it has necessarily led me into several new principles of metaphysical psychology involving distinctions not hitherto recognized by religious metaphysicists in their attempts to refute materialism on the basis of the soul's existence. As my view of the soul, mind, and life thus makes them in combination a real incorporeal organism, I am necessarily obliged to attach to such structure the qualities of form, size, dimension, appearance, etc., the same as we apply to the corporeal body. Former writers, not recognizing this incorporeal organism, have confounded the vital and mental entity, called the soul, with its attributes or operations, such as *love, grief, hope, fear, anger*, etc., and because the qualities of size, form, and appearance would surely not be applicable to grief, joy, hope, fear, etc., they have fallen into the grave error of supposing that these properties are equally inapplicable to man's mental and vital entity itself. They have even tried to show this by asking the question, as if to ridicule the idea of the *form* of the soul, is grief *square* or *hexagonal?* Is joy *round* or *triangular?* Is hope *oblong* or *octagonal?* etc., thus making no distinction whatever between the soul and its operations or attributes. Such want of discrimination is hardly conceivable in great writers, but it is a fact. Even the usually careful metaphysical reasoner, Joseph Cook, may be cited as one who has fallen into this very error. I will quote a single passage in which this absence of all proper distinction between the vital and mental entity of our being and its operations or attributes prominently occurs :'

"When Cæsar saw Brutus stab, and muffled up his face at the foot of Pompey's statue, was his *grief round*, or *square*, or *triangular?* [Laughter.]" "When Lincoln, by a stroke of his pen manumitted four million slaves, was his *choice hexagonal* or *octagonal?*" "These questions show that the terms which we apply to *matter* are totally inapplicable and meaningless when applied to *mind.*"—*Lectures on Biology*, page 224.

In "mind," in this quotation, he evidently includes *soul, life, spirit*, since on page 154 he says: "Only *matter* and *mind* exist in the universe," and as *soul* is not *matter*, it must be embraced under the general division of "mind." Now, is it logical, not to use a stronger word, to teach that because a *property* of the soul is without form, being neither "square" nor "round," nor "triangular," that the soul itself is formless and bodiless, having no shape or appearance, could our eyes be illumined so as to see it? This eminent lecturer could just as readily and logically have proved that a bar of iron is without *size* or *shape*, and thus have shown that *form* is "totally inapplicable and meaningless when applied to" it, because its *density* or *fusibility* is neither *long, square*, nor *hexagonal!* He could with the same philosophical and metaphysical perspicacity have held a strip of wood in his hand, and declared to his audience that *shape* or *size* is "totally inapplicable and meaningless" as applied to it, since its *combustibility* is neither *big* nor *little*, neither *straight* nor *crooked!* Suppose he were exhibiting an India rubber ball to his audience, and should use no finer discriminating power in distinguishing between the properties of that body and the body itself than he did between the soul and its properties, he might be expected to reason something like this, varying the quotation slightly: "When I hold this ball in my hand and compress it between my fingers, you observe that *form* or *size* is 'totally inapplicable and meaningless when applied' to it, because its *elasticity* is neither *round*, nor *square*, nor *triangular*. [Laughter.]"

I forbear to comment upon the appropriateness or real drift of this "laughter," not knowing whether the audience detected or overlooked the truly laughable character of the reasoning.

It is thus entirely clear that the logic of our greatest metaphysicists which ignores an incorporeal organism, and would thus deny form to our vital and mental entity because its qualities or properties of grief and joy, hope and fear, are not of a certain shape, must also deny form to all material bodies because their known properties, such as hardness, density, elasticity or malleability are not square, flat, six-sided, straight or crooked.

To make this distinction still plainer, if possible, we ought to observe that the properties of all bodies or substances, like their motions, are not entitative, being merely the name which we give to a condition or relation of a thing and not a name applied to the thing itself. Thus, the properties of the soul or the attributes of the mind cannot have an entitative existence any more than can the qualities or properties of a material body, such as its ductility or fusibility; or any more than can its motions, which exist only in name, being our mode of designating its acts in changing from one position to another. So grief, love, joy, anger, etc., are but modes of motion of our incorporeal, vital, and mental organism, and in no sense are they an entitative part of the organism itself, any more than is the hardness of the diamond an entitative factor or part of this gem. I trust the reader grasps the metaphysical and philosophical distinctions here pointed out.

But there are other classes of psychological facts or principles growing legitimately out of this view of an internal vital and mental organism, and which have an unanswerable bearing against materialism, facts which no metaphysicist, who does not recognize such an incorporeal structure or psychical organism, has any right to use or can use. I refer, in the first place, to the fact that in the darkest night, with our bodily eyes closed, we can clearly see with the eyes of our mental and vital organism objects and forms as distinctly and vividly as we might behold the same things with our corporeal eyes, and in broad day light. Yea, more vividly and distinctly. And this is not to be explained on the principle of *memory*, since, as every inventor knows, new machines, never seen before by

mortal eye, have been figured out and their working parts all seen to operate with the utmost distinctness by the psychical and mental eyes alone, as a real prophetic vision of what is afterward put into corporeal form. Tell such an inventor that his vital and mental entity is organless,—that the soul is sightless, even with the physical orbs extinguished,—and he will pronounce you an ignoramus, incapable of properly analyzing your own mental workings. If our vital and mental being is not an organism, then how does the soul possess eyes with which it sees even more acutely than with the external organs, and can behold every wheel of a complex chronometer, *even through its case*, a thing impossible to do by means of the physical sense of sight?

The same thing is true of the other senses. We can hear sounds with our psychical and mental ears that we never heard through the physical tympanic membrane. Take the musical composer as an example. He lies in his room surrounded with darkness, and when all is still as the chamber of death. His thoughts turn to his art and to his favorite employment. He touches the keys of his piano with the fingers of his soul and feels them tremble under the touch as truly and as substantially as if his corporeal digits pressed the veritable ivories. He sees upon the music sheet before him the staves and bars and notes as vividly as he ever saw them with his bodily eyes, and, what is more, he sees new combinations of notes that never existed before; and lastly, he *hears* the strains of the new music with his psychical ears, and which make an impression upon his mind so imperishable that the next morning he goes to his piano and plays the new concerto from memory, and writes down every note just as the *fingers* of his soul felt them, the *eyes* of his soul saw them, and the *ears* of his soul heard them, and in the original production of which neither his corporeal fingers, eyes nor ears had anything to do. If the soul be not an organism, how can such mental and psychical phenomena as these be accounted for?

In reading the metaphysical arguments of our greatest reasoners, drawn from the analogies in Nature, aimed to meet and break down materialism by demonstrating the existence of the soul, how often have we felt the utter weakness of the logic, and seen the whole chain of reasoning fall into a mass of broken links for the want alone of this rational view of the problem of human life which makes the soul the "inner man," constituting it a substantial organism as real in form, outline, and detail of structure as is the veritable organic body that we see with our physical eyes and handle with our physical hands!

I reluctantly refer again to the lectures of Joseph Cook, only as an explicit illustration of the point I am making and by which to impress it upon the mind of the reader, and not in any way to disparage the valuable services of this great worker in psychological science and religious philosophy. In his Lectures on Biology he employs the following analogical argument to prove the existence of the soul as a distinct entity, separate from, and external to, the brain. The reasoning is like this: The *eye* cannot *see* without the aid of *light*—an agent wholly external. The *ear* cannot *hear* without the aid of *sound*—an agent wholly external. So the *brain*, being inert, cannot *think* without the aid of the *soul*—an agent equally external. And as the destruction of the *eye* does not destroy the external agent, *light;* or the destruction of the *ear* does not destroy the external agent, *sound;* so the destruction of the *brain* does not destroy the external agent, *soul*. And to show the importance of this analogical argument in support of the substantial nature of the soul, he refers to Dr. Beale, author of the great work on Bioplasm, Dr. Draper, Hermann Lotze, and others who have used this same analogy in support of the immortality of the soul.

To a casual reader this illustration seems severely logical and conclusive, but when carefully examined under the "logical microscope," as Mr. Cook is in the habit of doing, it is seen to be incurably lame at every joint, and out of which Prof. Huxley could crush the life with his thumb-nail, and show that, in every feature, it is directly favorable to materialism. This I propose to allow him to do, but let me first quote the exact words of the lecturer:

"26. As, therefore, from the structure of the *eye*, we may infer the existence of a *wholly external agent, light*, or from that of the *ear*, the existence of a *wholly external agent, sound*, so, because of the absolute inertness of the cerebral structure in itself, we must attribute its activities to an agent *as external to it as sound is to the ear, or light to the eye.*" "That agent is the *soul.*"

"30. As the dissolution of the *eye* does not destroy the *light*, the *external agent which acts upon it;* and as the dissolution of the *ear* does not destroy the *pulsations of the air*, the *external agent which acts upon it;* so the dissolution of the *brain* does not destroy the *soul*, the *external agent which sets it in motion.* [Applause.]"—Biology, pp. 181, 182.

To all of which Prof. Huxley would reply: "Though the dissolution of the *eye* does not destroy the external *light*, yet it *does* destroy the power of *seeing;* and of what use would light be if the sense of seeing were obliterated? And though the dissolution of the *ear* does not destroy external *sounds*, yet it *does* destroy the power of *hearing;* and of what use would sound be if the sense of hearing were obliterated? And though the dissolution of the *brain* may not destroy that non-atomic etherial enswathement, called *soul*, yet it does destroy the power of *thinking* and *feeling;* and of what use would such an enswathement be with all *thought* and *feeling* obliterated?"

"And again," Prof. Huxley continues, "you make *light* an agent external to the *eye*, and *sound* an agent external to the *ear*, as *soul* is an agent external to the *brain*. Now, you admit that both *light* and *sound*, according to all established principles of science, are mere modes of motion, one of the particles of *ether* and the other of the particles of *air*, and that neither of them are substantial entities. This is plain by your speaking of sound as 'pulsations of the air.' The only conclusion, then, from this analogy is, that the *soul*, the agent external to the brain is also a *mode of motion* and not a substance of any kind, being merely the complicated motion of

the brain molecules, as my friend, Prof. Haeckel contends, placed together in a most varied manner. And since sound necessarily ceases to exist (not being substantial) when the pulsations of the air cease; and as light no longer exists (not being a substance) when the etherial undulations which constitute it cease, of course the soul will also cease to exist when the molecular undulations of the brain subside! Your illustration, therefore, of the relation of the soul to the brain by two universally admitted *modes of motion, neither of them substantial*, hands over your analogical argument into my hands as one of the most valuable trophies of materialism that I have yet seen, going to demonstrate, as all materialists claim, that the soul is but a mode of motion of the ultimate molecules of the brain, and in no sense a substantial entity. Unless, therefore," Prof. Huxley concludes, "you peremptorily reject the undulatory theory of sound and light, and adopt the view of the author of the *Problem of Human Life* that sound, as well as light, is a real *substance*, you are placed *hors de combat*, and are forced to train, from this on, in the ranks of materialism."

I beg of Joseph Cook and Hermann Lotze not to take offence at my putting into the hands and mouth of Prof. Huxley this disastrous reply to their supposed analogical proof of the soul's immortality, which turns out to be so complete a demonstration in favor of materialism. It is better that a friend should strike this blow than an enemy, since soon or late the blow was certain to come unless materialism has lost its senses. However deep its cut or keen its smart, there is a balm for the wound, if they will accept it, which will not leave even a cicatrice to tell the tale of its infliction. That balm is the incorporeal "enswathement" of the vital and mental organism, which these great advocates of religion have so strangely overlooked in framing their analogical arguments in support of the soul's immortality.

On the supposition that the soul is a veritable organism, it is plain that it must possess *eyes* and *ears*, as well as a *brain*. This being so, its eyes must really be the means by which the physical eyes see, and its ears the means by which the physical ears hear, and consequently the brain of the soul must really be the means by which the physical brain thinks. We prove this by the fact that the corporeal man can neither see, hear, nor think when he is dead, though his physical eyes, ears, and brain remain intact and continue as perfect in every part of their corporeal structure as when the man was living. Why, then, can he not *see*, *hear*, and *think?* Because the soul-organism has left its "earthly house." The incorporeal eyes, ears, and brain of the "inner man" have departed, leaving their tenement vacant, which is all that is meant by death, when we come to comprehend it. The corporeal eyes, ears, and brain remain in every respect as before dissolution, but that which did the seeing, hearing, and thinking,—this psychical organism of the real man,—has made its exit, though it is no less an entity because of its independent existence and new mode of life than is the *imago* when it takes its papilionaceous flight, bidding adieu to the no longer needed chrysalis.

Now where comes in the true analogy in the case to help out this very lame attempt to utilize the undulatory theory of light and sound, and which has so unwittingly proved the soul to be but a mode of motion, thus handing over bodily the whole question of immortality to the materialists? It is here. I have shown by reference to the inventor that the eyes of the soul can really *see* when the bodily eyes are closed, and consequently without the aid of external light. I have also shown, by reference to the musical composer, that the ears of the soul are really capable of *hearing* musical strains without the aid of any external sounds, or any action whatever upon the tympanic membrane and auditory nerve. Then reasoning from analogy, the *brain* of the soul may *think* while the physical brain remains totally quiescent as in sleep. Carrying out this line of thought still further: As the eyes of the soul can really *see* without the aid of the physical eyes, it follows that they could still see if the physical eyes were totally destroyed, which is known to be a fact. As the ears of the soul can really *hear* without the aid of the corporeal ears, it follows that the same thing would be true if the bodily ears were totally destroyed, also known to be a fact. Consequently, by the clearest analogy, it follows that the *brain* of the soul could continue to *think* were the physical brain totally destroyed. This kind of analogy comes home to our experience, and however defective it may be, in some of its details, it at least gives no aid nor comfort to materialism; while with the additional fact of the existence of the vital and mental organism scientifically established, and shown to be an absolute necessity to account for observed phenomena, otherwise wholly inexplicable—as I claim to have done—then this analogical proof of man's immortality becomes equally a scientific and rational conclusion. But without this recognition of the organic nature of the soul, possessing eyes, ears and brain, as the real entity in the physical man which does the seeing, hearing, thinking, and, in fact, performs all the other functions of life, no analogy will hold in favor of a future conscious existence, or prove worth a rush in combating the materialistic philosophy of the day. Without this definite recognition of the continuous and conscious existence of the "inner man," with his organs and faculties complete, all attempts at a rational solution of the problem of human life will end in signal failure, leaving the immortality of the soul but a visionary hypothesis, no more definite or satisfactory to the anxious and inquiring mind than would be the last evanescence of a fading hope, or the gossamer outlines of a half-forgotten dream.

[NOTE.—Readers who may not be specially interested in the discussion of purely physical science might profitably, at least for the present, skip the following two long chapters on Sound (V and VI), and continue the investigation of the Problem of Human Life, and the discussion of evolution, materialism, spontaneous generation, etc., in the seventh, eighth, ninth, tenth, and eleventh chapters, beginning at page 351. Those, however, who may desire to read a condensed epitome of the entire Sound question, will find it in the sixteen pages of the Addenda to Chapter VI, embracing the Brockett-Wilford discussion of the Wave-theory, and the Kephart objections with the author's replies, commencing at page 335. These sixteen pages, in fact, prepare the way for a better understanding of the monograph itself.—PUBLISHERS.

CHAPTER V.

EVOLUTION OF SOUND.—REVIEW OF PROFS. TYNDALL, HELMHOLTZ, AND MAYER.

The Wave-Theory of Sound Assailed.—A New Hypothesis of Substantial Sonorous Corpuscles Proposed.—The Difference between the two Hypotheses Pointed Out.—No Middle Ground is Possible between the two.—Hence, if Wave-Motion Breaks Down the Corpuscular Hypothesis must be Admitted.—All Phenomena of Sound claimed by the Writer to be Explicable on the basis of Substantial Pulses.—Several Illustrations Given.—Sympathetic Vibration Explained.—Resonance Proved to be Utterly Inexplicable by the Wave-Theory.—Many Illustrations brought to bear.—The Superficiality of Physicists Pointed Out.—Laughable Illustrations from Tyndall and Helmholtz.—Resonance Explained.—The True Law of Sound-Generation given for the first time.—Magazine Explosions Considered, and Turned Against the Wave-Theory.—Professor Mayer's Unphilosophical Reasoning Reviewed.—The Falling Pitch of a Locomotive-Whistle on Passing a Station Considered.—Other Objections Answered.—Reflection and Convergence of Sound Explained.—"Condensations and Rarefactions" shown to be Fatal to the Wave-Theory.—The Illustration of the Stridulation of a Locust shown to be Disastrous to the Wave-Hypothesis in many ways.—Professor Mayer's Fatal Admissions.—A Locust must exert Millions of Tons of Mechanical Force by the Motion of its Legs if the Wave-Theory is true.—Shown in Numerous Ways.—A Serious Scientific Mistake Perpetrated by Professor Tyndall.—The Propagation of Sound by Means of Sonorous Corpuscles Explained and Contrasted with Wave-Motion.—The Discrepancy Discovered by Newton of 174 feet a Second in Sound-Velocity Fatal to the Theory.—Laplace's Solution Proved Fallacious.—The Law of Sound-Velocity, or the Relation of Density to Elasticity, Examined.—Amusing Self-Contradictions of Professor Tyndall.—Why has the Current Theory of Sound, if False, not been Assailed before?—An Overwhelming Argument against the Theory drawn from the Supposition of Tympanic Vibration.—Over-Tones, Resultant Tones, &c., Examined.—Helmholtz's Analysis of the Ear Reviewed.—His Numerous Self-Contradictions and Inconsistencies Pointed Out.—Beautiful Analogies in Nature favorable to the Corpuscular Hypothesis.

Up to this point in the investigation of the so-called natural forces or modes of motion, I have only hinted that Sound, as well as Light and Heat, must, in the very nature and fitness of things, be a substantial entity, consisting of corpuscular emissions or some kind of atomic emanations. I now come to the work of argument and proof, and shall endeavor to satisfy the reader, in this and the following chapter, however exacting he may be, not only that the above position is every way reasonable and probably true, from innumerable facts and analogies, but that the current and universally accepted wave-theory of sound is demonstrably a pure and simple fallacy of science, founded upon the most superficial misapprehensions of Nature and her laws,—thus rendering the substantial nature of sound logically sustained by excluding the only other possible assumption—wave-motion.

I am aware of the magnitude of the task I have undertaken to perform, and have considered well the full import and consequences of assuming in this seventh decade of the nineteenth century to overturn an established theory of science,—especially a theory like that of *Sound*, which has not only stood unshaken for centuries, but has

never been so much as called in question or doubted by a single scientific writer for 2,500 years, or since its origination in the time of Pythagoras.

The truth is, the wave-theory—or, as it is popularly known, the undulatory theory—of sound has been so long in existence with no one to question its correctness, that modern physicists have been in the habit of accepting it, handed down from generation to generation, with all its unspeakable difficulties, as a kind of legacy bequeathed from scientists of the past; and, with an acquiescence unparalleled in the annals of physical investigations, have labored to explain its inexplicable contradictions and reconcile its infinite absurdities, with a patient persistence which a love of science can alone inspire. Hence it is that no physicist has had the hardihood, if he had the originality, to cut loose from the ancient landmarks of the theory, or to venture an hypothesis to take its place. The writer of these chapters is a solitary—possibly an unfortunate—exception, the result of whose venture the following pages will disclose.

I will only extend these introductory remarks here by adding that I have not ignored the important fact in thus attempting to revolutionize the theory of Sound, that I have to meet face to face the powerful intellectual abilities of such physicists as Helmholtz, Tyndall, Kuntz, Blacerna, Mayer, and a host of others, either one of whom, when it comes to the investigation of questions relating to physical science, is sufficient to make a cautious writer quail and hesitate, and even repudiate the deliberately formed convictions of his own judgment. This was the actual impression on my own mind for many months before putting pen to paper, even after I had become thoroughly satisfied in reading, experimenting, and investigating, that the wave-theory though ingenious was purely visionary, having not a single correctly understood fact of science on which to rest. I have at last thrown off my natural timidity and hesitancy, and, though the combat may be mortal on my side, I shall not have proved the first one who has immolated himself upon the altar of his scientific convictions.

It should be observed that Sir Isaac Newton held to the substantial or corpuscular theory of light, but which he was finally forced to abandon for the undulatory theory based upon the supposed existence of an intangible *ether* filling interstellar space, for which, by the way, not one scintilla of scientific proof exists. It was claimed by Newton's opponents that the *refraction* of light could be more easily explained by waves of some kind of substance, and hence this wonderful *ether* was invented to meet the trouble. Was there ever, before, such a trifling scientific difficulty magnified into such importance as actually to require the invention of a substance filling all space to meet it? (Query Why do not scientists invent a substantial *God* filling all space to account for ten thousand times greater difficulties in Nature? Is it because the natural heart is at enmity against *God*, but not against *ether?*) Had Newton thought of the simple fact that light is generated in *pulses* or *waves* by the incandescent tremor of luminous bodies, he need not to have been driven from his ground; for surely *a wave of substantial light itself will just as readily explain refraction as a wave of this supposed ether!* What was the use of inventing an all-pervading substance out of which to construct wave-motion, when substantial light, emitted in pulses or waves (as it really is), accomplishes the same result?

Sound is a parallel phenomenon every way we can view it, as it is well known to every scientific student that it was only the universally acknowledged fact that sound-phenomena resulted from the supposed undulatory motion of the air, which

led philosophers to the invention of this all-pervading luminiferous ether, extending, as is supposed, to the very outmost limits of telescopic vision, if not throughout all space. When Professor Young first suggested such a substance as *ether*, whose undulations might explain certain phenomena resembling those of sound, which no one had ever suspected to be other than caused by air-waves, it did not occur to this learned investigator that air-waves themselves, as the means of sound-propagation, were a pure fallacy of science, without one fact, or, when fully analyzed, appearance of fact, to warrant them,—as will fully appear in due time.

I am well aware that an intimation like this, after so many learned treatises on sound as the result of wave-motion have appeared from pens like those of Helmholtz and Tyndall, will naturally awaken in the scientific mind a feeling of contempt for its author, mingled perhaps with commiseration. Even my most intimate friends have warned me to desist from publishing these chapters, unless I wish to make myself ridiculous in the eyes of the scientific world, and be set down as a first-class candidate for a lunatic asylum. But as I have counted the cost and am not at all convinced of my insanity, I have, of course, declined the advice so gratuitously tendered.

Before introducing a single argument against the hypothesis that sound is propagated by means of atmospheric undulations or any other kind of wave-motion, I wish to clearly state the difference between the old and the new hypothesis of sound-propagation, and to name some of the well-recognized facts of these phenomena, on which there can be no controversy or difference of opinion, as the basis of all future argument. I do not propose to tear down the wave-theory without framing an hypothesis to take its place, and one which will serve as a basis for the solution of the undeniable problems presented in sound-phenomena. While maintaining, as I do, that the wave-theory is a most transparent and unmitigated scientific fallacy, I as strongly insist that, such fact being clearly established, there is nothing else left for sound to be but *substantial emissions.* It does not seem to me that a reflecting mind can draw any other conclusion than corpuscular emanations of some kind of substance, however attenuated it may be, if first of all the wave-theory breaks down hopelessly, as I shall attempt to show it must.

Even if the substance constituting these sonorous pulses were conceded to be as attenuated as the material atoms composing Professor Tyndall's *gelatinous luminiferous ether* which forms the basis of light-waves, I should still maintain that such substantial emanations are every way reasonable and consistent with Nature's analogues, many of which I will take occasion to introduce as the argument advances, while no advocate of the undulatory theory of light, and of these substantial *waves* of *ether* moving freely among the molecules of the diamond, can reasonably object to substantial discharges of sound, when, as I have just had occasion to intimate light itself could just as well be supposed to radiate in the form of substantial waves or pulses, as first to ignore such a substance entirely, and then substitute another material (luminiferous ether) almost infinitely more difficult to accept.*

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* "To account for the enormous velocity of propagation in the case of light, *the substance which transmits it is assumed to be of both extreme elasticity and extreme tenuity.* This substance is called the *Luminiferous Ether.* It fills all space; it surrounds the atoms of bodies. . . . The molecules of luminous bodies are in a state of vibration. The *vibrations*

I admit at once, in thus assuming what must now be unavoidable in my hypothesis,—namely, that the chirping of a cricket fills the surrounding air with substantial emanations,—that I invite, at first sight, the incredulity if not the ridicule of all scientific thinkers; but while this hypothesis will be shown to be entirely consistent with other well-known natural phenomena all around us, which no well-informed mind can doubt, it will be demonstrated that, according to the universally accepted wave-theory, the cricket is actually made to perform a miracle of physical power compared to which the crushing of a granite rock to powder by the drifting against it of a thistle-pappus would be as nothing.

I may also add, in this connection, that it never was thought of being urged in the arguments with Sir Isaac Newton, who strongly held to the corpuscular theory of light, that there was any possible middle ground between that view and the undulatory hypothesis; but rather it was tacitly conceded that if one was disproved the other was clearly substantiated. It was never intimated by any opponent of Newton's hypothesis—not even by the great mathematician Laplace—that if ether-waves were absolutely shown to be fallacious and impossible, some other hypothesis might be suggested besides substantial emanations. It seemed to be conceded on all hands that if wave-motion fell to the ground, the fact became established that light as substance of some kind must be taken for granted.

So, also, stands the question as regards sound. If atmospheric wave-motion is ruled out by fair logic and incontrovertible facts, there is no middle ground which can be assumed between it and substantial emissions. Professor Helmholtz lays down the principle in logic and science that a proposition is fairly sustained by the exclusion of all other supposable assumptions. I shall therefore avail myself of this logic (since something must cause the sensation we term sound), and insist that if I shall clearly succeed in demonstrating the fallacy of wave-motion as the cause of sonorous sensations, then the corpuscular theory becomes necessarily established till such time as physicists shall discover and elucidate some more plausible middle ground as a solution of sound phenomena. I doubt not the scientific reader will readily admit the fairness and logical necessity of the position here assumed.

What, then, is the real difference between the two hypotheses, one or the other of which must be accepted?

Sound is undoubtedly generated by the *vibratory motion* of whatever instrument produces it, just as light is admitted to have its origin in the *tremulous motion* of the incandescent molecules of luminous bodies. Sound thus produced is claimed in this hypothesis to be a finely attenuated substance, which is radiated from the sound-producing body by an unknown law of diffusion, just as the radiant atoms of light, heat, magnetism, electricity, and even odor, are sent off from their respective sources.

Science, as yet, has given us no light on the subject of radiation or conduction. It even can not explain osmotic action, or why liquids of different densities tend to mix or project their particles through each other, in opposition to the law of gravity; or why grains of odor tend to shoot through

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are *taken up by the ether* and *transmitted through it in waves*," &c.

"In fact, the mechanical properties of the *ether* are rather those of a *solid* than of an *air*."—"The luminiferous *ether* has definite mechanical properties. It is almost *infinitely more attenuated than any known gas*, but its properties are those of a *solid* rather than those of a *gas*. It resembles *jelly* rather than *air*."—TYNDALL on "Light," pp. 57, 60.

still atmosphere at considerable velocity, much less by what law magnetic atoms dart off from the poles of a magnet in ceaseless streams, or what motile force sends electric fluid through a wire at almost inconceivable velocity. It is enough for us, in the present investigation, to know that such laws of radiation and conduction do exist, and that each of these incorporeal substances named, if they be substances, such as Light, Heat, Magnetism, Electricity, Gravitation, Odor, and Sound, has its own peculiar law of radiation and conduction, suited by the Allwise Lawgiver to the use which each of these imponderable substances is intended to serve.

As sound is generated by the vibratory action of the instrument which produces it, and consists (as I assume) of atomic emissions, it is in strict accordance with philosophy and reason that these corpuscular emissions should be radiated in sonorous *pulses* or *discharges*, instead of continuous streams, each discharge synchronizing with the vibratory movement of the string or other instrument which generates it, exactly as I have assumed light to be emitted from stellar bodies.

The distance between these discharges as they pass off, or the interval occurring between their transmissions, determines the pitch of the sound. If the vibratory oscillations of the instrument be slow, thereby causing a low pitch, then the synchronous discharges of the sonorous substance will strike the tympanic membrane of the distant listener exactly the same intervals apart, and consequently will produce the same pitch of tone there. But if the sound-producing instrument vibrates rapidly, the sonorous discharges must necessarily pass off with a corresponding rapidity, and reach the ear with a correspondingly higher pitch of tone. Such discharges radiate through the atmosphere at ordinary temperature—say sixty degrees Fahrenheit—at 1120 feet a second, as proved by careful observation.

If sound consists of substantial atoms, as I propose to show must be the case before I conclude this treatise, then it must travel through whatever body conducts it—let that be air, water, wood, or iron,—in the manner here described, namely, as sonorous *pulses* or *discharges*, such discharges and vibrations keeping up their perfect synchronism or periodicity.

The current theory of sound, in speaking of these sonorous discharges, calls them "*air-waves*," and the intervals occurring between them "*wave-lengths*," which determine, in the same manner as I have described, the pitch of tone. If the vibratory motions of the instrument be *slow*, the *air-waves* supposed to be "moulded" and sent off by such vibrations are said to be *long*, or to be of a considerable distance from crest to crest or from sinus to sinus, or, to use the technical phrase, "from *condensation* to *condensation*, and from *rarefaction* to *rarefaction*," as expressed by all writers on the subject. If the vibrations of the string or other sound-producing body be *rapid*, the *waves* will be *short* and the pitch of the sound correspondingly *high*. The undulatory theory teaches that these *air-waves* are moulded by the string or tuning-fork into "condensations and rarefactions," and sent off in this form to the ear, however distant so the tone is audible, producing the sensation of sound *by the successive dashing of these air-waves against the tympanic membrane*, thus causing the drum-skin of the ear to oscillate synchronously to such waves. Hence, that these *air-waves*, moulded and sent off by the vibrating string or fork, *must travel undistorted the entire distance the sound is heard, it matters not what counteracting currents, waves,*

sounds, or atmospheric disturbances may cross their path!

Perhaps there is no better place than right here to make a few brief citations from the highest living authorities on this subject, in order that the real position of scientists on the current wave-theory may not be misunderstood. These citations are selected because they concisely embody the popular notions regarding sound-waves, with an authority which is looked up to as standard in all our institutions of learning. I request the reader to carefully read them; and, if not familiar with this branch of scientific investigation, to study them, as a proper comprehension of their teaching will save time in prosecuting the argument, and prevent the necessity for frequently recurring to this list of passages. All my quotations from Professor Tyndall's *Lectures on Sound*, in the course of this argument, will be made from the second edition, except in a few instances from the third edition, which will be indicated. This occurs for the reason that most of the arguments were prepared before the third edition of *Lectures on Sound* was published. Professor Tyndall remarks as follows:—

1.—"With regard to the point now under consideration, you will, I trust, endeavor to form a definite image of a *wave of sound*. You ought to see mentally the *air-particles* when urged outwards by the explosion of our balloon crowding closely together; but immediately behind this *condensation* you ought to see the *particles separated more widely apart*. You ought, in short, to be able to seize the conception that a *sonorous wave* consists of two portions, in the one of which the *air is more dense* and in the other of which *it is less dense than usual*. A *condensation* and a *rarefaction*, then, are the two constituents of a *wave of sound*."

2.—"Fix your attention upon a *particle of air as the sound-wave passes over it;* it is urged from its *position of rest towards a neighbor particle*, first with an *accelerated motion* and then with a retarded one. The *force* which first urges it is opposed by the elastic force of the air, which finally stops the particle, and causes it to recoil. . . . The *distance* through which the air-particle *moves to and fro, when the sound-wave passes it*, is called the *amplitude of the vibration*. The *intensity* [loudness] of the sound is also proportional to the *square of the amplitude*."

3.—"The motion of the *sonorous wave* must not be confounded with the motion of the *particles* which at any moment *form the wave*. During the passage of the *wave every particle* concerned in its transmission makes only a *small excursion to and fro*. The *length of this excursion* is called the *amplitude of the vibration*.'

4.—"A sonorous wave consists of two parts, in one of which the *air is condensed*, and in the other of which *rarefied*. . . . In the *condensed* portion of a sonorous wave the *air is above*, in the rarefied portion it is *below the average temperature*. . . . *This change of temperature produced by the passage of the sonorous wave itself virtually augments the elasticity of the air, and makes the velocity of sound about one sixth greater than it would be if there were no change of temperature*. . . . When I speak of a sonorous wave I mean a *condensation* and its associated *rarefaction*. . . . When a body capable of emitting a musical sound—a tuning-fork, for example—vibrates, it *moulds the surrounding air into sonorous waves*, each of which consists of a *condensation* and a *rarefaction*."

5.—"We have already learned that what is *loudness* in our sensations is *outside of us* nothing more than *width of swing* or *amplitude* of the vibrating *air-particles*."

6.—"Having determined the rapidity of vibration, the *length* of the corresponding *sonorous wave* is found with the utmost facility. Imagine this tuning-fork vibrating in free air [384 vibrations to the second]. At the end of a second from the time it commenced its vibrations, the *foremost wave would have reached a distance of* 1090 *feet* in air at the freezing temperature. In the air of this room, which has a temperature of about 15° Cen., it would reach a distance of 1120 feet in a second. *In this distance*, therefore, are embraced 384 *sonorous waves*. Dividing, therefore, 1120 by 384, we *find the length of each wave to be nearly* 3 *feet*."

7.—"How are we to picture to ourselves the *condition of the air* through which this *musical sound* is passing? Imagine one of the prongs of the vibrating fork swiftly advancing; it *compresses the air* immediately in front of it, and when it retreats it leaves a partial vacuum behind, the process being repeated by every subsequent advance and retreat. The whole function of the tuning-fork

is to *carve the air into these condensations and rarefactions*, and they, as they are formed, propagate themselves in succession through the air. A *condensation* with its associated *rarefaction* constitutes, as already stated, a *sonorous wave*. In *water* the *length of a wave* is measured from *crest to crest;* while in the case of sound the *wave-length* is given by the *distance between two successive condensations*. In fact, the *condensation* of a sound-wave corresponds to the *crest*, while the *rarefaction* of the sound-wave corresponds to the *sinus of the water-wave*."

8.—"Figure clearly to your minds a harp-string vibrating to and fro; it advances, and causes the *particles of air* in front of it to *crowd together*, thus producing a *condensation of the air*. It retreats, and the *air-particles* behind it separate more widely, thus producing a *rarefaction of the air*. The string again advances, and produces a condensation as before; it again retreats, and produces a rarefaction. In this way the *air* through which the *sound* of the string is propagated is *moulded* into a regular sequence of *condensations* and *rarefactions*, which *travel* with a velocity of about 1100 feet a second. The *length of the wave* is measured from the *centre* of one condensation to the *centre* of the next one."

9.—"We must devote a moment's attention in passing to the word 'amplitude,' here employed. The pitch of a note depends solely on the number of *aerial waves* which *strike the ear* in a second. The *loudness* or intensity of a note depends on the *distance* within which the separate *atoms of the air vibrate*. This *distance* is called the *amplitude* of the vibration."—TYNDALL, *Lectures on Sound*, pp. 5, 11, 44, 46, 48, 62, 69, 83.—*Heat as a Mode of Motion*, pp. 225, 372.

I also quote from Professor Helmholtz:

10.—"Suppose a stone to be thrown into a piece of calm water. Round the spot struck there forms a little ring of wave, which, advancing equally in all directions, expands to a constantly increasing circle. *Corresponding to this ring of waves sound also proceeds in the air* from the excited point, and advances in all directions as far as the limits of the mass of air extend. *The process in the air is essentially identical with that on the surface of the water.*"—HELMHOLTZ, *Sensations of Tone*, p. 14.

I have numbered the foregoing citations in view of possible reference to them as the argument advances.

With these passages before the reader there need be no difficulty in grasping the essential features of the wave-theory of sound, which, in fact, up to the present moment, is the only hypothesis ever advanced, so far as I have been able to learn, by which to explain these well-known phenomena. Other passages will be quoted, from time to time, as special questions come up for discussion.

Believing, as I do, that the new hypothesis of sonorous discharges of some sort of attenuated substance will fully and satisfactorily explain all phenomena observed in sound, even better than they can be explained by physical and mechanical air-waves, I will at once make a practical application of the corpuscular theory to a few problems which have been always looked upon as conclusive proof of the air-wave hypothesis.

The first and one of the most prominent examples of this kind is that of *sympathetic vibration*, or the surprising fact that if two strings or forks are tuned to perfect unison or in such a way that they will make exactly the same number of normal oscillations in a second, and if one of them is thrown into vibration, its unison neighbor if placed near enough to it will also start into vibratory motion, and sound audibly without any connection whatever with the actuating string or fork except the intervening air.

The reason assigned for this by the advocates of the current theory, is, that the air-waves moulded and sent off from the excited string or fork, striking against its unison neighbor in synchronism with its own normal tendency to swing, start it gradually into oscillation, very feebly at first, but each succeeding air-wave dashing against it in perfect periodicity to its own vibrations, gives it a new impetus at every blow, till finally this sympathetic motion is brought to its maximum. This phenomenon, first observed by Pythagoras

over twenty-five hundred years ago, was, perhaps, the origin of the atmospheric wave-theory, since which time it has reigned supreme, never having been called in question by any succeeding investigator of sound. It is, therefore, a venerable and highly respectable theory with which I have undertaken to deal in this discussion.

Though I shall undertake to show that the above explanation can not be the true solution of this sympathetic problem, and that it must be, therefore, a clear mistake based on superficial observation, yet, before doing so I will gradually prepare the reader for the new solution of this singular physical effect, that the two explanations may be placed in juxtaposition before him.

I assume that there is a veritable sympathetic attraction potentially existing in every sound-producing body for every other sound-producing body which has or may have a unison or synchronous vibration. The unison condition alone develops this sympathetic attraction into practical operation. As the analogue of this there exists potentially in every piece of iron magnetic attraction for every other iron body. When a piece of iron is converted or *tuned* into steel, and assumes the character of a magnet through the influence of electric currents, it may be said to be in unison with the molecular character of other iron bodies, causing an affinity to co-exist between them. Why it attracts another mass of iron, overcoming its inertia and causing it to change positions when made to approach it, science does not tell us, yet it is absolutely certain that some kind of substantial currents pass off from the magnet to seize hold of the iron armature or the corporeal result of lifting it could not occur, according to all known physical laws, since it would be an actual physical result caused by *nothing*. We simply know, also, that these substantial currents sent out from the magnet do not move or lift the iron by means of air-waves or the undulatory motions of any intervening substance whatever, as they will pass through platinum, gold, or sheets of water, without the slightest disturbance of their particles, and still move the iron beyond them by some intangible cords connecting them. We know, further, that this magnetic substance, whatever it is, passing from the poles of the solid steel magnet will not act in the slightest degree on any other body except iron, which alone responds to it sympathetically, just as a sounding string has no sympathetic attraction for any other body, and will stir no other object, however delicately balanced, unless it be a sound-producing body tuned synchronously to its own vibratory swing. There is nothing more mysterious, therefore, or difficult to accept, in a string sending off sonorous pulses of some kind of substantial atoms (which may sympathetically impinge upon the same potential substance in its unison neighbor, causing it to move by synchronously acting upon it and gradually adding to its momentum, the same as air-waves are supposed to effect it) than there is in believing in the almost analogous attraction of the magnet, with which every scientific student is familiar. Scientists do not pretend to explain why magnetic currents will move a piece of iron and nothing else; neither do I claim to know why the substantial pulses from a string will pass off and sympathetically influence a musical body which is in a certain condition and will move nothing else. We simply know that both phenomena exist in Nature. One of them—the magnet—no physicist pretends to explain; while the other, from the most superficial misconception, as I will now show, we are told is easily explicable by the synchronous dashing of literal air-waves against

it, as you might also start it by successive blows from a stick dealt with suitable periodicity.

As a proof that the sympathetic vibration of a unison body is not caused by the periodic impulses imparted to it through air-waves sent off from the actuating string or fork, I refer the reader to the unanswerable fact that a body may vibrate or oscillate ever so nearly to another body tuned in perfect synchronism with its own swing, and ever so rapidly, but so long as no audible tone is produced by these vibrations no motion whatever will be communicated to the unison neighbor, though it necessarily and continuously receives the synchronous air-waves driven against it by the actuating body. I have carefully tested this in the following manner: I arranged two pendulum balls, with very short rods of equal length, to cause rapid swings as closely together as possible without touching, being careful that their supports had no immediate connection (except the air) by which any impulse might be communicated from the moving ball to the one at rest. Though their swings were in perfect synchronism, *moving with twice the aggregate velocity of a tuning-fork's prongs*, and although they were so near together that the air-disturbances caused by the moving pendulum must necessarily strike the other periodically, or as nearly so as it is possible for air-waves to travel, yet no motion whatever was communicated to the one at rest, for the best of all possible reasons—*there was no tone produced.*

This is also illustrated in the case of a sonometer-string, if taken from its sounding-board and stretched over isolated pieces of rigid iron; though it will vibrate when plucked just the same, and "carve" or "mould" the air into waves, as Professor Tyndall expresses it, just to the same extent exactly as when in connection with its sounding-tray, yet its sound can scarcely be heard by a person standing near it, for the want of a resonant body to augment its tone by diffusion, as will be explained after a little. A string in this condition will not start a unison body into sympathetic vibration even if but a few inches distant, and then only in exact proportion to the intensity of its sound, and not at all in proportion to the amplitude of the air-waves "moulded," "carved," and sent off by its oscillations, which are exactly the same whether such string is connected with the sounding-board or not. If the air-waves are really moulded and sent off by the harp-string, with "condensations and rarefactions" traveling 1120 feet a second, as so explicitly taught by Professor Tyndall (see extracts 7 and 8, pp. 78, 79), and if these air-waves are really the cause of sympathetic vibration in a distant unison string or fork, then pray tell us why the sonometer-string can cause no response to its unison neighbor a foot from it, though it "carves," "moulds," and sends off the same air-waves it does when placed on its sounding-board? The air-wave hypothesis must therefore completely break down as the solution of sympathetic vibration.

Professor Robert Spice, of 230 Bridge Street, Brooklyn, N. Y., the foremost accoustician and one of the most careful and painstaking investigators of sound in this country, informs me that he has made tuning-forks which, when mounted on accurate resonant cases, have responded to each other sympathetically at a distance of 180 feet apart. Such forks, disconnected from their resonant cases and consequently deprived almost entirely of sound, would not cause the slightest sympathetic effect upon each other if held but an inch apart, simply for the want of effective tone, notwithstanding the air-waves "carved" and "moulded" by the prongs of the fork are

exactly the same in the one case as in the other. Something else, then, evidently, besides air-waves sent off from an oscillating instrument is required to account for sympathetic vibration.

But the advocate of wave-motion is here ready with an objection. He urges that in placing the fork or string into contact with the sounding-board the vibrations of the instrument are vastly multiplied by the greater surface of the board, producing thereby a greater effect upon the air, or, in other words, sending off more powerful air-waves than can be sent by the fork or string alone, and that these supplementary air-waves, caused by the vibratory motion of the sounding-board, are the real cause of the sympathetic response of a unison instrument at such a great distance.

This view of the case at first sight would seem to have some weight; but when carefully looked into it will be found to be based on a misunderstanding of the laws governing resonance. It will therefore be necessary to devote a few pages to this somewhat complex question, and thus try to explain the true function of sounding-boards, resonant cases, &c., in connection with musical instruments, at the same time correcting a number of superficial but palpable errors of physicists.

As an evidence that the advocates of the wave-theory of sound have no clear conception of the phenomenon of resonance, —attributing it, as they do, to a simple increase in atmospheric disturbance, or to an augmentation of air-waves,—we have only to note their flat and unavoidable contradictions when treating on different phases of their theory. The reader will be made fully aware, before this treatise is concluded, that the profoundest and most careful investigators of sound-phenomena are unavoidably forced to contradict themselves and the elementary principles of the wave-theory in numerous ways, simply because the theory itself is intrinsically erroneous, and based on a pure misconception of natural laws; hence, in dealing with different aspects of the subject, its ablest advocates are necessarily and naturally led into the most preposterous absurdities and laughable incongruities.

In explaining "sonorous waves" to his audience, and in what manner they are sent off from a vibrating string through the sounding-board of a sonometer, Professor Tyndall remarks:—

"The *sonorous waves* which at present *strike your ears* do not proceed *immediately from the string*. The *amount of motion* which *so thin a body imparts to the air is too small to be sensible at any distance*. But the string is drawn tightly over the two bridges, and when it vibrates its tremors are communicated through these bridges to the entire mass of the box."—*Lectures on Sound*, p. 87.

He next experiments with a similar string without any kind of a sounding-board, it being merely stretched over rigid pieces of iron, and remarks:—

"I now pluck the string. It *vibrates vigorously, but even those on the nearest benches do not hear any sound. The agitation which it imparts to the air is too inconsiderable to affect the auditory nerve at any distance*. . . . It is not the *chords of a harp*, or a *lute*, or a *piano*, or a *violin*, that *throw the air into sonorous vibrations*. It is the *large surface with which the strings are associated*."—*Lectures on Sound*, p. 88.

Professor Helmholtz, admitted to be the leading physicist on sound in Europe, teaches precisely the same doctrine in regard to the resonance of a sounding-board, and it was no doubt from his work on the *Sensations of Tone* that Professor Tyndall caught the above inspiration. This great German authority says, in speaking of the resonant effects of sounding-boards:—

"As we have had already occasion to remark, *vibrating strings do not directly* communicate any *sensible portion of their motion to the air*."—*Sensations of Tone*, p. 137.

Here, then, while declaring that it is not the air-waves from the string which we hear, since a string is "so *thin* a body" that its waves are not "*sensible* at any distance," Professor Tyndall forgets his explicit argument quoted on page 79, extract No. 8, in which he says:—

"Figure clearly to your minds a *harp-string* [which he says here can not "throw the air into *sonorous vibrations*"!] vigorously vibrating to and fro; it advances, and causes the particles of air in front of it to crowd together, thus producing a *condensation of the air.* It retreats, and the air-particles behind it separate more widely, thus producing a rarefaction of the air. . . . *In this way* [Mark it, "in *this way*," by the simple motion of the harp-string, without a word about its sounding-board advancing and retreating!] *the air through which the sound of the string is propagated is moulded into a regular sequence of condensations and rarefactions* which travel with a velocity of about 1100 feet a second."

Thus, in one breath he teaches that the air-waves are due entirely to the motions of the *string*, which moulds and sends them off at a velocity of 1100 feet a second; then, in the next, it is just as explicitly taught that "so thin a body" as a string can not produce sound-waves which would be "sensible at any distance"; and finally, to make the contradiction as flat as possible, he adds: "*It is not the chords of the harp . . . that throw the air into sonorous vibrations.* It is the large surface with which the strings are associated"!

A theory based on a correct understanding of the physical laws surely would not thus so palpably contradict itself. No better proof need be required by the unscientific reader that a theory is radically defective, if not intrinsically false, than to see such incongruous statements as to its fundamental principles when being presented by its ablest advocates. If its various phases will not hold together and harmonize, the theory must be false.

But is this transferrence of the vibratory motion of the string to the sounding-board, thus causing it to act on the atmosphere and send off augmented air-waves, the true solution of this problem of resonance? By a little reflection it will be seen that the sounding-board can not, by any possibility, aid the string by augmenting its sound, if such augmentation depends on air-waves generated by the motions of the board, and for reasons which I will now try to show are clearly unanswerable.

In the first place, the pitch of a tone, as every one admits, depends on the number of vibrations per second of the sounding body. In the second place, the tone of a string never changes its pitch in being transferred to and augmented by the sounding-board; and though the board necessarily receives a tremor from the vibrating string bearing against it, such tremor is mostly molecular and not the bodily movement of the board, as would be necessary in order to send off air-waves and thus cause resonance according to the wave-theory. As the generation of sound, in a vibrating string, can only be molecular, its augmentation by the board must be accounted for in the same way—by molecular tremor—not vibration.

As the sounding-board of an instrument often produces a hundred-fold augmentation of tone compared to that of the naked string, it is perfectly evident that this vast increase of sound can not be the result of corresponding increase of vibratory motion and of air-waves sent off, as the wave-theory unavoidably teaches, since this would necessarily make the sounding-board the controlling mechanism in the production of tone; and consequently, instead of playing a secondary part to the string, which has but a hundredth part the vibratory effect on the air, the board should at once take possession of the sound, and change its pitch to its own vibratory rate!

Is it reasonable to suppose, if resonance, producing a hundred-fold augmentation of tone, is caused by the vibration of the sounding-board and by the air-waves sent off from it, that its normal vibratory oscillation would be under the control of the string's trifling vibration, which, unassisted, can not make a hundredth part of the sound? Is it not clear that the superior mass, surface, and power of the board would assert their right to be heard, and instantly change the pitch of the tone from the string's normal rate to that of the vibrating body whose waves actually produce a hundred-fold more tone? If the wave-theory be correct, that resonance is really caused by the vibratory motion of the board, then evidently each string as soon as sounded should lose its own identity and be forced to conform to the normal pitch of the sounding-board. This wave-theory of resonance involves the startling inconsistency of a vibrating body, having a hundred-fold more power over the air, being coerced out of its own normal oscillation into an abnormal and obnoxious swing which causes a hundred-fold the amount of tone, while the string itself, not a thousandth part as large in area, retains its perfect pitch, mastering and annihilating that of its powerful coadjutor! As an effect so vast could not, by any possibility, be produced by such an inadequate cause, it follows that the resonance produced by a sounding-board must receive some other explanation than that given by the wave-theory.

The well-known comical illustration of the wagging of a dog's tail, though somewhat ludicrous, is so completely applicable to this case, and every way so mechanical and appropriate, that I am obliged to refer to it. The inquiry why a dog wags his tail was philosophically answered, because the tail was the *smallest*, or otherwise the tail would wag the dog! The theory of resonance, as taught by Professor Tyndall, inverts this sensible answer, and makes the diminutive "tail" of a string wag the enormous "dog" of a sounding-board, at the same time giving it a hundred-fold more wagging motion than it has to communicate! Surely an explanation so palpably absurd can not be the correct one.

That the tremor of the sounding-board, or the movement it may impart to the air, is only incidental, or a fortuitous effect of the actual cause of the sound itself in the motion of the string, just as the recoil of a cannon or the disturbance of the surrounding atmosphere thus produced at its discharge, is but incidental to the projectile's movement, and no part, necessarily, of such propulsion, will be made clear in a moment to the most unscientific reader.

The sounding-board of the piano, for example, has *eighty-five* separate sets of strings bearing against its surface, each of which has a different rate of vibration of its own, and consequently a separate pitch of tone. Now, while the sounding-board does really augment by resonance the sound of each of these eighty-five sets of strings, it has, as just intimated, but one normal rate of vibration of its own, and if bowed across its edge will produce but one pitch of tone—a heavy, low, and dull sound. Yet, if the eighty-five sets of strings, with eighty-five distinct rates of vibration and pitches of tone, were all to be sounded at one time, the board would nevertheless resound to every string at the same instant, while not the slightest change would occur in the pitch of tone or rate of vibration in either of the sets of strings! The wave-theory, in attempting a solution of resonance, in the case of a pianoforte, is thus forced to assume that a single board, with but one normal rate of vibration, is capable of sending off from its surface no less than

eighty-five separate systems of air-waves (as the real and only cause of the tones we hear, according to Professor Tyndall), each system having a different rate of vibratory motion, and oscillating with a different amplitude of swing at the same instant of time, and all save one forced or coerced away from the normal oscillation of the board, since the distinct note of any one set of strings can be sorted out from the entire mass of tone, even when all the strings are sounded together, if the ear is aided by a suitable resonator tuned accurately to that particular note!

The mere presentation of such a physical and mechanical impossibility (since aerial waves are nothing but the result of physical and mechanical forces and operations) ought to be sufficient to cause any properly trained, analytical mind, to at once reject a theory the truth of which has to depend on such a result.

No well-informed advocate of the current hypothesis of sound will pretend to call in question the truth of the position here stated, namely, that if the wave-theory be true, it must be possible for the surface of a single sounding-board to be thrown at one time into eighty-five distinct systems of undulations, all different in amplitude and rates of oscillatory motion, each rate of vibration sending off a system of air-waves corresponding in width of swing and periodic time to that particular undulation of the board, each causing a counter condensation and conflicting direction to the same air-particles, the whole eighty-five systems of waves occupying the same air of the same room at the same time, and each wave passing through it undistorted and independently of the other eighty-four systems, the same as if they were not at that very instant permeating the atmosphere!

Now, if I am able to show from the highest living authority on sound, as well as on all questions involving the operations of the physical laws, that these eighty-five different systems of vibratory motions and resultant air-waves, with their conflicting amplitudes, periodic rates, condensations and rarefactions of the air, or even two such systems, are wholly impossible and out of the question in the same atmosphere at the same time, must not the theory based on such a mechanical result be utterly shattered? I have at hand, fortunately, just such a conclusive and sweeping overthrow of the very foundation of the wave-theory from the pen of no less an authority than Professor Helmholtz himself, which the reader, if he be a believer in the wave-theory of sound, is requested particularly to note:—

"It is evident that at *each point* in the mass of air, at *each instant of time, there can be only one single degree of condensation*, and that the *particles of air can be moving with only one single determinate kind of motion, having only one single determinate amount of velocity*, and passing in only *one single determinate direction.*"—*Sensations of Tone*, p. 40.

And immediately after this, as if the foregoing language was not sufficiently strong to annihilate the wave-theory, the Professor adds:—

"It is *true* that *two different degrees of density* produced by *two different systems of waves can not co-exist in the same place at the same time.*"—*Sensations of Tone*, p. 42.

How, then, could eighty-five distinct and separate systems of undulations co-exist in the same air and pass off from the same surface of the sounding-board at the same instant of time, each system of waves of a different "condensation" or "density," as would be the case if there was the slightest difference in the intensity of the tones, since each wave produces a condensation of the air exactly in proportion to its loudness or the "width of swing" of its air-particles?

If there is any meaning in words, my position is fully sustained; for, if Professor Helmholtz had aimed to crush out the wave-theory of sound at a single blow and show its utter untenability, and particularly the idea of resonance consisting in augmented air-waves, he could not more effectually have accomplished his work than he has done in the above unnecessarily emphatic negation of the entire hypothesis.

To strengthen this view, that the tremor of the sounding-board and its resultant air-waves are but incidental, and not the cause of the great augmentation of the tone heard, it is a fact, proved by the beautiful experiment of Professor Wheatstone, that all the tones of the piano can be condensed and conducted longitudinally through a long slender rod, by letting one end of it rest on the sounding-board and placing a violin against the other; and I can not resist the temptation of here quoting bodily the beautiful description of this experiment given by Professor Tyndall in one of his lectures:—

"We are now prepared to appreciate an extremely beautiful experiment, for which we are indebted to Professor Wheatstone, and which I am now able to make before you. In a room underneath this, and separated from it by two floors, is a piano. Through the two floors passes a tin tube 2½ inches in diameter, and along the axis of this tube passes a rod of deal, the end of which emerges from the floor in front of the lecture-table. The rod is clasped by india-rubber bands, which entirely close the tin tube. The lower end of the rod rests upon the sound-board of the piano, its upper end being exposed before you. An artist is at this moment engaged at the instrument, but you hear no sound. I place this violin upon the end of the rod; the violin becomes instantly musical,—not, however, with the vibrations of its own strings, but with those of the piano. I remove the violin, the sound ceases; I put in its place a guitar, and the sound revives. For the violin and guitar I substitute this plain wooden tray; it is also rendered musical. Here, finally, is a harp, against the sound-board of which I cause the end of the deal rod to press; *every note of the piano is reproduced before you.* I lift the harp so as to break its connection with the piano, the sound vanishes; but the moment I cause the sound-board to press upon the rod, the music is restored. The sound of the piano so far resembles that of the harp that it is hard to resist the impression that the music you hear is that of the latter instrument. An uneducated person might well believe that witchcraft is concerned in the production of this music.

"What a curious transferrence of action is here presented to the mind! At the command of the musician's will his fingers strike the keys; the hammers strike the strings, by which the rude mechanical shock is shivered into tremors. The vibrations are communicated to the sound-board of the piano. Upon that board rests the end of the deal rod, thinned off to a sharp edge to make it fit more easily between the wires. *Through this edge*, and afterwards *along the rod*, are poured with unfailing precision the entangled pulsations produced by the shocks of those ten agile fingers. To the sound-board of the harp before you the rod faithfully delivers up the vibrations *of which it is the vehicle.* This second sound-board *transfers the motion to the air, carving and chasing it into forms so transcendently complicated that confusion alone could be anticipated from the shock and jostle of the sonorous waves.* But the marvellous human ear accepts every feature of the motion; and all the strife and struggle and confusion melt finally into music upon the brain."—*Lectures on Sound*, p. 80.

Had the wave-theory of sound not been assailed as utterly inadequate to account for this wonderful transferrence of the complicated sounds of the piano through the length of this rod by means of corresponding wave-motions, having each a separate rate of vibration and width of swing, we might still go on believing in such "witchcraft"; but the evidence a moment since quoted from Professor Helmholtz, proving that no two systems of waves—of different densities, of different rates of motion, and of different amplitudes,—can co-exist in the same place at the same time, is a sufficient proof that the incidental up and down tremor of this deal rod resting against the sounding-board is not and can not be the true cause

of communicating so many complex musical tones to the violin at the same instant. Besides, the explanation of Professor Tyndall is completely overthrown by substituting an *iron rod* for the one of *deal*. Such a rod receives the same tremor precisely from the sounding-board of the piano, and communicates it just as effectively to the violin,—as it surely ought to do, being a fourfold swifter conductor of sound than wood. But no music whatever is heard by the audience. If the *vibratory motion* of the sounding-board, thus transferred longitudinally through a rod to the violin, is the true cause of this resonance, then manifestly the music should be the same through the iron rod as through the deal, since the vibratory motion is essentially the same in both cases.

But in dealing with this question of resonance, which really lies at the foundation of the wave-theory, and which, if it can be satisfactorily explained without air-waves, overthrows the entire hypothesis, I am not left to simple argumentation based upon facts, however strongly they may bear against the current explanation. I am not even obliged to rest on the explicit admission of Professor Helmholtz just quoted, or the self-contradictory statements of Professor Tyndall, as shown at the commencement of this argument on resonance, in which he assures us that the harp-string both makes the tone and don't make it! I have at hand a simple and unquestionable demonstration, in the form of a single experiment within the reach of any one desiring to test it, which shows beyond the shadow of a doubt that the resonance of a sounding-board has nothing whatever to do with its incidental tremor or the air-waves thus produced, which, if it turns out as I now state it, alone breaks down the wave-theory.

This experiment consists in holding the stem of a large tuning-fork in contact with a dry pine chip of about the same bulk, which will cause a resonant augmentation of the tone of the fork at least twofold. Now, while the prongs of the fork can be plainly seen to oscillate a sixteenth of an inch, sending off corresponding air-waves, the chip is destitute of all visible vibration, and consequently can send off no appreciable air-waves as compared to those generated by the fork, *notwithstanding it doubles the volume of sound by resonance!* Professor Tyndall says the air-waves moulded and sent off from the fork do not cause the sound we hear, but it is caused by the waves generated by the *large surface* of the sounding-board against which the fork is held! Will the Professor tell us how it is when the surface of the board is no larger than that of the fork, while the sound is doubled, with not over one-fifth the vibratory motion? For it is perfectly manifest that the chip against which the stem of the fork is held can only receive a vibratory motion equal to the up and down motion of the stem, which can be but a very small fraction of that of the prongs laterally; and consequently, if air-waves be the secret of sound-production, the augmentation by the motion of the pine chip should not be appreciable.

Can these advocates of the wave-theory, who draw sage conclusions on profound scientific questions from a few superficial observations, tell us how this pine chip, with not over one fifth the oscillatory motion of the fork's prongs, can produce a twofold augmentation of the sound by the generation and propagation of air-waves, while the fork's five or ten fold oscillation, with a five or ten fold aerial disturbance, can not be heard "at any distance," as Professor Tyndall himself assures us?

As in the case of the sounding-board of the piano, there is unquestionably an incidental tremor communicated to the chip by the movement of the fork, which can be felt by the hand, though too infinitesimal to be seen. I stated on page 83 that this tremor of the sounding-board was only *incidental, as the result of the motion which produced the tone, and not its cause.* I will now prove it so clearly that a child can see it. If the *tremor* of the chip really is the cause which produces the augmentation of tone by moulding and carving the air into sonorous waves, then any other body of the same size, substituted for the chip, which necessarily must receive exactly the same tremor when in contact with the stem of the tuning-fork, would necessarily produce the same augmentation of tone, as just shown by substituting an *iron* for a *deal* rod in the Wheatstone experiment, because it would necessarily generate and send off the same amplitude and number of air-waves. So far from this being the fact, if we hold a piece of iron of the size of the chip against the stem of the fork, not the slightest increase of tone occurs, though the iron is felt to tremble exactly the same as the chip, even more so, being more firm and elastic. Here, then, we have all the vibration in the piece of iron that we had in the chip, and consequently all the additional air-waves sent off without a particle of augmented sound! To say that this utterly shatters the wave-hypothesis and Professor Tyndall's explanation of a sounding-board's resonance, is to say what the common sense of every reader has already admitted.

We can go even further in regard to the tremulous motion of the chip, or its iron substitute, caused by the up and down motion of the stem of the fork while the prongs are vibrating laterally. By means of a very delicate calculation and experiment made by Professor Robert Spice, as explained in a paper published in the *American Journal of Science* for December, 1876, the vibration of the stem of the fork vertically in proportion to that of its prongs laterally is clearly stated. The Professor found, by careful examination and measurement, to which he has called my attention, that a fork whose prongs oscillate a *sixteenth* of an inch communicates an up and down synchronous movement to its stem of *one eightieth* of an inch, or exactly one fifth of its lateral oscillation. Thus, in another and unexpected way, and by impartial scientific testimony, we demonstrate the fallacy of the air-wave explanation of resonance; for, while the fork's prongs oscillating a sixteenth of an inch can not be heard "at any distance," as Professor Tyndall says, though they necessarily produce considerable atmospheric disturbance in their immediate vicinity, yet the stem moving up and down but *one eightieth* of an inch, doubles the sound acting on a chip no larger than the fork, while the iron substitute having the same motion precisely and generating the same air-waves at the same rate per second and of the same amplitude, does not add an iota to the normal sonorous effect of the naked fork!

Is it not, then, overwhelmingly established, from these several considerations, that the advocates of the wave-theory are entirely mistaken as to the cause of resonance in a sounding-board? If they are thus mistaken, then, evidently, the wave-theory itself is left without a foundation on which to rest; for, if resonance can occur without the generation of corresponding air-waves, as we here see it can, so can any other tone ever produced!

But now we come to the important question, if the resonance of a sounding-board

by which the tone of a string is augmented ten, twenty, or an hundred-fold, be* not caused by its incidental tremor or by air-waves sent off, as we see it is not and can not be, then is there any probable or reasonable solution of this phenomenon? I answer, there is; and I will now try to make the reader understand it.

Resonance is of two kinds. One kind consists in the radiation or diffusion of tone from a body such as a piano sounding-board, where effectiveness depends on two principal conditions, namely, the molecular structure of the body itself and the extent of its surface, including also its form, partly, and its manner of support; while the other kind of resonance consists in the sympathetic vibration of a column of air tuned to perfect synchronism with the sounding body which excites it into action.

In the first-named variety of resonance are included all sounding-boards, such as those of pianos, harps, violins, sonometers, guitars, &c. In the second belong wind-instruments of all kinds, organ-pipes, flutes, horns, &c.; for the agitation of the air at the mouths or debouchures of these instruments, even when caused by the lips or by reed-motion, becomes the sound-generator, while the air in the horn or resonant pipe-chamber is made to express and augment the tone by its own resonant or sympathetic vibration.

To this class, also, belong resonant cases used for mounting tuning-forks, whose air-chambers, to be effective, should be of such a depth and capacity as to give forth its loudest resonance when the tuning-fork intended for it is sounded over its open mouth.

Advocates of the wave-theory, including Professors Tyndall and Helmholtz, assume and teach that the loudest resonant depth of such a case, in feet and inches, is exactly and invariably *one quarter of a wave-length* of the sound thus most loudly augmented. If this were so, it would be a remarkable coincidence, and go strongly to confirm the truth of the wave-theory; and it is a real pity to take from the hypothesis what seems to be absolutely its only collateral support, which will be done most effectually in the following chapter, when we come to the review of Professor Tyndall's famed lectures on sound.

Professor Spice, as before intimated, has constructed two unison forks, and mounted them on accurate resonant cases 180 feet apart, and caused one of them to speak sensibly by exciting the other with a violin-bow. How is this result effected?—and by what philosophical or physical law is corporeal motion generated in the distant fork by sounding its unison so far from it? The wave-theory has no practical solution to offer (being a purely physical and mechanical hypothesis, depending on the momentum of corporeal air-waves, with all their inertia and friction to be overcome), and can suggest nothing except that these air-waves are actually driven off the entire distance by the motions of the actuating fork and its resonant case; and that such aerial undulations, after traveling this distance, are successively dashed against the fork and its case till oscillation is gradually brought about, as recently explained.

This solution is manifestly absurd and impossible; and any scientific student would instantly see it should he reason on air-waves as he would reason on water-waves or any mechanical result requiring physical force and the overcoming of friction and inertia by momentum to effect it. Simple air-waves, or any other forms of aerial disturbance, can not move through the surrounding atmosphere, in its quiescent condition, except at a very slow speed and to a very limited distance, however

they may be put into motion, or whatever force may be exerted in starting them. It is astonishing that such a radical error should be universally taught and believed as that an air-wave started or sent off by a tuning-fork or string should travel on any other principle than if sent off from a fan or the motion of the hand. The prong of a tuning-fork in passing through the air at full amplitude, moves only at a very low velocity, *not one tenth as fast as we can move an ordinary fan,*—a fact perhaps never thought of by a writer on sound; for, if it had been, he surely would have abandoned the wave-theory. This fact will be fully illustrated at the close of the next chapter. But here permit me only to remark that it is mechanically impossible for a vibrating fork to send off air-waves at furthest over a foot or thereabouts from the oscillating prongs, while the velocity of such waves *can not, by any possibility, exceed the velocity of the moving prongs which impell them!*

Professor Tyndall, in the very commencement of his lectures on sound, indulges in such superficial and sophistical reasoning on this question that I can not refrain from pointing it out here. He compares, for example, the action of an air-wave sent off from a vibrating body to that of a *spring*, which, when shoved longitudinally, moves throughout its whole length, though recoiling somewhat under the impelling force according to its elasticity, and leaves the impression on his audience and on the readers of his book that air-particles act precisely in the same way when moved by a vibrating body like a fork or string. A weaker fallacy was never recorded; yet it is just that very logic on which his whole theory depends. Suppose the substance of a spring to be as mobile as air and as easily displaced laterally, what becomes of it when one end is shoved in the direction of its length? If the shoving motion is as slow as that of the prong of a tuning-fork (about seven or eight inches a second), the portion of the spring in front of the impelling body would quietly move around behind as fast as it advanced, thus forming an equilibrium of the spring's substance without stirring it a foot in front! If you move even the broad surface of a fan through the air at a velocity of only eight inches a second, *what becomes of the air in front of it, which is all the spring we have to take into consideration in this discussion?* It simply moves around the fan, quietly and silently taking its place behind it, without causing the slightest disturbance or displacement of these *spring-particles*, so talked of by these learned writers, a dozen inches in front of it!

I have thoroughly and carefully tested this velocity of air-waves and this spring-power of the atmosphere in transmitting condensed pulses, so essential to the wave-theory, by moving the broad side of a stiff fan through it in rapid oscillations, driving it at a velocity exactly ten times greater, by measurement, than that of the vibrating prong of a tuning-fork, and have thus determined the actual distance such air-waves can be made to travel by one-man power in a closed room, as well as their maximum velocity. To the utter discomfiture of the wave-theory, the experiment showed that a delicate and sensitive gas-jet could not be stirred at a distance of more than twenty to twenty-five feet, while it took the most powerful waves I could produce, using all the strength of my arm, *five seconds to travel that distance!* How fast, then, I ask these sagacious scientists and profound thinkers, would the same kind of an air-wave, manufactured on exactly the same principle, travel, driven off from the prong of a tuning-fork, which has

but a hundredth part of the surface, and moves with only one tenth the velocity?

If the atmosphere really possesses spring-power at all (which I do not doubt, under proper conditions), and which adds to the velocity of such manufactured air-waves, I surely ought to get *one thousand* times the advantage of it over the tuning-fork, having one hundred times the surface with which to take hold of the air, and ten times the velocity by which to impell the waves; for while the fork, with 128 vibrations a second, moves less than the sixteenth of an inch at a swing, making an entire aggregate of less than eight inches and return in a second, I moved the fan a distance of almost seven feet and back each second, with the result just given.

The truth is, this talk about the spring-power of the atmosphere in front of a fork's prong when slowly shoved, or when the air is not confined and acted on within an inclosed space, and about forcing it into "condensations and rarefactions" by this slow movement, thereby generating sufficient "heat" and "elasticity" to add "one sixth" to the velocity of sound, as claimed by the wave-theory, and as is really essential to its existence, while the air at the same time is perfectly free to move out of the way and not be "condensed," is the silliest nonsense ever indulged in by a scientific or unscientific mind; and conclusively shows either a profound ignorance or an utter disregard of the principles of pneumatics and ordinary mechanics. A man who can and really does believe that by moving the prongs of a tuning-fork through the free air at a speed of only *eight inches a second*, they will so compress or squeeze its particles together as to generate sufficient "heat" and "elasticity" *to add one sixth to the velocity of sound*, as does Professor Tyndall, ought to be excused should he believe in the most miraculous witchcraft as well as in all the gods of heathen mythology at once, which he surely ought to be able to do without dangerously overtaxing his credulity.

The only way to appreciably condense the free air by moving a body through it, is either to employ a very large displacing surface, at considerable velocity, or one, if small, at a very high velocity, as when a bullet is fired from a gun. But it is weaker than folly to talk of producing "condensations and rarefactions," and of generating sufficient additional heat thereby to add one sixth to the normal velocity of sound, all by the movement of a harp-string seven or eight inches a second through atmosphere perfectly free to get out of the way and not be "compressed"! The true solution of this problem of atmospheric spring-power will be given in a short time, when we come to look into the nature and effects of magazine explosions, which I hope will cast some light on this long-obscured question of sound-propagation in connection with the transmission of condensed air-waves.

The superficiality of writers on sound is really immense! They actually suppose, as is evident from their writings, that because a vibrating fork makes a *humming tone*, its prongs must therefore necessarily travel at an enormous velocity, so as to *condense* the free air in front sufficiently to generate additional heat and elasticity, and then retreat so rapidly as to create a rarefaction by causing a partial vacuum! This is no exaggerated statement, as will be abundantly proved in what is soon to follow. Professor Tyndall, in his *Lectures on Sound*, page 62, speaks of the motion of the fork in this way:—

"Imagine one of the prongs of the vibrating fork *swiftly* advancing; it *compresses* the air immediately in front of it, and when it retreats it leaves

a *partial vacuum behind*, the process being repeated at every subsequent advance and retreat. The whole function of the tuning-fork is to *carve the air* into these *condensations* and *rarefactions*."

Yet Professor Tyndall never thinks to tell his audience of scientific students that while this prong of the tuning-fork is thus "*swiftly* advancing," *cutting* and *carving* the air, retreating with such rapidity as to leave a "*partial vacuum*," thus generating "condensations and rarefactions" in the open atmosphere, it is absolutely only moving at the snail-like speed of *seven inches a second* in one direction, or fourteen counting both! It is but fair and charitable to say he did not know it, but rather that he really supposed the prong of the fork to be moving at a velocity about equal to that of a rifle-ball, or he never would have indulged in such a ridiculous travesty on science and fact.

But he was probably not so much to blame for this superficial misapprehension, since his great mentor, from whom he takes most of his inspirations on sound, Professor Helmholtz, had repeatedly fallen into the same error. Take, for example, his erroneous contrast of the velocity of a pendulum with that of a tuning-fork's prongs, as follows:—

"The pendulum swings from right to left with a uniform motion. . . . Near to either end of its path it moves slowly, and in the middle *fast*. Among sonorous bodies which move in the same way, only *very much faster*, we may mention *tuning-forks*."—*Sensations of Tone*, p. 28.

Whereas it is a fact, which a smart schoolboy should have been well aware of, that a pendulum which beats seconds when thrown into full oscillation, travels more than 64 inches in one direction, or with *more than four times the velocity of a tuning-fork's prongs*, counting their vibrations in both directions!

Professor Tyndall, again following the lead of Professor Helmholtz, as usual, falls into the same mistake in regard to the velocity of a pendulum's movements. He says:—

"The motion of a common pendulum, for example, is periodic; and, as it swings through the air it produces waves or pulses which follow each other with perfect regularity. *Such waves*, however, are *far too sluggish to excite the auditory nerve*. To produce a musical tone we must have a body which vibrates with the unerring regularity of the pendulum, but which can impart *much sharper and quicker shocks to the air*."—*Lectures on Sound*, p. 49.

How can the prong of a tuning-fork, with *only one quarter the velocity of a pendulum*, "impart *much sharper and quicker shocks to the air*" by dividing up this slower movement into sixteenths of an inch instead of continuing its accumulated motion sixty-four inches at a sweep? And how can this motion of the pendulum be called "sluggish," while the motion of the prong, having but one fourth the velocity, is called "much quicker"?

It seems strange, to say the least, that such careful and profound thinkers should be so easily misled by appearances, though it affords a satisfactory answer to the query why it is that the wave-theory of sound, so clearly a scientific fallacy, should be at the present moment believed in by the ablest minds of the world. It can only be because the theory was originally based on a few such superficialities as I am now pointing out, and which no modern physicist has had the originality or mental independence to see through and expose.

In order to get a clear insight into this actual but deceptive velocity of a tuning-fork's prongs, and thus wipe out this surface idea of their "*swiftly* advancing" oscillations, I have only to take the fork in my hand and swing it bodily through the air back and forth a distance of eight inches, making one complete oscillation each second, in which case I move it just

as rapidly as its prongs move when sounding, as a moment's calculation will show, while I produce vastly more mechanical and undulatory effect upon the surrounding atmosphere by the longer oscillations; for, while the sounding prong moves but a very short distance in one direction and then retreats, losing the effect of its forward motion in driving the air into any kind of waves or pulses, I swing it bodily at the same velocity exactly, but by continuing and thus accumulating the motion to a greater distance in one direction without interrupting its action, I evidently must produce a greater mechanical effect on the air in front of it than if the long swing were subdivided up into 128 short motions, with not a particle more distance traveled in the aggregate. One would think that a man with the least mechanical intuition could see this, and, in seeing it, would instantly abandon the wave-theory of sound as a most transparent scientific fallacy.

The law governing the generation of tone by a vibrating fork or string may now be concisely stated as follows:—

It is not the mechanical effect of the numerous short motions back and forth on the surrounding air which generates the tone of a fork or string, but it is the molecular effect of the sudden stops and starts on the atomic structure of the instrument itself, causing thereby the emission of the substantial pulses we call Sound, while the atmosphere, wood, water, or iron, through which they pass is but their conducting medium,—any motion of such medium, caused at the time by the vibration of the sound-producing body, being but incidental.

I call the attention of physicists to this important law, embodying, as I conceive, the true philosophy of the generation of tone, here for the first time announced; and I earnestly solicit their impartial judgment on the subject, in view of what has been and what is yet to be offered against the theory of wave-motion,—which, up to the present time, is the only hypothesis ever framed to solve this difficult problem of sonorous propagation.

Upon these sudden stops and starts of a sounding string or tuning-fork, occurring at the rate of a certain definite number per second, depends the pitch of its tone. As these vibratory swings necessarily but incidentally produce air-waves or atmospheric disturbances in the immediate vicinity of the instrument, it was an easy matter for Pythagoras, 2,500 years ago, to make the superficial observation and draw the weak inference, that, since the wider oscillations of the chord make the louder sounds, hence that the loudness of a tone must also depend on the amplitude of these incidental air-waves, or mechanically on the distance the air-particles swing "to and fro" as the sound is propagated to a distant ear. And marvelous as it may seem, this superficial but erroneous view has continued to prevail to the present time, philosophers still continuing to echo the observation and inference of Pythagoras; that as the string swings greatest when the tone is loudest, hence the loudness of a tone at a distance from the sounding body must necessarily depend on the amplitude of the oscillating air-waves, which, instead of traveling as supposed 1120 feet a second, absolutely do not and can not move away from the string a total distance of more than a dozen inches!

Even as great a philosopher as Professor Helmholtz, observing that the loudest sound occurs when the string has the greatest amplitude, jumps to the same superficial conclusion that this proportional width of swing is transferred to the atmosphere, and continued on through it

to a distance, the air-particles oscillating at a less and less width as the sound grows weaker and weaker. He says:—

"We easily recognize [just as Pythagoras did] that the force or loudness of a musical tone *increases or diminishes* with the extent or so-called *amplitude of the oscillations of the particles of the sounding body*. When we strike a string its vibrations are at first sufficiently large for us to see them, and its corresponding tone is loudest. The visible vibrations become smaller and smaller, and at the same time the loudness diminishes. . . . The same conclusion results from the diminution of the loudness of a tone when we increase our distance from the sounding body in the open air, although the *pitch* and *quality* remain unaltered; for *it is only the amplitude of the oscillations of the particles of air which diminishes as their distance from the sounding body increases. Hence, loudness must depend on this amplitude.*"—*Sensations of Tone*, p. 17.

Thus, the greatest physical philosopher of the present time can see no deeper into these beautiful effects than to follow Pythagoras, and suppose that the inertia of four square miles of air can be overcome, and all its particles made to oscillate back and forth a definite distance more than 4,000 times a second by the note of a piccolo flute, thus creating *condensations* and *rarefactions* and generating "heat" sufficient to add "*one sixth*" to the velocity of this sound, *requiring hundreds of millions of tons pressure*, as I will clearly demonstrate before this chapter is ended! This observation of these renowned scientists is just as devoid of foundation in fact or philosophy as that of the little child, which, seeing the *trees swing back and forth farthest as the wind blows strongest*, supposes that this *swinging* of the trees is the cause of the wind rather than its effect! I remember distinctly that this was my earliest scientific impression as to the true cause of the wind, when I was about four years old (I should now be ashamed to have been any older), and so explained it to my sister, who still recollects the same highly philosophical observation, which was at least equal in scientific profundity to these sonorous observations of Pythagoras and Helmholtz.

It really seems that no physicist has been able to look below this surface idea and grasp the thought that the reason why the greater periodic swing of a vibrating chord produces the louder tone is because it generates and radiates a greater quantity of sonorous substance, just as the longer sweep or deeper cut of the harvester's cradle brings down the greater quantity of grain; and that the reason why the sound becomes weaker and weaker as the distance from its source becomes greater, is simply because the sonorous particles, radiating in all directions, naturally and necessarily become sparcer and sparcer the more space they are distributed over, which accordingly involves the fact that a less and less number of these sound-atoms strike the tympanic membrane the farther the ear is from the sound-producing body, just as a less and less number of substantial odorous particles enters the nose the farther it is from the source of the fragrance.

Instead of a conclusion so rational, logical, and every way scientific, though lying beneath the surface, Pythagoras observed the merely accidental air-waves generated by the string, and took all the rest for granted; and although the slightest mechanical intuition should have convinced him that such waves were but incidental, as the effect of the motion which produced the tone and *not its cause*, these palpable and self-evident facts and data were ignored, and the childish hypothesis maintained that these same incidental and meaningless disturbances of the air were absolutely the cause of the tone, and continued on through the dense atmosphere at a velocity of 1120 feet a second, or

nineteen hundred times greater than the motions of the string which gave them their impetus! But the strangest thing of all is that every writer on sound from that time to the present has continued to hold on to the same preposterous idea.

Physicists, however, who take their inspirations from Pythagoras, or even from the great German investigator, Helmholtz, as does Professor Tyndall, will be certain to fall into the gravest of errors, as just seen in regard to the velocity of a tuning-fork's prongs as compared to that of a swinging pendulum.

For example, take the explanation given by Professor Helmholtz of the manner in which a violin-string oscillates under the action of the bow. A more superficial and inexcusable misapprehension does not occur in any work on physics making the least pretensions to scientific accuracy, though his explanation is a vital one, as will be seen, to the wave-theory in some of its essential features. I will now show this so clearly that the unscientific reader will have no difficulty in comprehending the unenviable plight of this learned authority.

He illustrates the action of a bowed string by the motion of a trip-hammer, which is slowly raised by the mill-work and then let drop suddenly, with vastly greater velocity than it ascended, the mill-work representing the bow, while the falling hammer represents the string. But I will give his own words in full, that the reader may the better see the force of my comments:—

"Among motions which produce musical sounds, that of a violin-string, excited by a bow, would most nearly correspond with this [trip-hammer], as will be seen from the detailed description in Chap. V. The *string clings for a time to the bow, and is carried along by it*, then suddenly releases itself, like the hammer in the mill, and like the latter retreats somewhat, *with much greater velocity than it advanced*, and is *again caught by the bow and carried forward*"!—*Sensations of Tone*, p. 29.

The above remarkable scientific statement is the more astounding when we reflect that Professor Helmholtz is a practical violinist of considerable attainment in the art, as well as one of the greatest acousticians of the present time. Yet he does not seem to know the important fact that if a bow should travel slower than the string's normal oscillation at the place where the hair touches it, as he tells us it always does, *there would be no sound produced, since even an attempted vibration of the string would be instantly checked and interrupted, and its tone destroyed by the slower movement of the hair!* If a string can fly back when released from the rosined hair "with *much greater velocity* than it advanced" or than the bow was traveling, as he distinctly teaches, then it will of course rebound forward again *faster than the bow is moving*, since its motion must necessarily be nearly the same one way as the other, when free to move. How, then, in the name of acoustics and mechanics, is it to be "again caught by the bow and carried forward," since it is already moving "forward" with "*much greater velocity*" than the bow? If Professor Helmholtz is right, the "much greater velocity" of the rebounding string would catch the bow and carry it "forward"! And since the string could not be expected to carry forward the slowly moving bow held in the player's hand, the string itself would of course have to stop. The reader must see that it is an unavoidable necessity for the bow to be always moving with as great velocity at least as the normal oscillation of the string when swinging in the same direction or when flying back after being released from the bow, or otherwise the hair would not carry the string with it, but the string would have to carry the hair; and,

as before observed, would stop. Yet this highest living authority on acoustics tells us, as above quoted, that the string of the violin, when momentarily released from the hair, will swing back "with much greater velocity than it advanced," or than the bow was moving, which would necessarily cause it to outstrip the bow at its next swing forward, or else to stop at each backward vibration (which, of course, it could not and would not do), and wait for the slowly moving bow to again pick it up and carry it along!

Now, to enlighten this physicist, for he certainly needs it, let us look at the actual movement of a bowed string mechanically for a moment. The open G-string of a violin makes 198 complete oscillations in a second. By the most accurate observation and measurement it is ascertained that this string does not vibrate in ordinary playing over one *sixty fourth* of an inch at the nodal point, or where the hair rubs it, which is about one tenth of its length, measuring from the bridge, thus making the aggregate velocity of the string at this point, or the whole distance it travels in one direction, but *three inches in a second.* To produce an ordinarily loud tone, therefore, the violinist is compelled to draw his bow at a velocity of at least three inches in a second, or otherwise his lagging bow must of necessity interfere with the string's normal oscillation and tend to check it, thus preventing its tone.

It may be observed, however, that in producing a very soft tone, as in piano passages, the string necessarily oscillates considerably less than when yielding a full sound, possibly not the one half of a sixty-fourth, making an aggregate distance traveled in one direction of *not over an inch and a half* in a second, in which case the bow, pressed very lightly, would only need to travel at a corresponding velocity, and still make a pure tone. Less velocity than this would again destroy it.

It is also true that in producing a very heavy note on the violin (in which case the bow has to be pressed down with considerable force), this G-string will be often observed to oscillate at its center nearly or quite a quarter of an inch, which would make its swing at the nodal point about the twenty-fifth of an inch, or eight inches a second in one direction; but in such a case as this, the violinist is absolutely compelled to move the bow at a velocity of at least *eight inches in a second*, or he will not produce the slightest semblance of a musical tone, though he may, as will be soon explained, move it as much faster as he pleases. If he should drop below this velocity while pressing down the bow sufficiently to cause this large oscillation of the string, the musical tone instantly ceases and degenerates into a horrid scratch which no sensitive ear can endure but for a moment. This scratch occurs for the reason I have already given, by the oscillations of the string being started and prematurely checked before reaching their normal limit by the too sluggish movement of the bow. Any violinist can easily demonstrate the truth of what I am now saying (which equally demonstrates the enormity of the error into which Professor Helmholtz has fallen), that the bow never does and never can travel slower than the string normally oscillates when producing a musical tone. He has only to remember, as the basis of his calculation, that the G-string has just 198 complete vibrations in a second, and then calculate the distance it oscillates.

Now, while the minimum velocity of the bow, to produce pure tone, must of necessity be equal at least to the velocity of the string's normal oscillation (never *less*, as Professor Helmholtz says it always is), yet

any violinist knows, or may easily know, that the bow may travel as much swifter than the string oscillates as the player chooses, many times, when great power is required, with a velocity six or eight times that of the string, often moving a distance of even thirty and forty inches in a second, *since the greater velocity of the bow will always be sure to catch the string exactly at the commencement of each of its swings in the direction in which the bow is traveling at the time, and thus facilitate its movement from the start!*

Strange to say, the thing turns out exactly the opposite of what Professor Helmholtz supposed, and the facts are precisely the reverse of those on which his elaborate theory was based! While he tells us, as just quoted, that *the string* always and necessarily *travels slowly with the bow*, and swings back "with much greater velocity than it advanced," the same as a trip-hammer falls, it is here demonstrated to be a scientific fact, that, in all ordinary playing, the string positively travels at least four times faster with the bow than it can oscillate when released, as it is perfectly clear that it can only fly back at its normal velocity or rate of swing, in proportion to its length, size, weight, and tension. Thus, the string in all ordinary playing absolutely acts in diametrical opposition to what Professor Helmholtz teaches, since it travels with the bow, or while it clings to the rosined hair, "with much greater velocity than it" retreats, after being momentarily released, since it can only swing back in accordance with its normal pendulous rate of oscillation, or at a speed of, say, *three to six inches a second*, while it is compelled to travel with the bow or while clinging to it at the rate at least of the bow's movement, or a full average of a foot to two feet a second! It thus makes its journey with the bow in about one quarter the time it takes to return! There is not, perhaps, in the investigations of science a case on record where all the facts and figures relied on to favor a theory have been so clearly and demonstrably shown to be exactly the reverse! I challenge the world to show a parallel. Assumed facts of science have been often proved to be incorrect and entirely misapprehended; but never, so far as I know, to be precisely the reverse, in every sense of the word, and to demonstrate the exact opposite of the explicit requirements of the hypothesis, and that, too, when the theory is under the manipulation of its ablest exponent.

Another marked peculiarity of this string's movement, which this careful investigator appears never to have thought of, must not be here overlooked. While the string is traveling with the bow at a *much greater velocity* than it can swing backward, it must necessarily travel at a *uniform speed* from the commencement to the end of its journey in that direction, since the bow necessarily travels in that manner; whereas, when it retreats, after being released from the rosined hair, it at first starts back slowly, moving faster and faster, the same as a pendulum, till it reaches the center of its amplitude and accomplishes one half of its swing, from which point it moves on by its acquired momentum through the other half of its journey, swiftest as it leaves the center but slower and slower till it reaches the other limit of its swing. No one disputes this pendulous movement of a string, when drawn aside and released. With this self-evident law before him, Professor Helmholtz tells us that the string, after being released from the rosined hair, *swings back just as a hammer falls after being released from the trip-wheel;* whereas, any schoolboy who has studied natural philosophy a

month knows that a hammer starts slowly at the commencement of its descent, and falls faster and faster to the end of its journey, increasing in velocity throughout the entire distance by a certain definite ratio based on its constantly accumulating momentum added to its gravity, which ratio of increased velocity would be maintained by a body falling toward the earth for any distance, if a thousand miles, minus the resistance of the air. Is it possible that this greatest of modern physicists is not aware of this law of a falling hammer, and of the pendulous law governing the movement of an oscillating string when drawn to one side and released? To suppose him ignorant of these well-known laws is to suppose an impossibility. To suppose he knowingly misrepresented the facts, to favor the theory of "vibrational form" he was laboring to establish, is inconceivable. I leave him to the mercy of a charitable world.

Such erroneous and superficial conceptions of the physics of sound generation and propagation as the foregoing, are the very kind of scientific data on which the entire wave-theory rests. Yet with all these and similar absolutely laughable misapprehensions, which will be abundantly pointed out as the argument advances, I am sincerely and kindly cautioned by my friends not to assail this theory, or venture into collision with such names as those of Tyndall, Helmholtz, and Mayer, unless I desire to be so finely pulverized, as one of them expressed it, that it would "require a microscope of several horse-power to detect the fragments!" The reader can well imagine, that, knowing as I did of scores of just such scientific escapades by these great authors, such as those I am now evolving from their writings, I I felt very little alarm at these annihilating predictions.

In view of the foregoing inversion of the facts and arguments of Professor Helmholtz, showing them to establish the exact opposite of what he intended them to prove, what must become of the various graphical diagrams which this writer has taken the trouble to prepare for his book, illustrating the "vibrational form" supposed to take place in bowed strings, every one of which is based on this idea of the trip-hammer moving up only a tenth as rapidly as it falls, and this self-evident fallacy that the bow must act in the same way, always traveling about *ten times* slower than the string's normal oscillation? A child might have confounded this great philosopher by asking what makes the string vibrate at all if the bow travels *ten times* slower than the string naturally swings? For, it is a recorded fact, that, in his very first diagram illustrating this principle of the trip-hammer's movement and that of a bowed string (page 32), he shows that it takes the hammer *ten times as long to be lifted as it does for it to fall;* whereas the intuition of the child would have taught him that as the motion of the bow causes the string to keep up its oscillation, it must of necessity travel as fast at least as the string can oscillate, and in all ordinary playing much faster! And what, I may ask, further, becomes of his "law," which he so elaborately formulates, that the *quality of tone* is caused by the vibrational form of the oscillating instrument and of the air-waves which it thus produces, when his principal graphical illustration and proof of this law, repeated five times, is this same misconception of the bow having only about one tenth the normal velocity of the string?

As I have clearly shown, by figures which every physicist will admit, and which any observer can see to be correct by the least attention to a violinist when playing,

that in all ordinary execution on the violin the bow must travel and actually does travel at least four or five times as fast as a string normally oscillates at the nodal point, moving from twelve inches to two feet a second, *thus carrying the string along with it four or five times faster than it can fly back again*, it gives us the somewhat novel and startling mechanical improvement in trip-hammers which would require them to fall only about one quarter as fast as they are lifted by the mill-work, that is, if their movement corresponds to that of the string when excited by the bow, as this philosopher teaches! If his mechanical ideas concerning the principle of a trip-hammer's movement are here correctly represented by the motion of a string as compared to that of a bow, I doubt if any mill-owners would care to employ him to superintend the construction of their machinery! A trip-hammer falling with only one quarter the velocity of its ascent, as is proved to be the case with the string, would do but little forging unless the anvil were placed above it, which is evidently the way this philosopher would have to construct it! But I will not be too hard on him, and will agree to let him off on the condition that he at once renounce the wave-theory of sound and adopt the hypothesis of substantial sonorous pulses!

A true theory is always consistent with itself, or at least *may* be, even down to the unimportant minutiæ of its details; and though there may be phenomena involved in its analysis which it can not explain, such phenomena, nevertheless, can not contradict it; whereas a false theory, however plausible or apparently consistent in its principal features, is certain to contradict itself in the discussion of details. Such we shall see to be the case all the way through this investigation of the wave-theory of sound.

This fallacious reasoning of Professor Helmholtz, based, as we have seen, on his utter misconception of facts which the commonest observer should have noted, is not a whit more surprising than that of Professor Tyndall, just hinted at, in supposing that a tuning-fork's prongs must necessarily move with enormous velocity, when, in the very nature of things, as the reader can instantly calculate, they can not travel in one direction over seven or eight inches a second, or, counting both directions, more than fourteen to sixteen inches in the same time. This being the fact, what, then, becomes of his "condensations and rarefactions" of the atmosphere wrought by this snail-like motion, with the *heat* and additional *elasticity* of the air thus generated sufficient to add "*one sixth*" to the velocity of sound, which hypothesis is absolutely essential to the existence of the wave-theory, as will be soon demonstrated? I will again quote his language:—

"Imagine one of the prongs of the vibrating fork *swiftly advancing* [at the rate of *seven inches* a second!]: it *compresses the air* immediately in front of it, and when it retreats it leaves a *partial vacuum* behind, the process being repeated at every subsequent advance and retreat. The *whole function* of the tuning-fork is to *carve the air into these condensations and rarefactions*."—*Lectures on Sound*, p. 62.

The Professor may well request us to "*imagine* one of the prongs of the vibrating fork *swiftly* advancing"; for, whenever the reader is undeceived on this subject by a correct statement of its facts, and thus becomes aware that the prong of the fork only moves *seven inches* in a second, not one half as fast as a year-old baby can walk, it requires a considerable stretch of the *imagination* to see it "*swiftly* advancing," thus *carving* the air into a "condensation," and then retreating so "swiftly" as to cause a "rarefaction" by leaving a "*partial vacuum behind*," all of which gen-

erate the required heat and elasticity to enable these air-waves to travel with sufficiently augmented velocity not to contradict the wave-theory! Not a word does this scientist suggest as to the possibility of the fork generating its tone by the molecular effect of its numerous sudden stops and starts on the atomic structure of the instrument itself, the only rational supposition possible in the premises! An intellect capable of *imagining* a tuning-fork "*swiftly* advancing," and generating heat by squeezing the air into "condensations" when only traveling at the rate of *seven inches* a second, could hardly be expected to grasp an idea so beautiful, fundamental, and scientific, as the one suggested by the above molecular hypothesis.

I have sometimes wondered if this lecturer ever thought of the really amusing character of this tuning-fork's performance, as he has described it! He tells us that when it advances it "*compresses the air immediately in front of it*, and when it retreats *it leaves a partial vacuum* behind." Now, this amounts to an unprovoked scientific slander on our atmosphere! With all its acknowledged *elasticity* or spring-power, especially under *pressure*,—one of its most persistent, important, and undeniable characteristics,—it is here made out to be so *lazy* and *sluggish*, under the manipulation of this learned savant, that, even after it has been *compressed* into a *condensation*, it allows the prong of a tuning-fork when traveling but *seven inches a second* to run right away from it and leave a *partial vacuum!*

Seriously, I think it is about time for physicists to call a convention, and reconsider this entire question of sound-propagation, or else hire some good mechanic to reconstruct their wave-theory, and so to arrange it that its parts will hang together, unless they want the whole thing to become the laughing-stock of the unscientific world! For, at the present rate of progress, Professors Tyndall and Helmholtz, its two ablest and most popular exponents, are fast bringing the hypothesis into contempt. To make out, as they do, that the *compression* of the air, by this slow forward movement of the fork's prong, will send off a condensed wave 1120 feet a second, or at the observed velocity of sound, and then tell us that the same condensed wave, after being compressed, can not recoil fast enough *to keep up with the retreating prong and prevent a vacuum, requiring only this same velocity of seven inches a second*, is laughable enough to have a place in the funniest column of *Punch*.

Returning now for a moment to the tuning-fork upon its resonant case vibrating by sympathy 180 feet distant from the actuating fork, I ask what explanation can possibly be given of such a sonorous effect save the one assumed in my hypothesis of substantial pulses, having a definite law controlling their velocity of propagation? We have seen that literal, physical air-waves, moulded and driven off from the prongs of the oscillating fork, moving but seven inches in a second, if they should travel as swiftly as the moving prongs themselves (and they surely can move no faster), and if all inertia and atmospheric friction, or tendency to quiescence, were abolished, *would require over five minutes to pass from one fork to the other!* Yet we absolutely know that the sympathising fork commences responding to the other the moment the sound is heard by the assistant standing near it, or in almost one two-thousandth part of the time it would take an air-wave at its highest possible velocity to reach it were there nothing to hinder its progress!

On the hypothesis of sound consisting of substantial pulses generated by the

actuating fork, augmented and diffused by its resonant case and its sympathetic air-column, and radiating through the atmosphere by a law of conduction peculiar to sonorous pulses, as light is radiated by a law peculiar to luminous discharges, it is easy comprehending that such sonorous discharges might travel to the distant fork at a velocity of 1120 feet a second, or at the observed velocity of sound, without any regard whatever to the intervening air except as to its conducting properties (the same as electricity depends on the character of its conducting medium), acting, at their arrival, first on the sensitive unison air-column which fills the resonant chamber, and which, being so exceedingly mobile, will of course first respond by sympathetic action, which is instantly communicated to the surrounding case, and, through it, to the prongs of the fork.

One of the most fatal and mischievous errors, and one which has tended, perhaps, more than any other to keep the wave-theory of sound in existence, is the assumption, that, because an inclosed air-column, a singing flame, or a stretched membrane, will stir at a distance from an actuating instrument of the same pitch *the intervening mass of air throughout the whole distance must therefore be thrown into vibratory motion*. This fallacy led to the invention of an all-pervading luminiferous *ether*, to account for, or rather provide for, the undulatory theory of light. This hypothetic ether is supposed to fill all interstellar space, the entire mass of which must, of course, be thrown into waves, and must continue perpetually to vibrate by the light of *one single star*, which, of course, shines through it in all directions; while millions of other stars also shining through the same mass in all directions must necessarily produce millions of independent co-existing and conflicting systems of waves within the same mass of ether at the same instant! Thus, taking any single cubic inch of interstellar space you choose to select, the ether which it contains must be actually oscillating with a million different systems of waves, from a million different stars, while these millions of diverse and conflicting motions of the same ether are carried on harmoniously at the same instant and without the least disturbance of each other, according to this consistent and highly scientific hypothesis of wave-motion! Yet the same authorities tell us that two systems of aerial or ethereal waves "*interfering*" will completely neutralize and destroy each other!

Having seen how a unison air-column can resound by means of synchronous but substantial pulses dashing against it, let us revert again for a moment to the sounding-board, whose principle of resonance, as before intimated, is entirely different, and try to learn how the sound of a fork is augmented by its stem simply being held in contact with the wood, if it is not caused by the augmentation of air-waves, as the undulatory theory supposes it to be.

The fundamental laws of conduction and radiation, lying at the bottom of this and all analogous phenomena, such as those of Heat, Light, Electricity, Magnetism, &c., are not understood, and probably never will be by man. It is only by the analogies of the so-called forces, elements, and modes of motion, that we can arrive at any definite or satisfactory conclusion on the subject. We definitely know, however, from the best of analogical reasons, that the resonance of a sounding-board can be nothing but the simplest radiation of sonorous substance, the same as heat is radiated in larger quantities from a more extended surface or from one of a better radiating material. No one pretends to

believe that heat radiates or diffuses itself through a room from a metallic surface by means of augmented *air-waves* driven off, though the atmosphere may tremble, and no doubt does, from the effects of such radiating heat. But as some kind of an undulatory motion seemed to be necessary for heat, in order to keep up its complex analogy with sound-waves and light-waves, that "all-pervading" *ether* (which has no existence in fact, but which Professor Tyndall describes as resembling "jelly,") has recently been pressed into service, and now, instead of heat being a common-sense substance, as simple as odor or the atmosphere itself, it is converted into a certain mode of motion of this gelatinous ether, *another substance* infinitely more difficult to believe in than the substantial nature of the very thing it is intended to explain. Thus, science, "falsely so-called," instead of simplifying the problems of Nature, and bringing to light her hidden mysteries, seems to complicate and confuse every phenomenon it touches.

Suppose, for example, a cubic inch of iron at a permanently red-hot temperature, placed in the middle of a room twenty feet square, on a cold day, its effect would scarcely be sensible a short distance from it; yet, if the same quantity of iron were spread out into a sheet thin enough to cover the floor of the room, and could be kept at the same temperature, the diffusion of heat would be so intense, owing to the greater radiating surface, that no one could live in the room for a single minute. Place the same cubic inch of permanently red-hot iron in contact with a sheet of copper, and its heat would be rapidly diffused over the surface of the sheet, and from it radiated in augmented warmth throughout the room. This cubic inch of iron represents the tuning-fork, while the sheet of copper answers for its sounding-board. Although the heat radiates with augmented rapidity from its more extended surface, and owing to its peculiar molecular structure, yet it requires no vibratory motion of the copper whatever to cause this increased radiation. A sheet of iron in lieu of the copper would prove a poorer sounding-board for radiating the heat, because, being a poorer material for the purpose, the heat would not spread with the same facility over its surface as over that of the copper, consequently we would feel less warmth in the room.

All these facts in regard to the radiation and diffusion of heat are instructive as analogies of the radiation of sound; and, though governed by different laws in some respects, yet the general principle of the two operations is the same. On the quality of the radiator and the extent of its surface in the two phenomena depends the amount of diffusion both of sound and of heat; and in neither case does this augmentation depend in the slightest degree on the motion communicated to the radiating surfaces, and thence to the air, whatever contingent vibration either may incidentally produce.

The same law of radiation in proportion to surface holds good with reference to odor. A quantity of musk would not diffuse itself and fill a room with its peculiar fragrance as rapidly if in the form of a ball as if it were spread out over a large radiating surface; and even then the character or quality of the surface on which it was spread would have something to do with it. The warm surface of a board would radiate the fragrance with much greater intensity than a sheet of ice. The diffusive and radiative action of odor is almost exactly the same in these respects as those of sound and heat, yet no one thinks of making odor anything but sub-

stantial emissions; and I have yet to learn that either Helmholtz or Tyndall has ever gone so far in their mystification of Nature's phenomena as to attribute the diffusion and radiation of a certain fragrance to the oscillatory petaliferous tremors of the rose and honeysuckle! They, in fact, find no difficulty whatever in accepting the proposition that a substance constituted of real atoms in the form of musk can diffuse and propagate itself by an unknown law from particle to particle of the atmosphere, and thus project its rays of substantial fragrance over acres of still air in a few minutes without any kind of undulatory motion or air-waves whatever. Yet, like sound, this substantial emanation must have a suitable conducting medium or it will not travel at all. Place a grain of musk under an exhausted receiver, and no odor would radiate to fill the vacuum. So, also, place a bell within the same receiver, and cause it to strike by suitable mechanism, and no sound emerges from this region of vacuo. The sonorous atoms generated by the vibrations of the bell, as well as the odorous atoms generated by the musk, fall powerless for want of a conductor. The substantial atoms of electricity will not travel without a conducting medium, neither will those of sound or odor. Yet, evidently, they are equally substantial.

Although electric discharges are generated by the chemical action of the acids upon the zinc in the battery, and notwithstanding this chemical process may, and no doubt does, cause a degree of tremulous action among the molecules of the metal and of the liquid while generating and releasing this wondrous substantial element called electricity, yet no one would be so weak as to suppose that this tremor actually "*sends*" off these electric pulses at the enormous velocity of thousands of miles a second, much less that they are propagated by means of air-waves or wire-waves "moulded" and "carved" by this tremulous motion of the zinc or this effervescing action of the acid! No! chemists and physicists have more reason and logic when they come to treat on the generation and propagation of electric pulses, and at once concede that although the electricity is generated and liberated by the molecular tremor of the zinc and the effervescing action of the acid, yet its propagation through a wire depends on an unknown law of conduction peculiar to that particular substance, without bringing into the solution either *ethereal*, *aerial*, or *metal* undulations. Yet, whenever they change to the production of sound-pulses, which are generated by an almost similar kind of molecular tremor, and propagated by a similar unknown law, they at once become mere children in the superficiality of their logic, ignoring all ideas of the possible radiation of substantial pulses of sound by a law of conduction peculiar to that particular kind of substance the same as electric pulses travel; but, trampling under foot all analogical propriety and consistency, conclude that these sonorous discharges are literally *driven* off as air-waves, or iron-waves as the case may be, the entire distance they are propagated by the actual motion or tremor of the sounding body, though the slightest observation would have convinced them that the pulses *start with a velocity nineteen hundred times greater* than that of the movement of the instrument which is supposed to "send" them!

I now enter upon the consideration of a sonorous problem second in importance to no other question connected with the present discussion,—a question involving phenomena which are looked upon by physicists, and especially by all writers on

sound, as among the most conclusive proofs that sound is propagated by means of air-waves constituted of "condensations and rarefactions."

I refer to the well-known and universally observed effects of magazine explosions in the breaking of windows at a distance,—sometimes even miles away from the source of the atmospheric concussion. As strange as it may appear to the reader, it is absolutely taken for granted by all physicists that the concussive shock or condensed atmospheric wave which crushes in windows and sometimes even houses, is the same as the sound-pulse generated at the instant of the explosion, no distinction whatever being even dreamt of between such sound and such condensed wave of air! Yes, surprising as it will appear before we get through with this examination, not one writer on sound, among these greatest scientific investigators of the world, has been able to see the least difference between the sound of such an explosion and its concussive shock, which would knock a man lifeless to the ground if standing near the magazine! That such careful thinkers should be *totally ignorant* (I use the word *ignorant* with due respect, but at the same time mean it,) of any distinction between the two phenomena, but should employ them in their descriptions of such events interchangeably, as meaning one and the same thing, is among the most startling facts connected with the investigations of modern science.

The subject is therefore of so much importance that I shall be obliged to devote several pages to its discussion, in which I propose to show, not only that all scientific writers upon this subject so far are mistaken, but that the explosions of magazines furnish one of the most conclusive and unanswerable arguments against the atmospheric wave-theory of sound which could be desired. If the advocates of the wave-hypothesis should thus be obliged to look on and see their most important weapon wrenched from their hands and fatally turned against them, surely they will begin to consider their theory as becoming hopelessly involved.

I now call attention to the fact, which appears never to have entered the minds of these astute writers, that at the explosion of a magazine thousands and possibly tens of thousands of cubic yards of gas are instantly generated and added to the air, which necessarily, without any reference to the accompanying sound at all, shove away the circumambient atmosphere in all directions; and, in doing so, naturally and unavoidably condense its particles, thus forming an intensely compressed air-wave, which is driven away at an enormous velocity, producing the agitation and concussion at a distance which break windows, as so often witnessed. These great investigators of natural phenomena have never thought of the least difference between an effect thus produced, where a mountain of gas is instantaneously added to the air, and that of a sound perhaps equally as loud caused by the clashing of two trains of cars together or the falling of a building, in which nothing is added to the bulk of the atmosphere! No, so far from making this manifest distinction, so clearly scientific, and which, as we shall soon see, explains the whole matter at the expense of the very theory it has been supposed to favor, these sound-writers speak in the most unsophisticated manner of windows being crushed in by a "sound-pulse" sent off from a magazine explosion, ignoring entirely the distinction I am here pointing out.

As an example of this childish superficiality, I will quote Professor Tyndall's innocent description of the breaking of

windows at Erith. It will surely amuse the reader, if it does not instruct him:—

"The most striking example of this *inflection* of a *sonorous wave* that I have ever seen, was exhibited at Erith after the tremendous explosion of a powder magazine which occurred there in 1864. The village of Erith was some miles distant from the magazine, but in nearly all cases the windows were shattered; and it was noticeable that the *windows turned away from the origin of the explosion suffered almost as much as those which faced it.* [This effect is simply explained by the tremendous shove given to the air, causing it to compress around the buildings equally on all sides. Professor Tyndall thinks it was the "sonorous wave" which *inflected*, and doubled its two ends around the building, thus crushing the windows!] Lead sashes were employed in Erith church, and these being in some degree flexible, enabled the windows to yield to the pressure without much fracture of the glass. Every window in the church, front and back, was bent inwards. In fact, as the *sound-wave* reached the church it separated right and left, and for a moment the edifice was clasped by a *girdle of intensely compressed air.*"—*Lectures on Sound*, p. 23.

The reader observes, no doubt with some degree of surprise, that no distinction is even hinted at in the above citation between the "girdle of intensely compressed air" caused by the cubic acres of added gas, and the "sound-wave" which appeared to accompany the concussion; but, instead of this manifest discrimination, the two are used interchangeably,—the fallacy of which will now be made apparent.

First of all, I here make an announcement,—call it a prophecy, if you like,—to which I invite the attention of Professors Tyndall, Mayer, and Helmholtz, namely, that the condensed air-wave or atmospheric concussion which breaks a window at a distance from an explosion of powder, *will be found, when tested, to be altogether a different effect from the sound produced by the same explosion, and that it will also be found to travel at a different velocity, which velocity will be in proportion to the quantity of gas added and the distance the condensed wave has traveled!* If this prediction shall ever be subjected to careful scientific experiment, which can be easily done and at trifling expense, it will be found that the velocity of the concussive shock as compared to the velocity of the sound itself will bear the following relation: For a short distance from the explosion (depending on the quantity of gas added to the air) the condensed air-wave will probably travel faster than the sound by utilizing the greater spring-power of the air at the start, but at a long distance (say three or four miles) from the explosion the sound will certainly be found to reach the observer first, since the greater expansion of the condensed atmospheric shell will weaken the effect of its elastic spring and decrease the velocity of the concussive shock. While the sound-pulse (which is a separate and independent thing from the condensation of the air caused by the instantaneously added gas) has but one uniform rate of velocity from the time it starts till it reaches its maximum distance, the speed of the condensed wave of air which breaks the window will be found to be at its maximum at the start, and gradually to travel slower and slower as a larger and larger circle of atmosphere is embraced within the wave, till finally its velocity must entirely die out with its effect, not moving probably a foot a second. And while the audible sound-pulse would necessarily be limited and entirely die out within a certain distance, there is no conceivable limit to the condensed atmospheric wave but the upper boundary of the aerial ocean, as philosophy must teach us, if we take the trouble to reflect, that a single cubic yard of gas added to the air anywhere would so act on its elasticity and expansibility as to continue the displacement and motion to its upper sur-

face,—gradually, as before observed, becoming weaker and weaker. This is clearly taught by the principle of the conservation of force, the displacement of matter, and the persistence of motion.

It is entirely different, however, in case of a sound caused by a falling tree, for example, which does not add a cubic inch to the bulk of the air, though its report moves off with the same velocity exactly as that of the sound of an explosion. The atmosphere is merely displaced by the moving tree from in front, and has only to pass around behind the trunk and fill the partial vacuum caused by its motion, thus producing by its *mobility* (which these sound-investigators seem almost entirely to ignore) an equilibrium, without probably stirring the air half a dozen rods off. For this reason, the falling of a tree or of a building produces no atmospheric concussion outside of this limited agitation, though the sound may be heard for miles away, and might prove even equal in intensity to that of an explosion. There being no large amount of gas or other elastic material added to the atmosphere by the falling tree there is no shell of "*intensely compressed air*" driven off to a distance to crush windows, which must necessarily be the case when such a body of gas is instantly generated, compelling the air which had just occupied that space to move off at great velocity in all directions. Yet, clear and simple as this exposition must be to the reader, Professor Tyndall, with all his reputed scientific penetration, was incapable of seeing it, and hence deliberately mixed up this "*girdle of intensely compressed air*," caused by the added gas, with the *sound-pulse*, which, let it be ever so intense, is not capable of stirring the lightest feather unless tuned to oscillate in unison with its own periodic pulsations.

But I do not yet propose to leave this magazine problem, clear as it is, without further elucidation. I will now give an illustration of the distinction here pointed out between a sound-pulse and an atmospheric concussion caused by the sudden addition of a large quantity of gas, which will make it so clear that a schoolboy will be able to comprehend it, though I anticipate more difficulty with physicists who are not capable of seeing any difference between an atmospheric concussion which breaks windows and the sound generated by the same explosion.

We will figure to our minds a smooth tube, say a couple of miles long, having a closely fitting piston in one end and being open at the other. It is evident, if the piston should be suddenly forced into the tube a few inches it will create a condensation of the air immediately in front of it, which, not being able to escape sidewise, will act on the air in front of that, and so on communicating the condensation from one particle of air to another till the concussion reaches the far end of the tube, where it would demonstrate itself by acting on a candle-flame or any sensitive object, whether in tune or not, such as a feather, placed at the outlet.

This sudden shove of the piston is exactly the same in principle as the sudden addition of a quantity of gas to the surrounding atmosphere by an explosion of powder or nitro-glycerine. If the piston is moved an inch into the tube, it will, in effect, add one inch to the air in the tube directly in front of the piston, which, as a matter of course, must shove the air of the tube with a force equal to the spring-power of this condensation, and will not cease with its shoving process till its effect reaches the open air at the far end of the tube, which will then, and not till then, establish an equilibrium in the general atmosphere outside of the tube, or com-

pensate for the vacuum produced behind the piston in giving the original impulse. This vacuum is, of course, instantly and almost completely filled by the expansive tendency of the surrounding atmosphere near it, but the equilibrium can not be said to be fully re-established till the condensation within the tube has traveled the two miles and has been added to the bulk of the outside air.

Thus far it is, of course, plain sailing, and without any chance for controversy. But right here begins the confusion of physicists. They seem to think if the piston is shoved instantaneously but a single inch, thus in effect adding one inch to the air of the tube directly in front of it, that such a condensation would travel throughout the length of the tube *with the same velocity precisely as if the piston had been shoved twelve inches or twelve feet in the same instant of time*, and thus added as many inches or feet to the air of the tube instead of a single inch; though this manifestly can not be the case, because the spring-power of a twelve-inch condensation instantly generated must be vastly greater on the column of air in front, and must drive it with vastly greater velocity toward the outlet of the tube, notwithstanding the compressibility of the air, than could be effected by a spring-power of one inch. It seems to me to be so self-evident that the speed of the concussive impulse or condensed wave along the tube must bear some sort of proportion to this force of the spring or quantity of air instantly added by the movement of the piston, that it requires no argument to prove it; and I must say I fail to form a very favorable estimate of a man's philosophical or mechanical perspicacity who can not see it, or who takes the opposite view, as do our most learned savants. So far from admitting this, as I conceive, elementary principle of physics, they actually teach the principle that if the piston could be instantaneously moved a distance of fifty feet, thus compressing this quantity of air within the space of a single inch or even less (representing the condensed force of powder before its explosion), such an expansive spring-power would not shove the remainder of the air in the tube with any greater velocity than if the piston had moved but a quarter of an inch, having the very weak spring-force such a trifling condensation would have produced! This, I admit, is a serious charge to make against the greatest scientists of the age; but I will sustain it unequivocally not only from the record but by the unavoidable logic of their explanation of magazine explosions, in making them conform to the wave-theory. Let me have the reader's attention for a few moments upon this single point.

In the first place, these physicists fully justify my charge by making the condensed wave of air which is shoved away in all directions at the explosion of a magazine, *identical with the sound-pulse which the same explosion produces*, without any reference to the amount of gas added, as just quoted fully from Professor Tyndall, with which also all other writers on the subject agree. I will illustrate this. If a single barrel of powder, for example, should be exploded at the magazine, the sound would, of course, be heard, and the concussive shock felt, at the distance of a mile away. Professor Tyndall says this sound-pulse and this condensed air-wave are identical. Then, if one thousand barrels of powder, instead of a single barrel, should be exploded at the same place, causing one thousand times as much gas and spring-force to drive the air, *the concussive shock and the sound-pulse heard a mile away would still be identical*, according to this same

high authority. Now, since there is no appreciable difference between the velocity of a loud and of a feeble sound, as universal observation proves, and consequently no difference between the velocity of the sounds of the two explosions just supposed, it is clear that my charge is sustained to all intents and purposes, namely, that the logic of Professor Tyndall and his collaborators on sound teaches that the velocity of a *condensed wave* caused by the sudden addition of air or gas to the atmosphere does not depend in the slightest degree on the *quantity of air or gas added*, since both quantities and their resultant condensations in the two explosions are identical with their accompanying sound-pulses, and since all sounds have but one uniform velocity in air of the same temperature! Hence, it follows, as the result of this reasoning, that, could a piston be instantaneously pushed into our supposed tube a distance of *fifty feet*, producing the same effect as if fifty feet of additional air were instantly introduced in front of the piston, it would not drive the condensed wave toward the far end of the tube with any greater velocity than if the piston were shoved *the sixteenth of an inch*, since *all condensed waves of air are identical with sound, and all sounds have the same velocity!* There can be no escape from this conclusion, grind as it may the logic of these great scientific investigators, as will soon be demonstrated by the very words of one of the foremost of their number. To attempt to modify it in the least would be at once to abandon the identity of the "sound-pulse" and the condensed air-wave sent off from a magazine explosion, and such a modification would be the simple renouncement of the entire wave-theory of sound.

I have already explained that a condensed wave in the open air, driven off by the explosion of a given quantity of powder, dynamite, or nitro-glycerine, would travel at its greatest velocity at the start, its speed becoming slower and slower the larger the circle of atmosphere embraced within the expanding condensation. Not so, however, with the condensed wave in our supposed tube. As the wave instantly generated by the motion of the piston can not expand laterally, like the condensation caused by a magazine explosion, but must continue on in the same direct course, controlled by the same limits of the sides of the tube to its far end, it must seem evident that any given condensation caused by the moving piston will travel with the same uniform velocity from one end to the other of the tube. If the added air, or, what is the same, if the movement of the piston be small, the spring-force of the condensation thus generated will be slight, and its velocity throughout the tube will be correspondingly low; but if the piston should move suddenly a larger distance the spring-force of the condensed wave and its velocity will be correspondingly increased, though in both cases the velocity will probably be uniform, or at least very nearly so, from the start to the finish.

In assuming this condensed wave of air resulting from an explosion (which is precisely the same thing as that in the tube, since the explosion of a little powder in front of the piston would produce the same effect exactly,) to be identical with the sound-pulse, as all physicists are compelled to do according to the wave-theory, they are unavoidably forced to assume, as already demonstrated, that such atmospheric condensations, whether large or small, must travel at the same uniform velocity, without any retardation by expansion in the open air, since the velocity of all sounds is exactly the same whether caused by

small or large explosions. The final result of this reasoning is, either that all additions of gas to the air by the explosions of powder, whether large or small the quantity—whether a hundred pounds or a million tons—must drive the condensed wave with the same velocity, or else such condensation is not identical with the sound-pulse, since all sounds, as every one admits, *travel with the same velocity!* This logical sapping and mining of the wave-theory must inevitably result in the surrender of the citadel, as will now be seen.

The foregoing being the unperverted and undeniable logic of physicists, let us for a few minutes turn to the record. By reference to *Appleton's American Encyclopedia* and its elegantly written article on "Sound," fortunately within the reach of all students desiring to investigate the matter, Professor Mayer, the highest authority on sound in this country and called by many the Helmholtz of America, makes use of this very illustration of the tube with a movable piston at one end, and actually assumes and teaches that the velocity of the atmospheric condensation caused by a sudden shove of the piston must necessarily be the same as that of sound, or must of necessity travel 1090 feet in a second at a temperature of 32 degrees Fahrenheit, since that is the admitted velocity of sound. As surprising as it may seem to the unscientific reader, and in exact conformity to the foregoing argument, this physicist makes no distinction whatever in the velocity of the condensed wave thus generated, whether the piston is moved one inch or ten feet, so the movement is instantaneous; and consequently he points out no difference in the speed of such a wave, whether the spring-force of the condensation generated by the piston's motion be equal to a pressure of one ounce or one thousand pounds! He assumes this velocity of the condensed wave along the tube to be the same as that of sound,—nothing more and nothing less,—and hence it must be the same necessarily, whatever the spring-force employed to drive it, since the velocity of sound through this tube at any definite temperature, as already shown, is always the same!

As this writer fails to note this distinction, but rather ignores it, the same as did Professor Tyndall in reference to the magazine explosion and the destruction of the windows at Erith by a "sound-wave," I am therefore compelled, as I did in the other case, to definitely point out the law governing the transmission both of the sound and of the atmospheric condensation through this tube, and thus indicate the manifest difference between them, which science and its exponents so far have failed to do.

Let us suppose the piston to be moved instantaneously into the tube a certain distance by the blow of a hammer, which also makes a sharp report at the same time. This simultaneous sound of the blow and atmospheric wave produced by the movement of the piston might or might not travel with the same velocity toward the far end of the tube. It would, of course, depend entirely upon the distance the piston was driven by the blow of the hammer, or, in other words, upon the quantity of air (in effect) thereby added to the atmosphere of the tube. It is evident that a true distance for the piston to suddenly move by this blow might be arrived at by experiment which would furnish just enough spring-force to carry the condensed wave through the tube with a velocity equal to but not exceeding that of the sound-pulse caused by the same blow of the hammer. But it is likewise evident that a distance might be selected

for the piston to move (say *one sixteenth of an inch*) which would produce so little compression of the air in front as to cause the condensed wave to lag behind, and possibly not travel one tenth as fast as the sound of the hammer. In this case, however, the condensation, as before remarked, would probably travel through the tube at a uniform velocity from end to end, though the sound would vastly outstrip it. The speed of so slight a condensation would resemble that of a condensed wave from a magazine explosion when it had nearly spent itself by expansion and rarefaction, as already explained. And, finally, it is evident that a distance could be determined for the piston to move (say ten, twenty, or forty feet,) simultaneously with the blow of the hammer, provided it could be instantaneous, which would add sufficient spring-force to carry the condensed wave with a velocity twice or even three times that of sound. Is not this simple and clear? Yet these palpable and manifest distinctions, lying at the very basis of pneumatics and acoustics, as any analytical mind must perceive, have never entered the thoughts of these great physicists. Why? The answer is plain. Simply because the universally accepted wave-theory of sound is obliged to lay down as its fundamental principle that a sound-pulse of any kind consists in and is propagated by means of a *condensation* of the air, and can only travel as such compressed atmospheric pulse. Hence, after starting out with this fallacy, it became necessary, in order to harmonize natural phenomena, to compel all kinds of atmospheric condensations to conform to this law, and thus to travel at the observed velocity of sound! As physicists were unable to separate the concussive shock of a magazine explosion from its sound-report, but must suppose the two necessarily to be one and the same thing, according to this wave-hypothesis, it is asking altogether too much of them now to distinguish between the velocity of a condensed wave in a tube and its accompanying sound derived simultaneously from the blow of a hammer! It is owing entirely to the blinding effect of this all-pervading fallacy of atmospheric sound-waves having "condensations and rarefactions," generating thereby "heat," and thus adding "one sixth" to the elasticity of the air and the velocity of sound, that we see Professor Tyndall deliberately and almost pitiably jumbling a "sound-wave" or a "sonorous pulse" with the "girdle of intensely compressed air" *which crushed in the windows at Erith!* And it is owing to the same reason that we see Professor Mayer, one of the most brilliant intellects of America, laying down his law that the velocity of a condensed wave in a tube, caused by the sudden shove of a piston, must necessarily be 1090 feet a second, or, in other words, must conform to the observed velocity of sound, without the least regard to the amount of condensation the piston produced, or the force thus brought to bear in propelling the wave!

I will now quote Professor Mayer's own words from the *Encyclopedia*, that their clearly erroneous character may be manifest to the reader:—

> "If air were *incompressible*, a motion produced at any point of its mass would *instantaneously be transmitted to every other point of the atmosphere.*"

Then, to show what he means by the *transmission of this "motion"* "to every other point of the atmosphere," he continues, without break, to use the illustration of the tube, of which I have spoken:—

> "Thus, if we imagine a tube open at one end and closed at the other by a piston that moves in the tube without friction, it is evident that if this piston were pushed into the tube a certain distance

the air would at the same time move out of the tube at the open end. [That is, on the supposition, as above, that the air was "incompressible."] But air is *compressible* and *elastic*, and after the piston has been pushed into the cylinder, a *measurable interval of time* will have elapsed before the air would move out of the open end of the tube. *This interval is the time taken by sound to travel the length of the tube.*"

He thus not only confirms what I have already said, that the condensed wave caused by pushing the piston into the tube must necessarily travel, according to the wave-theory, with the velocity of sound, whether it be accompanied by sound or not, and without any regard to the amount or force of this condensation or the distance the piston is instantaneously moved, but he also teaches the enormous and self-evident error that "if air were *incompressible* a *motion at any point of its mass* would instantaneously be transmitted *to every other point of the atmosphere*," which "motion" he immediately explains to be the absolute displacement of the entire atmosphere to the extent of the movement! This he manifestly means to teach by his illustration of the tube, out of which the air would instantly rush as the piston was pushed into the other end, supposing the air to be incompressible, and to the exact amount of the piston's movement. A more erroneous inculcation than this can not be imagined, as I will now show.

As recently remarked, he here ignores *in toto* the *mobility* of the air, and overlooks one of the plainest principles in science, that even if the atmosphere were wholly "incompressible" it still might possess extreme *mobility*, and thus compensate for any "motion," and neutralize its effect by its disturbed portion moving around the disturbing body and thus establishing an equilibrium, without the motion being transmitted more than a few inches from the center of disturbance. Instead of recognizing this elementary fact of science, he makes no reckoning of this principle of *mobility* at all, and teaches that if the air was incompressible, a fly, by moving its wings and thus stirring the atmosphere, would actually continue the same displacement "to every other point of the atmosphere," even carrying this same motion around the earth, just as the air would move out of the tube by the motion of the piston!

Now, we have just such an element as he supposes in *water*, which is practically incompressible though possessing the same *mobility* in proportion to its density as the atmosphere. Hence, if we had an inexpansible tube two miles long filled with water free from air, a piston pushed into one end would cause the water to pass out at the other end at the same time. Why? Because, in the first place, being incompressible its particles can not squeeze together; and, secondly, its *mobility* can not be made available to counteract this motion, or to compensate for the displacement, owing to its confinement by the sides of the tube. But supposing the tube were not there, and the same disturbance of the water should take place in the open ocean by pushing the same sized piston through it the same distance, this authoritative writer teaches, if his words have any meaning at all, that this motion "would instantaneously be transmitted to every other point of the" ocean, displacing every particle of its millions of cubic miles of water to the full extent, in the aggregate, of this piston movement, just as truly and literally as that the same quantity of water would be forced out of the end of the supposed tube! There is no possible escape from this conclusion, since the water is practically incompressible, and its *mobility* is not named or so much as hinted by this physicist. I doubt if he

even thought of it, or he surely would have detected the fallacy of his teaching, and not have placed on record, to stand forever, such an unmitigated philosophical blunder.

And here we are compelled to note the surprising fact, that, while these writers on sound are constantly calling our attention to the "elasticity," "density," and "compressibility" of the air, and its consequent spring-power in conveying a pulse or atmospheric condensation with great velocity to a distance, they never even name the *mobility* of the air, one of its most important and persistent characteristics! Is there any meaning in this astonishing fact, or any way of accounting for such a remarkable oversight in scientific writers? I will not say it is an intentional suppression of a well-known scientific fact, but when we come to consider that should the *mobility* of the air be recognized in their arguments on wave-motion, it would in every instance overthrow the wave-theory of sound, the coincidence becomes at once startling and suggestive! When these physicists are engaged in constructing their beautiful mathematical hypothesis of a sound-pulse causing a "condensation" of the air, which generates *heat* enough to add "one sixth" to the velocity of the sound, and which, owing to the spring-power of the air resulting from its *compressibility* and *elasticity*, is driven from mass to mass of the atmosphere at a velocity of 1120 feet a second, all by the trifling aggregate movement of a tuning-fork's prongs *seven inches in a second*, they seem to shut their eyes to the fact that if the air possesses any *mobility* at all, or the least tendency to get out of the way of the advancing prong and move around behind it, the continuation of this supposed "pulse" or "condensation" a single inch beyond the travel of the prong is utterly impossible. It is therefore clearly manifest that this principle of atmospheric *mobility* or this tendency of the air to move aside as an object is passing through it, even if its density and mechanical viscosity were equal to those of mercury, completely nullifies the hypothesis of an air-pulse or condensed wave being continued a single foot in advance of any object, if even moving as swiftly as a bullet when fired from a rifle, which travels at least 2,000 times swifter than the prong of a tuning-fork! If the air did not possess the principle of *mobility*, or, in other words, could not get out of the way of a body passing through it and thus pass around behind, then the pulse must necessarily continue on in a direct line in advance of a fork's prong the same as in our supposed tube, moving at a velocity corresponding to the velocity of the impelling body, as before illustrated. But the mobility of the air, which the wave-theory wisely and necessarily ignores, alone counteracts and neutralizes this supposed tendency of a pulse or condensation to travel any distance in free air driven by a body moving through it at whatever velocity.

The fact that any physicist claiming to think or reason, knowing of the *mobility* of the air and its perfect freedom to escape sidewise when disturbed by a moving body, should have ever taught, except as a huge scientific joke, that condensed air-waves are actually driven off at a velocity of 1120 feet a second in advance of the prong of a tuning-fork moving but *seven inches in a second*, must prove a source of almost infinite amusement to scientific investigators of the not very distant future; while the very writers, I doubt not, who now advocate these infinite impossibilities will themselves be the first to laugh at their unparalleled absurdity as soon as the question is once fairly brought to their attention.

So far, then, from the position of Professor Mayer being correct in regard to the instantaneous transmission of a disturbance to all parts of an "*incompressible*" body, it turns out to be exactly the reverse, as was seen in the analysis of the motion of a violin-string, and the enormous blunder of Professor Helmholtz. If the air were really *incompressible*, while at the same time possessing *mobility*, as seen in the case of water, this very condition would prevent such transmission instead of encourage it! But with the atmosphere compressible, as we know it to be, let a movement take place in the midst of the aerial ocean, and this very principle of compressibility will permit the disturbance to extend around for some distance, as seen in the movement of a fan in a still room, into which smoke has been admitted to visualize the motion; whereas, if the air were practically "*incompressible*," as in Professor Mayer's supposition, the same as water, the disturbance would be rigidly confined to the moving body, while the *mobility* of the air would continually come into play to re-establish equilibrium.

I have thus far spoken of water as practically *incompressible*, which it is so far as any ordinary motion producing an appreciable effect is concerned, since its utmost compressibility which mechanics has been able to demonstrate, amounts to but one part in 22,000 for each atmosphere, or fifteen pounds pressure to the square inch. It is perfectly evident that the mobility of a body in no way depends upon or is related to its compressibility, since mercury is just as mobile as water, while it possesses but *one twentieth* the compressibility, or but one part in 440,000 for each atmosphere. Even the mobility of atmospheric air itself does not exceed that of quicksilver, though the air is the most compressible of all corporeal substances, since it is susceptible of reduction in bulk by pressure till it contains 770 atmospheres, when its density, which would be equivalent to its weight, would exactly equal that of water at sixty degrees Fahrenheit. We thus see that a fluid might be assumed to be absolutely *incompressible* and yet retain the highest degree of mobility, which completely annihilates the argument of Professor Mayer.

A little reflection must teach us that, if we suppose the air to be really "incompressible," a motion would have to be sufficiently powerful to displace the entire atmosphere with its millions of tons weight in order to instantaneously effect this transmission of "motion" to its extreme limits, as Professor Mayer asserts! To illustrate it, suppose the experiment to be tried with water. According to the teaching of this savant (and it is impossible for his language to be misunderstood), if a *moneron* should move its body at the bottom of the ocean, four miles below its surface, supposing the water to be incompressible, or should thrust out one of its pseudopodia, the *mobility* of the water directly around this little creature counts for nothing at all in the scientific estimation of this physicist, since he wholly ignores it; but in lieu of this, he tell us the "motion" would absolutely be "*transmitted to every other point of the*" *ocean*, or, in other words, the entire ocean would be displaced bodily to the aggregate extent of this movement, thus requiring the physical lifting force of thousands of millions of tons by the efforts of an animal no larger than a pin's head, since the weight of the entire ocean rests upon it, and being "incompressible," must be displaced to its farthest limits, according to this highest American authority on physics! A philosopher who really and deliberately supposes that if water were "incompressible," which, as we

see, it is almost, he would actually stir the *entire ocean*, and thus displace its countless millions of tons by dipping his finger into it, as unmistakably taught by Professor Mayer in the quotation I have made, since the *motion would be instantaneously transmitted to every part of it*, notwithstanding the wonderful *mobility* of water and the facility with which its particles accommodate themselves to the movements of a disturbing body, can hardly be pronounced the proper man to write important scientific articles for encyclopedias. I say this with all deference to his great ability and his acknowledged scientific achievements, since it is entirely evident that the errors into which he has fallen, and which have equally misled the greatest physicists of all ages, are due to this prodigious fallacy of atmospheric wave-motion, and not to any fault as to his scientific education.

Returning to our supposed tube for a moment, and the transmission of a condensed wave through it by the motion of the piston, it is well to note the fact that Professor Mayer does not confine his unscientific reasoning to the *pushing* of the piston alone, but reverses the operation and supposes the piston to be *withdrawn* a short distance, with an exactly corresponding effect. It is undoubtedly true that this withdrawal tends to rarefy the air immediately behind the piston, and necessarily causes the entire atmosphere of the tube to move backward and fill up the vacuum thus produced. The palpable error into which he here falls, is in making the velocity of this "rarefaction" necessarily the same as that of the "condensation" caused by instantaneously pushing the piston, and both of them necessarily the same as that of sound, whereas, if he had duly considered the matter, he would have seen that while the vacuum caused by the instantaneous backward movement of the piston is *limited*, and can only produce a suction-force of about fifteen pounds to the square inch, whatever be the distance the piston may travel or whatever the length of the vacuum produced in the tube, the spring-force of the air caused by *compression* is practically unlimited, depending entirely upon the distance the piston is supposed to be instantaneously pushed forward, since atmosphere may be, as we have just seen, compressed with sufficient force to produce a spring of 1,000, 5,000, or even 10,000 pounds expansive power to the square inch. Yet this manifest difference between the maximum force of a vacuum (fifteen pounds) and the unlimited spring-force of a condensation (from one ounce up to 5,000 or 10,000 pounds), with which every student of natural philosophy is familiar, is wholly left out of the calculation by this learned physicist, the same as was the *mobility* of the atmosphere.

I again assert that it is upon this very kind of scientific (!) reasoning that the wave-theory rests; and it is these very misapprehensions about the possible velocity of the transmissions of "condensations and rarefactions" of the air, while ignoring its mobility, which have led physicists into the monstrous errors, already exposed, of the assumed propagation of air-waves at a velocity of 1120 feet a second, sent off by the aggregate movements of a tuning-fork's prong but *seven inches!* It is, in fact, these very false notions here pointed out, combined with the sheer want of a little attention, which have led all sound-investigators to detect no difference between a *condensed wave of air* caused by the addition of a large quantity of gas at an explosion and the *sound-pulse* which is simultaneously generated. Professor Tyndall, by this weak system of reasoning, as has been fully shown,

necessarily supposed it was the "sound-pulse" which broke the windows at Erith, when the least attempt at philosophical analysis would have convinced him that the sound had nothing whatever to do with it, and only accompanied the "*girdle of intensely compressed air*" which did the work of destruction, the same precisely as the so-called tidal wave crushes shipping and houses when sent off by a volcanic explosion beneath the water.

It would be just as sensible and scientific for the physicist to come before an audience and attempt to explain the tidal wave which recently shattered the shipping and destroyed a town on the Pacific coast of South America by calling it an *aqueous "sound-pulse,"* as to do the same thing with the condensed air-wave which crushed the windows at Erith! The two upheavals are entirely analogous, only the one acts on the ocean of atmosphere while the other acts on the ocean of water, while they are susceptible of precisely similar solutions, since the tidal wave, as has often been observed, is accompanied by the sound of the submarine explosion, showing that this sound has nothing whatever to do with the *aqueous concussion*, as a very stupid schoolboy ought to see.

If this great scientific lecturer should ever undertake to account for the phenomena of tidal waves and their destructive effects on shipping and houses, I guarantee that he would employ no such superficial and fallacious reasoning as he did in regard to the explosion at Erith. He would at once recognize, unless I underestimate his sagacity, the proper distinction between the *rumbling sound-pulse* and the *aqueous concussion* generated and radiated by the same volcanic upheaval, and would not think of perpetrating such a stupendous scientific imposition upon his audience or upon his own intelligence as gravely teaching that the shipping and buildings were shattered by a "sound-wave" of "intensely compressed" water! I repeat that he would not think of applying to tidal waves his logic in regard to magazine explosions (though the philosophy of the two cases is precisely the same), unless his mind is more deeply imbued with the fallacies of the wave-theory of sound than would seem to be possible. Then, if this be the true explanation of tidal waves, which no one can question, Professor Tyndall has only to apply the same reasoning to the explosion, and the shattering of the windows, at Erith, and his wave-theory of sound would at once vanish into air many times thinner than one of his thinnest "rarefactions"!

It now becomes a matter of curiosity to know whether these great investigators of sound-phenomena will be able to comprehend the distinctions here so elaborately pointed out. Or will they continue on in the future, as they and their predecessors have done for centuries past, to represent the "girdle of intensely compressed air" which is driven off by a magazine explosion and which crushes in windows and even buildings, as identical with the "sound-pulse" generated by such explosion and radiated at the same time?

If they shall not yet be able to distinguish between these two distinct effects, then let them try the experiment of burning a couple of barrels of powder, and observing the effects at two separate stations, —distant, say, one and two miles,—with suitable instruments for recording the two arrivals of both the condensed wave and the sound report, and I again predict and guarantee that they will have an abundant reason for abandoning the wave-theory of sound by learning, to their amazement, that near to the explosion the concussive shock will outstrip the sound, while at a

sufficient distance from it the sound will arrive some seconds in advance of the concussion.

I have thus ventured this scientific prediction in direct opposition to the universally accepted theory of sound, and in the face of the prevailing opinion of scientists in regard to the identity of the sound-pulse and the condensed atmospheric wave caused by an explosion. Should any scientific association consider this prediction of sufficient importance to waste a barrel or two of powder upon it, let them explode the former by exploding the latter; and, should they be successful in doing it, no one will feel more gratified at the result than the writer.

Directly related to the foregoing, we encounter another difficulty of similar import. Advocates of the wave-theory labor under an ever-present misconception that there is an exact similarity existing between the cause of the stirring of a unison body by sympathetic vibration (governed, as I will show, by a law of affinity as real and as impossible for us to understand as is that of magnetic attraction,) and that of the breaking of a window by this concussive atmospheric shock produced by an explosion; whereas there is a difference between the two principles, their causes, and their effects, as wide and as deep as between any other observed natural phenomena. I will here, as in the preceding case, try to point out a rational distinction.

We are referred to the fact, as a proof of this assumption, that a very thin and brittle vase may have its air-chamber so accurately tuned to the pitch of an organ-pipe that a powerful peal will cause such sympathetic vibration as to shatter it. The same thing has also occurred with panes of glass which happened to be so secured at their edges and held with such tension that a loud unison tone from the organ by sympathetic vibration has caused them to break. Yet all the air-waves ever generated by vibratory motion, if wrought in silence, I care not what their synchronism might be, could never break a vase nor stir a pane of glass by exciting sympathetic action. This self-evident distinction between atmospheric vibrations with or without accompanying tone, may be new to scientists, but it is nevertheless a distinction they are compelled to recognize.

This mysterious sympathetic action of an organ-tone on a unison body, or on a body tuned to make the same number of normal vibrations per second, by which a pane of glass may be broken by a certain organ-peal, must not be confounded with the concussive atmospheric shock caused by an explosion, as just explained, which crushes in windows indiscriminately, without the least regard to their unison tension. Writers make no distinction whatever between these effects, as just seen, but note them promiscuously as the result of atmospheric sound-waves. I offer the following single remark, which I trust will point out the difference:—

In the case of an explosion, no matter what the pitch of the tone may be, or what the vibratory tension of the thousands of panes of glass to be broken may be, such glass will be broken exactly in proportion to the force of the atmospheric wave, or the quantity of gas generated and added to the air, and the distance from the origin of the explosion. Is this not plain? Whereas in the case of the pane of glass vibrating from sympathy and breaking by a unison tone of the organ, no other tone save of that identical pitch could have affected such pane of glass in the slightest degree. If all the pipes of the organ, save that one, had been made to peal out in a single concentrated blast—even if the combined sound were of a hundred times the

intensity of the one pipe referred to—they would not have stirred the pane of glass, because no sound in the combination contained the necessary synchronous pulses to cause sympathetic action. The reader, I am certain, must see the difference between these various classes of phenomena, however physicists may jumble them together in their learned essays and lectures.

Professor Tyndall gives an account of two clocks placed close together against a wall, with their pendulums so accurately adjusted in length that the *ticking* of one clock finally starts the other by sympathetic action, and of course attributes this result to the air-waves sent off by the vibrating pendulum. But to show how erroneous is this assumption, let the escapement of such actuating clock be so muffled that the pendulum will be made to move in silence, or oscillate without the music of its "ticks," (and let the clocks be so placed that their supports will not oscillate from the motion of their pendulums,) and it may run till it wears out without stirring its neighbor, notwithstanding its hypothetic air-waves, which are just as real in the one case as in the other, dash in synchronism against the pendulum to be moved.

It is a singular fact, frequently observed, that dogs will howl at the sound of a horn or other loud musical tone. Who knows but that the sonorous discharges from the instrument may act by sympathetic synchronism on the laryngeal muscles or the unison tubes of the animal's trachea, causing thereby a vibratory sensation to which he gives way in a prolonged howl? In support of this supposition, it is a fact, as observation shows, that tones from a horn about the pitch of that portion of the scale employed by the dog are more apt to excite howling than notes of a distinctly different pitch. I throw out this hint without indorsing it. Possibly a deaf dog would not be thus affected, which would indicate that the sympathetic action of the tone was conveyed to the vocal organs through the tympanic membrane, and not through direct contact with the trachea.

The hypothesis of sound as substantial emissions furnishes a beautiful explanation of the well-known phenomenon of the rising pitch of a steam-whistle as a locomotive approaches the listener, and its sudden fall as it passes and recedes.

The pitch of the whistle, as is well known, is produced by a certain number of vibrations per second, which causes, as I assume, a corresponding number of sonorous discharges to come in contact with the tympanic membrane. If the pitch of the whistle, when the engine is at rest, is the same as that of the A-string of the violin, it has 440 vibrations to the second, and consequently emits 440 pulses of sonorous substance, now supposed to be so many air-waves. The number of vibrations to the second necessary to any particular pitch is definitely ascertained by means of an instrument called the *siren* (which will be explained in the next chapter), and the following explanation is based on the known velocity of sound through the air being 1120 feet a second at ordinary temperature, or about 60° Fahrenheit.

If the whistle is sounded while the locomotive is at rest, 440 sound-pulses thus reach the ear of the distant listener each second, and consequently the pitch of the tone is A, as before observed, since it takes just that many pulses per second to create that pitch. But if the locomotive starts toward the listener at the rate of 60 miles an hour, its own speed (88 feet a second) is added to that of the sound, and consequently an equal proportion of the 440 (or about 35 more) sound-pulses strike the

ear each second, which actually raise the pitch about one note in the scale, since the greater the number of sound-pulses striking the ear in a second the higher is the pitch of the tone.

But as the locomotive passes the listener at this rate of speed, the tone of the whistle is observed instantly to fall about two notes of the scale; for, in receding, it also subtracts 88 feet a second from the speed of the sound, consequently deducts another 35 sound-pulses from its pitch when at rest, making a difference of about 70 pulses between its approaching and receding tone. In a word, as the whistle when approaching causes a greater number of sound-discharges to strike the ear than when at rest its pitch is raised, so in receding it allows a lesser number to strike the ear, which correspondingly reduces the pitch.

Can any explanation of this interesting problem by means of atmospheric undulations be more simple or satisfactory, even if such air-waves had a real existence? But when it is considered that a steam-whistle can not stir the atmosphere thirty feet from the locomotive in any direction (except, as before provided, in case of sympathetic vibration), and that what aerial movements are thus incidentally produced in the immediate vicinity of the locomotive can not, by any possibility, travel at a velocity of more than four or five feet a second, less than the two hundredth part of the velocity of sound, the beauty of the new hypothesis of substantial sound-pulses, as well as its absolute necessity for solving the problem, becomes strikingly manifest, for otherwise the mystery of sound-velocity is wholly without explanation.

Another fatal misconception of scientists in regard to the laws and principles brought into play by the necessities of the wave-theory may be here pointed out. They tacitly assume—in fact their hypothesis compels them to assume—that there are two entirely distinct principles of *wave*-motion in atmosphere, or, in other words, that there must necessarily be two entirely different classes of air-waves: one suited to their sound-theory, which will travel 1120 feet a second; and another class, adapted to common sense, which will not move more than four feet a second,—both manufactured in substantially the same manner. For example, they all know and will readily admit, if I move a string or piece of wire back and forth in my hand through the air with the most perfectly pendulous regularity, and cause it to travel at an aggregate velocity even ten times greater than it is possible for it to attain when sounding, that the air-waves will not travel over four or five feet a second, if that fast, and will not be able to make headway through the dense air a dozen feet till they will entirely die out. But the moment the same string moves through the same with its two ends supported in such a manner as to *generate tone*, though with an aggregate velocity not one tenth as great, then, presto! it sends off air-waves, according to these learned physicists, which travel 1120 feet a second, or more than two hundred times as fast! Why this difference? The truth is, there can be no difference in their nature or manner of propagation, and these writers would certainly see it if they came once to reason on the question with any degree of scientific accuracy. The necessities of the wave-theory, it is true, absolutely require this distinction to be kept up, when the difference does not and can not exist. I will extend the above illustration, and make this arbitrary distinction so plain that a blind man can see it.

Suppose the same string to be fastened at its two ends to the same supports, and

that it is caused to vibrate in the same manner precisely by plucking it in the middle. Now, if it happens to be so stretched as to oscillate *less than sixteen times a second* it makes no sound, and consequently the air-waves which pass off from it, since they belong to the *slow* class, can not travel more than a few inches in a second, as these writers will readily admit; but give its tuning-pin a turn, causing it to make forty or fifty vibrations in a second instead of fifteen, though moving exactly on the same principle and traveling the same aggregate distance, and instantly its air-waves, *moulded* and sent off in the same manner, start through the air at a velocity of 1120 feet a second! Can any well-balanced intellect see either consistency, sense, or science in this arbitrary and absurd distinction?

The true and only explanation of the matter is simply this. The air-waves moulded and sent off by the motions of the string are in all respects alike in the two cases, having about the same trifling velocity, not exceeding a few inches in a second. In the first instance the stops and starts are so slow that they generate nothing but air-waves, while in the second instance the changes of direction are sufficiently rapid to generate sound-pulses as well as air-waves, because the sudden stops and starts, at forty or fifty vibrations in a second, succeed each other so rapidly and produce such a molecular effect upon the atomic structure of the string as to cause the emission of that peculiar substance we call sound. While physicists utterly fail to make any kind of a satisfactory explanation of these phenomena on the theory of air-waves, but are forced to encounter two entirely distinct classes of aerial undulations,—one kind traveling seven or eight inches a second, the other kind traveling 1120 feet in the same time, yet both kinds produced exactly in the same way and by the same instrument, the new theory of substantial sonorous pulses steps forward, and in a single sentence, as above, untangles the whole problem, separating the wheat from the chaff,—sifting the sound-pulses from the incidental air-waves,—placing the whole question in an orderly and a systematic form before the reader. No physicist can fail to appreciate this eclaircissement, and yield his full consent to its truthful consistency, if in connection with it he will turn back and re-read the law of sound-generation as announced on page 93. The truth is, whenever scientific investigators shall come to understand that air-waves have nothing whatever to do with either the generation or the propagation of sound, and that they are no more an essential part of these phenomena than are the incidental waves sent off by a steamboat's wheel an essential part of the boat's forward progression, the wave-theory will at once be relegated to the limbo of exploded hypotheses, taking its place by the side of the Ptolemaic theory of astronomy, where it should have been consigned a thousand years ago.

The foregoing argument is beautifully illustrated by the blowing of a bugle-horn, which is often heard in a still night for a distance of *three miles* in all directions. The bugler may blow directly through his horn without producing tone, and exert all his lung-power and he can not stir a sensitive gas-jet twelve feet distant, while the air-waves he thus produces do not travel more than *four feet a second*, as I have repeatedly demonstrated by experiment, and as the reader will no doubt willingly admit. Yet the moment the bugler adjusts his lips to the mouthpiece in such a manner as to cause the horn and its air-column to generate tone by the proper molecular vibration, he manufactures and

sends off air-waves, as the current theory teaches, with less than one fourth the lung-power he employed before, which shake the entire atmosphere into oscillations *throughout thirty-six square miles*, causing *every particle of the air* to change its position from a state of rest into "a small excursion to and fro"! He not only shakes this vast extent of atmosphere, causing every atom of it for three miles high to "*swing to and fro with the motions of pendulums*," as Professor Mayer expresses it, but he hurls these agitations at the enormous velocity of 1120 feet a second! He not only does all this, but, according to the wave-theory, he converts these thirty-six miles of atmosphere into 6,000 circular "*condensations* and *rarefactions*," the largest of which are nineteen miles in circumference, that is, supposing the tone to represent A, with 440 vibrations to the second, so compressing the condensed portions of these 6,000 waves at one and the same instant as to generate sufficient heat and elasticity to add *one sixth* to the normal velocity of the sound of his horn! This generation of heat and elasticity, the wave-theory tells us, is caused alone by the *compression* of the air-particles together, notwithstanding their *mobility* and freedom to escape pressure, requiring a physical force, even if each inch column of the atmosphere were confined within a tube and acted on by a piston, equal to *thousands of millions of tons*, as I will conclusively demonstrate, in a dozen different ways, before this chapter is concluded.

Is it possible that any physicist can be found, worthy of the name, who really believes that a man's lips adjusted in a peculiar way to the mouthpiece of a horn can actually produce such a mechanical compression of the air? I declare, upon my conscience, that I do not believe there is a sane man living, who, with these facts before him, can believe for a single moment in such a stupendous and transparent fallacy.

At this point in the discussion, I ought to say a few words in regard to the well-known phenomena of the *reflection* and *convergence* of sound, which correspond in all respects to the same action in light and heat. Physicists teach us that sound, light, and heat are all based on the same general principle of undulatory movement, and alike are simply "modes of motion," instead of the radiation of attenuated material atoms,—that they are all governed by the same law,—while the undulatory theories of light and heat are admitted on all hands to have had their origin in the universally accepted hypothesis of sound-waves. Professor Tyndall says:—

> "The action of sound thus illustrated is *exactly the same as that of light and radient heat.* They, like sound, are *wave-motion.* Like sound they diffuse themselves in space, diminishing in intensity according to the same law. Like sound, also, light and radiant heat, when sent through a tube with a reflecting interior surface, may be conveyed to great distances with comparatively little loss. In fact, every experiment on the *reflection of light has its analogue in the reflection of sound.*"—*Lectures on Sound*, p. 13.

There will, therefore, be no difference of opinion throughout the scientific world on the deduction I make from this citation, namely, that if the wave-theory of sound shall be unequivocally overthrown, the wave-theories of *light* and *heat* must share the same demolition, even if not one reference shall be separately made to those "modes of motion," since the latter only exist as deductions from the former. The reader will please remember this.

I now undertake to show, from the very nature of wave-motion, that there can be no such thing as *convergence*, *concentration*, *reflection*, &c., in the case of either sound, light, or heat. Should I succeed, I shall, of

course, demonstrate the fallacy of this undulatory law, and thus, in another way, shatter the current hypothesis of sound.

I state, as a fact recognized by all writers on sound, that, in undulatory motion of any kind *there is no forward movement of the particles constituting the wave.* The forward movement which takes place is not that of the particles themselves which compose the wave, but the continual progressive change in the swell caused by the *succeeding local oscillations up and down of the wave-molecules.* There can be, in fact, no forward movement of any matter whatever in a wave, the apparent progressive advancement being only that of *motion* and not of *substance.* Hence, I shall assume, as I believe the philosophical judgment of the reader will bear me out in doing, that without the *forward* or *projectile motion* of some kind of *substantial atoms* there can be no *reflection*, since reflection, as every one knows, consists in the tangential rebound of a body under forward velocity, the rebound taking place in a direction corresponding to the angle of *incidence.* Professor Tyndall says:—

"The motion of the *sonorous wave* must not be confounded with the motion of the *particles* which at any moment form the wave. During the *passage of the wave every particle concerned in its transmission makes only a small excursion to and fro.* The length of this excursion is called the amplitude of the vibration."—*Lectures on Sound*, p. 44.

I have often observed the undulatory movements of a field of *flax* when in bloom, acted on by a steady wind. The waves, undulating over its blue and apparently liquid surface, are a perfect representation of the waves on the surface of a clear blue sheet of water, and occur by the rhythmically progressive sinking and successive rising of the individual stalks of flax as the breeze passes over them. Almost any field of small grain, when nearly ripe,—such as wheat, rye, or barley,—exhibits the same wave-effects by the action of the wind, as no doubt the reader has often observed.

Now, it is just as rational and philosophical to suppose that the waves on the surface of a field of *flax* can be reflected tangentially at the angle of incidence by striking the fence diagonally, as to assume the possible reflection of any other waves whatever. A moment's careful thought will convince the reader of the truth of this position. Take, for example, waves on the surface of a pond of water, which are referred to by all writers on this subject as illustrative of supposed sound-waves. I assert here that physicists are self-deceived, while unintentionally deceiving others, in claiming that such water-waves exhibit phenomena in any way resembling *reflection* or *tangential rebound*, in the proper sense of the term. Let such water-waves strike diagonally against a plain perpendicular surface, such as a ledge of rocks, and, so far from darting off in a direction corresponding to the angle of incidence and at the velocity with which they came, as is always the case with light and sound, they simply run along this barrier, recoiling slightly upon the next succeeding wave, the motion becoming thereby interrupted, broken up, and distorted into a mass of indistinguishable hillocks, the same exactly as a wave driven over a field of flax disappears after striking the fence by its recoil against the next succeeding wave.

Another fact, which utterly annihilates the hypothesis of sound-waves, the recoil which does take place, if any particular point of it is carefully watched, will be seen to re-act directly from the ledge of rock, moving away at right angles to the line of its surface, whatever may be the angle of incidence of the approaching wave! If there could be such a thing as

the *reflection* of a wave, then, evidently, what little recoil there would be should change its direction after the contact, by this law of tangents conforming to the angle of incidence.

But the strongest reason against the possibility of waves reflecting—a reason which is simply unanswerable—is the fact that, in order to reflect, a wave is compelled to meet other waves of superior, or, at least, equal force and velocity, which, in the case of physical or corporeal bodies is an utter bar to any further progress! The common sense of a schoolboy must teach him that a reflecting or rebounding India-rubber ball must stop on meeting a direct ball of equal size, weight, and velocity. This illustration is at least directly applicable to air-waves and water-waves, as they are corporeal bodies, governed by the physical laws of inertia and momentum. In the case of incorporeal substances, such as the corpuscles of heat, light, sound, magnetism, electricity, and *ether* (if there be such a thing), this physical law which tends to neutralize two equal forces in case of collision does not come into play, since incorporeal atoms will collide and pass through each other without either being impeded in its progress, as seen in the rays from two magnets when made to cross each other's path. Now, it is simply impossible for a wave of water to recoil and retain its proper form after striking a rock, any further than to meet the first direct wave following it. The collision must, by the very laws which control the meeting of physical bodies of equal force, distort and shatter both the recoiling and the direct waves, and prevent all further symmetrical progress. Thus, in every way it can be viewed, the reflection of sounds, as in case of echoes which move off with the same *freedom* and *velocity* as the direct sounds, is thus shown to be impossible on the basis of wave-motion, according to the laws governing the movements of physical bodies.

The same effect as here described in water-waves will be found to hold good in the case of air-waves produced in a still room by the movement of a fan, especially if sufficient smoke be admitted to visualize the atmospheric movements. The waves, or, more properly, convolutions of air, will be seen to leisurely roll up against the wall of the room, not at the speed of sound but at a velocity of about four or five feet a second, then slightly recoil and mix up with the next succeeding convolutions, without the slightest semblance of true reflection, as I have frequently proved by practical experiment.

Tangential rebound, which is all there is of *reflection*, is only predicable, therefore, of the *atoms of a substance* moving forward with a certain *velocity*, being suddenly impeded by a resisting surface, as a child can fully comprehend in bounding its toy ball. Does not the reader's intelligence at once admit the truth of this law? Hence, as the particles of air or the supposed particles of ether in light-waves do not travel with the undulations at all, but merely oscillate up and down, making only "a small excursion to and fro," having no forward movement, it follows, therefore, that there is absolutely nothing to rebound or *reflect!* But if light and sound consist of real atoms, having an absolute forward velocity, or are projected with the speed of light and of sound against the reflecting surface, the tangential reflection corresponding to the angle of incidence is as natural and reasonable as that elastic balls shot from a gun against the same surface should rebound in the same manner and at the same angle. To a philosophical mind desiring only the truth, this scarcely needs elaboration.

This must not, however, be confounded with the rebounding of a jet of air or water forced from a hose-nozzle diagonally against a plain surface, for then the air and water particles have a forward velocity, which, as repeatedly taught by Professor Tyndall and others, can not be the case in wave-motion, every particle composing the wave having but a stationary and unprogressive oscillation.

The same thing, then, follows equally true of *convergence* and focal *concentration*. If a wave can not rebound tangentially for the want of forward movement in its particles, then it can not increase its intensity by focal convergence through a funnel-shaped tube, though the water may momentarily rise in the tube to the height of the wave, for convergence consists only in a succession of tangential rebounds or reflections from side to side of such a funnel, concentrating a greater number of particles into a smaller compass, and thus gathering force or intensity as the atoms approach the focal point. Is not this as clear as that reflection consists of a single rebound? It follows, therefore, as there is no velocity or forward movement to the particles of any wave, that it is utterly impossible to account for reflection or convergence of light or sound by the current theory of wave-motion, while these phenomena are beautifully consistent with my hypothesis of sonorous and luminous discharges. This ought to be self-evident to the advocates of the wave-theories of sound and light, since they teach us that the ether-particles composing the waves of light do not travel a single inch toward the earth in the whole journey of a ray from the most distant visible star. How, then, in the name of reason, could such ether-waves, with no forward movement to their particles, strike a reflecting surface and rebound off tangentially with the velocity of light?

Let it therefore be remembered, as a logical and unassailable proposition, that there can be no *rebound* where there is no *forward movement of particles;* and without rebound *tangentially*, or at the angle of incidence, there can be neither *reflection* nor *convergence*. Will any true philosopher call this proposition in question? If not, then this syllogistic consequence follows: In all sorts of wave-motion there is no forward movement of particles, as proved by the authority of Professor Tyndall in a score of passages. Without the forward movement of substantial particles there can be no rebound or tangential reflection. Hence, *reflection* or *convergence* of *sound* or *light* by means of undulations, and without the forward movement of particles, is a practical absurdity.

But how strikingly different is the aspect of this problem of convergence by means of a funnel, if sonorous pulses are viewed as substantial emissions radiated with a velocity of 1120 feet a second! And how beautifully may this funnel be supposed to gather up the scattering sound-particles, even when so sparce as to be inaudible without it, and thus convey distinct sonorous impressions to the auditory nerve! Viewing sound as composed of atoms under velocity, a little child, with sufficient judgment to watch the tangential ricochetting of his India-rubber ball, can comprehend the philosophy of convergence and concentration. The sound-particle, like the rubber ball, strikes the side of the funnel's open mouth and rebounds at an obtuse angle, leaping to the opposite side of its inner surface, every rebound bringing it nearer and nearer to the smaller end, till the sparcely scattered particles thus entering congregate at the focal point; and this is the history of all the particles entering this wide mouth, at which point they may be so few and scattered as to be insensible

to audition, yet by this converging process may be so concentrated in numbers as to become distinctly audible at the focus.

By a similar convergence, through the means of a large funnel-shaped device on shipboard, a sufficient number of scattering sound-particles has been collected from the ringing of a church-bell on a coast, to be distinctly audible *one hundred miles* at sea, as recorded by Herbert Spencer in his *First Principles*, p. 183. Yet, as surprising as it may seem, this careful analytical thinker falls into the scientific rut of the wave-theory, and takes for granted that the whole atmosphere over an area two hundred miles in diameter was actually churned into "condensations and rarefactions," with a force which would have required the energy of more than *two thousand million horses*, all by the strength of one man's hand at a bell-rope! The laughable absurdity of such an idea will be made fully apparent a few pages further on, in which the most incontrovertible figures will be brought to bear against the wave-theory. When it is known, as an absolute fact, which is susceptible of easy demonstration, that the ringing of the largest bell in the world can not stir the air at a distance of *twenty feet from it*, except in case of sympathetic action in which a column of air is tuned to perfect unison, as already explained, the almost infinite fallacy of the current theory becomes apparent.

The successive rebounding of sound-particles from side to side, as shown by the converging and concentrating power of a funnel, is the same precisely as that which takes place in a smooth tube, by which a moderately voiced conversation may be carried on between two persons at its opposite ends a mile apart. Instead of the sound-particles radiating in all directions, as they do if unconfined, thus growing weaker in the exact ratio as they *scatter* and become *sparcer*, this tendency to radiation is checked by the inner surface of the tube, the different particles rebounding from side to side and thus reaching to a great distance without becoming sensibly weakened. While articulate sounds might thus be conveyed for many miles, it is a fact which the advocates of the wave-theory would do well to consider, namely, that notwithstanding such laryngeal action does not stir the air within the tube twenty feet from either end, the firing of a pistol into the mouth of such a tube would produce a distinct atmospheric *concussion* a mile distant, and even "*extinguish a lighted candle.*" This, Professor Tyndall, with his usual perspicacity, adduces as another illustration of the effect of a "sonorous wave" or "sound-pulse," without the least capability of distinguishing between an explosion which adds a body of gas to the air of the tube and the words of a person which merely disturb a small portion of its equilibrium! This unaccountable lack of discrimination in writers on sound, which has just been so fully exposed in our examination of magazine explosions and their effects, is one of the most demonstrable evidences of the superficiality and utter incompetency of modern physicists as scientific guides.

This assumption of scientists, that sound is propagated by means of *air-waves*, consisting each of a "*condensation* and a *rarefaction*," though infinitely impossible, as it will soon be shown to be, is nevertheless an essential feature of the current theory of sound, or, more properly, it is the very foundation of the hypothesis. It is conceded by Professor Helmholtz that no other kind of a wave save that consisting of a *condensation* and *rarefaction* of the air is possible in the midst of the aerial ocean, as there is no vacant space into

which the atmosphere may be projected and depressed in the form of crests and furrows, as is the case with undulations on the surface of water or any other liquid body. He says:—

"The *crests* of the waves of water correspond in the waves of sound to *spherical shells where the air is condensed*, and the troughs to *shells of rarefaction*. On the free surface of the water the mass on compression can slip upwards *and so form ridges*, but in the interior of the sea of air *the mass must be condensed, as there is no unoccupied spot for its escape.*"—*Sensations of Tone*, p. 14.

Frankly and flatly, then, this great authority has told us, and in unmistakable language, that without these literal "condensations and rarefactions" of the air there can be no such a thing as a sound-wave, since troughs and crests are out of the question "in the *interior of the sea of air*," "as there is no unoccupied spot for its escape," as on the surface of a body like water. The reader will please remember this important and unavoidable admission, which in the end will show beyond all question that the idea of sound traveling by means of wave-motion is a pure chimera, having not the slightest foundation in science or in fact.

It is perfectly plain, and must be so admitted by every one who takes the trouble to reflect, that if I can now show the entire impossibility and the undeniable absurdity of a "condensation and rarefaction" of the air caused by the transmission of a sound-pulse, that it necessarily shatters the whole wave-theory, leaving it without the shadow of a basis on which to rest.

To show that this statement of Professor Helmholtz is not a mere slip of the pen or one of his numerous inconsiderate remarks, such as his *trip-hammer* fiasco (see p. 95), I will now quote from Professor Tyndall a few passages to prove that he not only holds to the same idea, namely, that a sound-wave can not exist except as a "condensation and a rarefaction" of the air, but so essential and fundamental is this fact to the theory that he deliberately reiterates it in numerous places and in various forms. To quote all the passages from this writer in which he assumes this position, would be to copy nearly a quarter of his *Lectures on Sound*. I will therefore cite a sufficiently emphatic instance or two. He says:—

"With regard to the point now under consideration, you will, I trust, endeavor to form a definite image of a *wave of sound*. You ought to see mentally the air-particles when urged outwards by the explosion of our balloon *crowding closely together;* but immediately behind this *condensation* you ought to see the particles *separated more widely apart.* You ought, in short, to be able to seize the conception that a *sonorous wave consists of two portions*, in the one of which *the air is more dense*, and in the other of which *it is less dense than usual.* A *condensation* and a *rarefaction*, then, *are the two constituents of a wave of sound.*"

"And here it is important to note that when I speak of vibrations, I mean complete ones; and when I speak of a *sonorous wave* I mean a *condensation and its associated rarefaction.*"—*Lectures on Sound*, pp. 5, 69.

No one can ask a more concise and definite statement of an hypothesis than this, and we may thank these writers, particularly Professor Tyndall, for leaving not a lingering doubt hanging over the question as to what is meant by and what constitutes a sound-wave—

"A *condensation* and a *rarefaction*, then, are the two *constituents* of a *wave of sound.*"—"When I speak of a *sonorous wave I mean a condensation and its associated rarefaction.*"

But lest some of my readers should remember the unfortunate self-contradictions in which Professor Tyndall has involved himself and his theory, and thus be led to place too low an estimate upon his support of Professor Helmholtz, I will re-enforce the English physicist by the

American, as I did the German by the English. Professor Mayer (article on "Sound," *American Encyclopedia*) remarks:

"A sonorous wave is *always* formed of two parts, *one half of air in a state of condensation, the other half of rarefied air.*"

I think the reader will now admit that I have struck the true scientific definition of a sound-wave, since the three leading physicists who have written on that subject explicitly concur, and thus mutually re-enforce each other.

The application of this definition of a sound-wave will not only be now made to the theory in question in a way which can not fail to test its value, but it will have an entirely different and unique application in the following chapter, in which the scientific reader will no doubt be deeply interested.

Before, however, making a direct application of this frank but ruinous definition to the working of the wave-theory of sound, it is necessary to look briefly at one of its unavoidable results and adjuncts, to which I have frequently had occasion to refer in the early part of this chapter, and that is the incidental generation of *heat* by the squeezing of the air-particles together which takes place in the production of these "condensations."

It is well known that if the air in a tube should be compressed or squeezed together by means of a piston, this condensation also generates heat, the temperature of the air rising exactly in proportion to the pressure applied; whereas, if the piston should be withdrawn a short distance, thus creating a suction in the tube instead of a compression, cold is developed by the rarefaction of the air. Professor Tyndall demonstrated before his audience, in one of his lectures, that by a sudden compression of the air in the tube a piece of amadou or common punk could be ignited, so intense was the heat generated by this condensation. (See *Lectures on Sound*, p. 28.)

It is a singular coincidence that not only are these "condensations" essential to the life of the wave-theory of sound, but the very *heat* they must naturally generate, if they occur at all, has quite recently become another absolute necessity to its existence. I will tell how this occurred. It was universally agreed among physicists that as sound traveled by wave-motion, its velocity, in passing through all bodies, must be in the exact ratio of their relative density and elasticity, or, in other words, it was this relation of density to elasticity which determined the velocity of sound through any medium. It so happened, however, that Newton, independently of the necessities of the wave-theory, calculated the exact relative density and elasticity of the air, which, when applied to the admitted requirements of the theory made the velocity of sound in air at the freezing temperature but 916 feet in a second, whereas the well-known observed velocity was 1090 feet, thus showing an undeniable discrepancy of 174 feet a second between the observed and the required velocity, or a deficit of about "one sixth" against the wave-hypothesis.

Now, while physicists were forced to admit Newton's calculation to be correct, on the basis of the air's known elasticity and density, the only ground upon which wave-motion, as they agreed, was possible, here was an absolute contradiction of the wave-theory by their own basis of calculation, since observation proved sound to travel 174 feet a second *faster* than waves could travel in an element thus constituted. What was to be done? No one thought of abandoning the wave-theory. Such a radical and revolutionary idea was

impossible, since no other supposition had ever been suggested than wave-motion, and there was no one to propose this beautiful hypothesis of substantial sonorous discharges to take its place, which so completely, as we have seen and as we shall see, solves all the problems and mysteries which can be brought to bear. No one disputed or could dispute Newton's calculation, and there the matter stood, while various suggestions were made by physicists from time to time with a view to overcoming and reconciling this discrepancy.

Fortunately for the wave-theory (and the only thing which could have given it a lease of life), an idea occurred to Laplace, the great French mathematician,—if not a *red-hot* idea, at least one sufficiently *warm* to meet the present emergencies of the case. It consisted in simply utilizing the imaginary incidental *heat* generated by these supposititious *condensations* produced by these hypothetic sound-waves! An elaborate statement of this calculation of Laplace is given in Professor Tyndall's *Lectures on Sound* at about the 30th page, which only goes to show to what extent a fallacy of the most glaring and transparent nature may be bolstered up by a profound theorist, even when no foundation whatever exists for the ingenious explanation. I can not quote this long mathematical exposition, occupying some eight or ten pages, and it is unnecessary to do so, as the substance of it can be given in a few sentences. It is substantially as follows:—

If a sound-pulse really produces a condensation and rarefaction of the air, which at that time was admitted by all physicists, then it follows that the air-particles must be alternately driven out of their normal position into the condensed or heated portion of the wave, and drawn back again into the rarefied or cooled portion as each wave passes, thus causing them to keep up a continuous "excursion to and fro" as long as the sound lasts. (The reader will turn to page 78, and read extracts Nos. 2 and 3.) Now, as observation proves that sound travels faster in heated air than in cold, and as heat also adds to the elasticity of this compressed portion of the wave, it was calculated that this excursion of the air-molecules into the heated or condensed part and out again would be executed more rapidly than if no heat or augmentation of elasticity was generated, and hence it was concluded that the velocity of a given sound would be sufficiently increased by this change of temperature to make up the required 174 feet a second, or the deficiency proved by Newton to exist between the observed velocity and that which it ought to be according to the known density and elasticity of the air. Professor Tyndall generalizes it in these words:—

"The velocity of sound in air depends on the *elasticity* of the air in relation to its *density*. The greater the *elasticity* the *swifter* is the propagation; the greater the *density*, the *slower* is the propagation."—"Over and above, then, the elasticity involved in Newton's calculation, we have *an additional elasticity* due to the *changes of temperature produced by the passage of sound itself*."—"This *change of temperature, produced by the passage of the sound-wave itself*, virtually *augments the elasticity of the air* and *makes the velocity of sound about one sixth greater than it would be if there were no change of temperature*."—*Lectures on Sound*, pp. 29, 45, 46.

With this statement of the hypothesis and this assumed explanation of the discrepancy demonstrated by Newton, let us proceed at once to make an application of the data thus collected to the wave-theory in general.

I have already repeatedly shown the impossibility of a tuning-fork's prong sending off a condensed air-wave at the enor-

mous velocity of sound by its slow aggregate movement of only *seven inches in a second*, owing to the extreme *mobility* of the air, an attribute which sound-theorists never name when descanting upon the other characteristics of the atmosphere, namely, its *density*, *elasticity*, and *compressibility*. I defy the reader or any other man to put his finger on a single passage in the writings of ancient or modern physicists where the *mobility* of the air is named or in any way referred to in connection with these hypothetic "condensations and rarefactions." No writer on sound would think of embarrassing and even smothering his theory of wave-motion by such a stultifying and laughable inconsistency, since the two things placed in juxtaposition would instantly neutralize each other by exposing the hollowness of the whole assumption, and thus furnish demonstrative proof that the slow movement of a tuning-fork's prong could not drive a wave or condensed pulse of air even a single inch in advance of it with the atmosphere as mobile and perfectly free to turn aside and take its place behind the prong as it is known to be! Hence, the policy and wisdom in these great scientific writers suppressing (I do not charge *intentionally*) all mention of this well-known principle of atmospheric *mobility* when treating on the possibility of a condensation and rarefaction being driven off 1120 feet by a diminutive body like a tuning-fork *moving through the air a distance of only seven inches!* Were there no other reasons which could be urged against this hypothesis, that sound consists alone of condensations and rarefactions of the air which are capable of generating heat and cold, the facts just stated would be all-sufficient to show the foundationless character of the supposition.

I have before intimated that one of the chief errors into which writers on sound have fallen is this superficial habit of making no distinction whatever in the effects of bodies moving *swiftly* or *slowly* through the air. The misapprehensions of Professors Tyndall and Helmholtz in supposing the prong of a tuning-fork "swiftly advancing" when it was actually moving but *seven or eight inches in a second*, and in supposing a pendulum moving "slowly" as contrasted with the motion of a tuning-fork's prong, when it was really traveling *four times* as fast, have been already distinctly pointed out. On this erroneous conception alone rests the prevalent fallacy of a vibrating string or fork sending off air-waves, with "condensations and rarefactions," at the velocity of sound, while no matter what the velocity of the fork or string might be, moving but the small fraction of an inch in one direction and then reversing the movement, the *mobility* of the atmosphere would prevent such aerial disturbances from traveling more than a few inches from the vibrating body before an equilibrium would be established and all wave-motion of the air would cease. If these two principles of the mobility of the air and the small velocity of a vibrating string or fork had ever been duly considered by physicists, the wave-theory of sound would long ago have exploded, and would now be looked upon as an error of the most glaring and superficial character.

But while I thus emphasize the *mobility* of the air, and the impossibility of a slow movement, such as that of a fork or string, producing any such effect on the atmosphere as the wave-hypothesis requires, I do not ignore the fact that a body passing through the air under very high velocity meets with great resistance. This consideration alone would prevent *condensed waves* from traveling through the air at

the rate of a thousand feet a second by some trifling vibratory motion like that of a string or fork, or anything in fact short of a magazine explosion or something of equally tremendous power. No other argument would seem to be necessary to show that sound must be a substantial emission of some kind, since a physical wave of condensed air, to travel at such a velocity, must require hundreds if not thousands of tons of propulsive power to start it and then keep up the motion. How pitiably absurd, then, to talk of such condensed waves being sent off at such velocity by the infinitesimal strength of an insect!

Notwithstanding, then, the mobility of the air, it may, at the same time, present a resistibility *equal to that of a granite rock*, if the movement against it be of sufficient velocity. Meteoric stones, in passing into the upper or rarer stratum of our atmosphere, move with such velocity that they are first heated to incandescence, and in reaching the more dense portion of the air they are often crushed to atoms by the contact, scattering their fragmentary scintillations in all directions. It is only when meteorites enter our atmosphere in the same or partially the same direction that the earth is traveling around the sun, or its surface revolving, that they can reach the ground without being crushed. The hardest specimen of meteoric iron would crumble to powder on the first contact with our atmosphere should the collision take place in opposition to the earth's rotation around the sun, and thus meet a counter velocity to its own of *nineteen* miles a second; though it is easily conceivable that a meteorite might enter the air in a direction corresponding to the earth's rotation both on its axis and around the sun, and that the combined velocities might thus so nearly agree that the visitor would reach the ground at a speed which would not mar a block of ordinary sandstone. Specimens of such meteoric rock have often been found almost intact.

This mechanical viscosity of the air—that is, its tendency to resist displacement by a body passing through it—is beautifully illustrated by the fact that a mass of common gunpowder, exploded upon the face of a granite rock, will not mar it the slightest, for the reason that its conversion into gas, as well as the molecular expansion of the gas when generated, is so slow, comparatively, that the air has time to move out of the way without the rock being affected. I have even seen a man explode a pistol-charge of powder in his naked hand without suffering any injurious effect from it. But let a body of nitroglycerine of any size be placed on the flat surface of a rock and exploded, and the surface will be found to have been shattered to a considerable depth, which can only be accounted for by the rigidity of the air in resisting the enormous expansive velocity of the gas. To say that the air is as solid as a rock would seem ridiculous, yet it has a good deal of truth in it when the motion which attempts its displacement has a sufficiently high velocity.

But I have evidence to present against the hypothesis of sound-waves and their constituent "condensations and rarefactions," compared to which the foregoing unanswerable considerations are but as the softest zephyr contrasted with the devastating cyclone. I now proceed to present a single argument, which, in its ramifications and various phases, will form an avalanche of testimony against the theory so overwhelming that its strongest advocates will be forced to recognize it as entirely unassailable.

There is a well-known insect—one of the locustidæ (a saltatorial family of the

order of orthoptera)—whose stridulation can be easily heard a distance of more than a mile. In the summer of 1867 I had the pleasure of listening to one of these insects singing in a grove of trees on the opposite side of a valley more than a mile wide, and it was a source of astonishment that so diminutive an insect—weighing less than a quarter of a pennyweight—could fill, as it did, four square miles, including, no doubt, a mile high, with its wonderful music! Yet such was the fact, which is well recognized by our greatest naturalists, including Mr. Darwin, who describes the same species of locust in his work on the *Variations of Animals and Plants*, and admits that its stridulation can often be heard a mile.

According to the wave-theory of sound, which I have the honor of opposing, this trifling insect, by simply rasping its legs across the nervures of its wings (for this is the way its tone is produced) creates a physical agitation and displacement of the air which converts the whole four cubic miles of atmosphere into waves, each wave consisting of two parts, a "condensation and a rarefaction," the compressed portion of which contains a sufficient augmentation of heat above the normal heat of the atmosphere, to add "one sixth" to the elasticity of the air and the velocity of sound! I unequivocally assert that no sane mind can accept such a proposition or intelligently believe it, and that any man who pretends to believe it (as all advocates of the current sound-theory must do) is self-deceived, having never seriously thought of the infinitely impossible consequences involved. I will now try to undeceive these astute physicists by pointing out the consequences, and thus prick the most stupendous scientific bubble ever inflated by man.

Within these four square miles which are filled by the sound of this insect, there are, in round numbers, 16,000,000,000 square-inch columns of air, each exerting a pressure on the earth and in all directions of fifteen pounds, or, in the aggregate, 120,000,000 tons. Now, since sound can *only travel* by means of air-waves, and as air-waves can *be constituted only* of "condensations and rarefactions," and as a condensation can *only take place* by the particles of air, as Professor Tyndall says, "*crowding closely together*," or a rarefaction occur except by the particles of air separating "*more widely apart*," and as every particle of air constituting a sound-wave, according to the same high authority, must necessarily make "a small excursion to and fro" every time a wave passes (see extract No. 3, page 78), it inevitably follows, if this theory be true, that this insect by simply moving its legs displaces all the particles of air constituting these 16,000,000,000 inch-columns for a mile high and restores them to their place again 440 times each second (its tone being very nearly A, or that of the second string of the violin), and continues this process of thus churning the atmosphere into condensations and rarefactions a full minute at a time! Do these advocates of the wave-theory really believe this? Theoretically and superficially, they may. Intelligently, they do not. Whether they do or not, however, it matters little to me, so long as their theory unequivocally teaches it, for I am not dealing with them at all save so far as they are identified with their theory.

No one will pretend to doubt, who admits the truth of the wave-theory, or, in fact, any theory involving the motion of the air by the passage of sound, but that the stridulation of this locust must absolutely displace and cause to move "to and fro" every particle of air 440 times a

second throughout these four cubic miles of atmosphere, since it is manifest that there is not an inch of space anywhere within this vast area wherein the sound would not be heard if an ear were present; while no one will think of questioning the physical fact that it must necessarily require an appreciable amount of mechanical force and energy to shake a single inch-column of air for a mile high, displacing all its atoms for a certain distance (I care not how small that distance, if it is but the breadth of a hair), and then restoring them the same number of times each second.

As every particle of air constituting a single inch-column for a mile high is thus continuously shaken while the sound lasts, being alternately *condensed* and then *rarefied*, *heated* and then *cooled* (as sound, remember, can not travel without this), will some modern Laplace or Newton please figure out this mathematical problem, and tell me the exact—or, if that is impossible, the approximate—mechanical force it would require to produce this physical tremor and this continuous agitation of this column of air? I have not a doubt but that Professor Helmholtz could do it to the thousandth part of a grain, if he should set himself about it; and provided, first of all, that he could tear himself loose long enough from the ridiculous theory of sound-waves.

In order to form an approximate idea, I employed two different mathematicians to determine the problem for me, but I am not sure of their competency, since their calculations differed so widely from each other,—one of them estimating it to cost the expenditure of fifteen pounds of mechanical force per second, while the other made it about forty, that is, supposing the distance the air-particles oscillated back and forth to be the one thousandth part of an inch in amplitude. The latter gentleman, however, took into consideration the mechanical equivalent of the heat generated in the agitation of this inch-column of air, according to the calculation of Laplace, estimating such heat as sufficient to add one sixth to the velocity of sound, while the former rejected the heat hypothesis entirely, claiming that by no conceivable possibility could this column of air be changed from heat to cold, however slight the transition, 440 times a second, *or even ten times*, since it would necessarily take an appreciable length of time for the heat to radiate or be transferred from the hot part of the wave to the cold, even if such heat and cold exist, as the wave-theory requires. This suggestion, which had never occurred to me before, became at once another conclusive evidence of the infinite impracticability of the wave-theory, which actually requires the same particles of air, through which the sound, for example, of the high D of the piccolo flute passes, to be alternately heated and cooled off 4,752 times each second, since that many separate air-waves are sent off by this tone, a thing so transcendently improbable and inconceivable that it alone ought to cause the rejection of the wave-theory with any mind capable of reasoning on a scientific subject!

This view is also tacitly admitted by Professor Tyndall, since he distinctly tells us on page 36 of *Lectures on Sound* that the air is practically devoid of "radiative power." If atmosphere can not *radiate* its heat, how then in the name of philosophy can the same mass of air-particles become alternately heated and cooled thousands of times each second, as they must do according to the wave-theory? The same air-particles precisely have to become *condensed* and then *rarefied*, *heated* and then *cooled*, at this rapid alternation;

yet this "highest living authority," as Professor Youmans calls him, teaches "*the practical absence of radiative power in atmospheric air.*" If there is no power in air-particles to *radiate* their heat, and thus transfer it to other bodies or other air-particles, then it manifestly follows that particles of air once heated must continue to retain their heat, and can not continuously alternate from heat to cold thousands of times a second. Yet this "highest living authority" can not see that this "practical absence of radiative power in atmospheric air" utterly annihilates the wave-theory, which depends alone for its existence upon this almost infinite facility of change from heat to cold by "radiative power"!

Finally, to provide against the contingency of a possible excess of physical force in this calculation, I reduced the actual *vis viva* required to produce the rapid vibratory motion of a single inch-column of air for a mile high to *one pound a second*, evidently much below the actual force it would take, which reveals the tantalizing fact, as it must be to Professor Tyndall, that an insect which could not stir a half-ounce weight by exercising all its strength to the best advantage is made by the wave-theory to produce a physical and mechanical effect by the movement of its legs equal to *sixteen thousand million pounds*, as there are that many inch-columns of air to be thus thrown into violent tremor by this stridulation, as certain as there is the least basis of truth in the current theory of sound! Is it possible that any well-balanced intellect can really subscribe to this inevitable result of the theory? I care not how much this calculation is reduced in reason below these figures,—even if we suppose it to require but the *one thousandth part of an ounce* of mechanical force to shake this inch-column of air for a mile high, it would still require a physical moving power to be exerted by this locust, as any one can demonstrate by a few figures, of *one million pounds!* Is a theory requiring such manifestly impossible results worthy of the nineteenth century? Is it not, rather, utterly inconceivable that any physicist in his senses can believe, as does Professor Mayer, that these four cubic miles of atmosphere, with a mechanical pressure of 120,000,000 tons, are actually churned into condensations and rarefactions, and its particles made to oscillate "*to and fro with the motions of pendulums*," as he expresses it, by an insect which has not strength enough to compress a single cubic inch of air, if acted on in a tube without friction, *the one four hundred and eightieth of an inch*, estimating its shoving power against the piston at half an ounce? Is it possible that any man capable of reasoning at all can believe that by the motions of this insect's legs—no larger than small pins, and not exceeding in the aggregate a distance of *three inches in a second*,—air-waves constituted of "condensations and rarefactions" are actually hurled throughout this vast area at a velocity *four thousand times greater than that of the instrument which gives them their impetus?*

It will not do for physicists to "Pooh! Pooh!" this calculation, and try to blot out the difficulty or the danger to their theory by shutting their own eyes to its overwhelming character,—as the ostrich shuts out the danger of the hunter by thrusting its head into the sand,—and say, as some of them have done, "Oh, these figures are all very easily made, and look very formidable on paper, but they amount to nothing when arrayed against the long-established scientific data upon which the current sound-theory rests!" Well, we shall see, a little further on, whether or not a theory can stand on the strength of

its venerable character, after being proved in a hundred different ways to contravene the unchangeable laws of mathematics and mechanics, while at the same time contradicting observation and the reason of all reflecting minds. We shall further see whether a theory can continue to prevail and rank as scientific, when its ablest advocates can not advance an argument in its support which will not, when fairly analyzed, overthrow it, as recently seen with magazine explosions and their effects in the breaking of windows at a distance. Let us now look at some of these self-annihilating efforts of physicists in support of the current theory of sound, as exemplified by the stridulation of this locust.

Writers on sound seem to keep up a show of respect for the physical laws of mechanics and mathematics, even when their premises completely overthrow their theory. While insisting on the hypothesis that sound in passing through the air produces actual "condensations and rarefactions," which alternately generate heat and cold enough to add "one sixth" to the velocity of sound, they are unavoidably at times driven into the terrible necessity of the perpetration of *figures*, which, when analytically considered, absolutely annihilate wave-motion. In opposing the undulatory theory of sound, therefore, I do not need to put forward a basis of my own as to the physical force a tone must exert on the air through which it passes, and thus determine the corporeal strength of a locust in churning four cubic miles of atmosphere into "condensations and rarefactions." I have simply to take the figures furnished ready to my hand by these authoritative writers, and apply them to the observed sound of the locust, in order to exhibit the wave-hypothesis as one of the most inexcusable fallacies ever conceived by a human intellect.

For example, Professor Mayer, the highest American authority on sound, has not left us to flounder in the dark on this question, but tells us in explicit terms how much "compression" a sound-wave produces on the air in passing through it, so that we may have a definite basis for calculating the mechanical strength of the locust. He says:—

"This *compression* gives for the *compressed half of the wave an increase of* $\frac{1}{679}$ *to the ordinary density of the atmosphere.*"—*Article on "Sound," American Encyclopedia.*

He here refers to the note C, having 250 vibrations to the second. He does not say whether a tone lower or higher than this would or would not produce a greater "compression" of the air; but we would naturally infer that the note A, with 440 waves a second, should generate more compression and a greater quantity of heat than one giving to the air-particles a less number of pendulous movements. However this may be, the difference is not essential to my argument should it be a little one way or the other, so we will consider the amount of "compression" produced by any sound to be practically the same, and assume that the figures here announced by Professor Mayer are properly and accurately calculated, with the wave-theory as a basis, which will enable us at once to determine the mechanical force exerted by any sounding body in converting four cubic miles of atmosphere into "condensations and rarefactions."

Now, as this sound, in passing through the air, actually produces such a condensation as makes the "density" of the *compressed half of the wave* "$\frac{1}{679}$" greater than that of the normal air through which no sound is passing, and since one half of the four cubic miles of atmosphere permeated by this stridulation is continually in a state of "compression" while the

sound lasts, it mathematically follows that each cubic inch of air within this compressed portion—or, in other words, one half of all the cubic inches constituting this mass of atmosphere—is absolutely increased in "density" "$\frac{1}{679}$," while the other half of the atmosphere constituting the "rarefactions" is reduced in "density" in like proportion.

There is no escape from this astounding conclusion, as these are the figures of the foremost advocate of the wave-theory of sound in this country—not mine, while they are figures which the physicists of the whole world are forced to admit, since without exception writers on sound assume the same "condensations" of the air by the passage of sonorous waves which he does, and boldly claim that they generate sufficient heat by *compression* to add "one sixth" to the velocity of sound, while Professor Mayer is but the frank, outspoken mathematician, who formulates their calculations, and gives us the result in plain vulgar fractions, thus showing us exactly how much a sonorous wave must necessarily compress the air.

The culmination, then, of this destructive argument, amounts to this: As a cubic inch of air, when compressed to *double* the normal density of the atmosphere, requires a squeezing force of *fifteen pounds*, as every student of philosophy knows, it will of course take but the simplest mathematical talent to calculate the whole amount of pressure exerted by the locust throughout the four cubic miles,—since it must be the $\frac{1}{679}$ of 15 pounds to each cubic inch in the "compressed half" of this mass of air! As there are, in round numbers, but correct figures, 1,000,000,000,000,000 cubic inches within these four cubic miles, one half of which (500,000,000,000,000) is under pressure, having an increased *density* equal to $\frac{1}{679}$ of 15 pounds for each cubic inch, we reach the definite and authoritative result of 10,000,000,000,000 pounds physical pressure, or an actual mechanical energy exerted by this insect in producing its stridulation of *five thousand million tons!*

Will physicists "Pooh! Pooh!" these figures, as having no *weight* against the venerable wave-theory of sound? If they do, then they scout their own data, deliberately formulated and placed on record by one of their ablest collaborators. Any schoolboy can take the statement of Professor Mayer, quoted above, and in fifteen minutes reach the same incontrovertible result here given.

It now becomes a matter of curiosity and exciting interest to the scientific as well as to the unscientific world to know what physicists can say to these mathematical demonstrations! Will they say anything?—or will they attempt to pass the whole matter over in silence, on the ground that the writer of this monograph happens to be unknown,—having not the prestige of a great scientific reputation by which to herald his discoveries and announcements? We shall patiently wait and see. One thing is certain, whatever physicists may do or say: it now stands upon record, and will so stand while books are read, that if the wave-theory of sound be true, as presented in all scientific works on the subject, a mere insect, by the movements of its delicate legs, can and does absolutely convert four cubic miles of atmosphere into "condensations and rarefactions," exerting a literal, physical, and mechanical energy, as above demonstrated, of 5,000,000,000 tons! As such a result is an infinite impossibility, the wave-theory, without another argument against it, is thus demonstrated to be an infinite absurdity.

No doubt the reader by this time is

ready to ask: "Though you have used the stridulation of the locust to make the wave-theory of sound appear almost infinitely ridiculous, have you not also by the same illustration succeeded in making your own hypothesis of substantial emissions equally absurd? Is it possible," he might naturally continue, "that such a diminutive insect can fill four square miles with any conceivable substance, how much soever attenuated, keep up these discharges for hours, and still not appreciably diminish its weight?"

I admit the legitimacy and fairness of this inquiry, provided the one who makes it is not a believer in the hypothetic luminiferous *ether*, believed in by all advocates of the wave-theory of sound, which circulates freely in the substance of the diamond, yet is a *material substance* resembling a "jelly"!* No scientist who holds to the undulatory theory of light and this gelatinous *ether* has any business to put a question involving a doubt as to the possible tenuity or penetrability of any substantial entity, even if a quantity the size of a pin's head should be claimed as sufficient, when spread out, to cover the whole earth; but the unscientific reader has a legitimate right to ask this question, and to him I propose to give a brief, and, I trust, satisfactory answer.

I have in the preceding chapters had occasion to refer frequently to the wonderful nature and inconceivable tenuity of *odor*, though perfectly cognizable by the olfactory nerves, just as sound is cognizable by the auditory organs.

Fortunately for my hypothesis of sound as substantial emissions, I am left uninvolved in any absurdity, as I will show, by the universal admission of science that fragrance is a real corporeal substance, having definite material atoms,—so I am relieved of the necessity of all argument on that point.

Though odor is governed by a different law of radiation and conduction from those of sound, light, heat, magnetism, electricity, &c., each having its own peculiar conditions of diffusion and conduction, yet it is a probable fact, sufficiently well attested by approximate experiments, that a quantity of musk no larger than a locust, if properly distributed and with suitable conditions for confining its emanations, would fill four cubic miles with its material corpuscles, till a sensitive olfactory at any square inch of this area would detect its presence, yet if the original mass were to be afterward weighed with the most sensitive balance it would show no appreciable reduction in weight.

To add to the force of this illustration, I will adduce a well-known fact which can not fail to show the marvelous tenuity of odor, defying absolutely all efforts of the imagination to conceive it as composed of separate substantial atoms.

A *hound* of a certain breed, with highly sensitive olfactories, will follow the direction of a *fox* over hill and dale, through forest and jungle, hours after it has passed, and even when it has reached a score of miles ahead. Yet the hound does not depend on touching the tracks of the fox with his nose, or even of following its exact

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* "The luminiferous *ether* has definite mechanical properties. It is almost *infinitely more attenuated than any known gas*, but its properties are those of a *solid* rather than those of a gas. It resembles *jelly* rather than air."

"To account for the enormous velocity of propagation in the case of light, the *substance* which transmits it is assumed to be of both extreme elasticity and extreme tenuity. This *substance* is called the luminiferous *ether*. It fills *all space;* it surrounds the *atoms of bodies*. . . . The molecules of luminous bodies are in a state of *vibration*. The vibrations are taken up by the *ether* and *transmitted through it in waves*."—TYNDALL *on Light*, pp. 57. 60.

path; but, as observed by the writer (having seen a fox pass hours before, and noting the exact path taken by its feet), will frequently vary rods from the true path, yet, keeping on in the general direction, will pursue his game with unerring certainty.

So defined and substantial are the odorous particles emanating from the footfalls of the fox, that a dog, on striking a trail hours old, will almost instantly decide, by the arrangement of the atoms in the air, the direction it has taken; but if momentarily mistaking the back-track, the difference, probably, in the intensity of the surcharged air warns him of his error, and leads him to reverse his course.

Before stopping to quibble about the impossibility of sound being substantial emanations from its inconceivable tenuity, let us try to grasp the marvelous lesson taught by this fox and hound. Though the wind may blow across the trail, carrying off for hours the odorous clouds which have risen from the instantaneous impress of the feet upon the earth, filling thus, perhaps, vast areas along the trail with those magical atoms of perfume, exceeding possibly in extent many times the four square miles of air surcharged by the locust, yet sufficient odor remains, extending for rods on both sides of the trail, to enable the hound to pursue his distant game with infallible precision.

I now ask the puzzled reader, who fails to see how the locust can fill an area two miles square with sonorous substance and not appreciably reduce its weight, to tell me approximately how much *reynard* has reduced his feet in size and weight by the clouds of odor diffused along his track for a hundred miles? Though the feet may have deteriorated by the roughness of the journey and their two hundred thousand impacts upon the hard earth, yet I venture the suggestion that the cubic miles of odorous substance which encompassed the trail and guided the hound, did not diminish the weight of either foot an appreciable fraction of a grain. Yet those miles of odor-surcharged atmosphere were filled with *substantial emissions*, as all science unites in assuring us, though not so tenuous, probably, as sonorous substance, yet sufficiently near it to cause the imagination to retire discomfited and confounded.

The reader thus has a rational answer to his question in this somewhat analogous substance of odor, showing that it is not at all among the impossibilities, nor is it even improbable, that the locust should fill such an area with sonorous substance, from this analogue in the fox's feet,—whilst not the shadow of an answer can be offered by the advocates of the wave-theory of sound for the reasonableness of corporeal results equal to the mechanical energy of a *million locomotives* ascribed to the physical strength of a single insect.

The possibility of a locust filling four cubic miles with some kind of tenuous substance, is not, therefore, at all inconceivable, since we have the positive demonstration that there is no imaginable limit to the tenuity of substantial emissions, as seen with odor. This fact of unlimited tenuity is a very different thing, however, from the unlimited strength of an insect in accomplishing physical and mechanical results by doing absolute work in the agitation and displacement of a corporeal body like atmosphere,—exerting an energy, as it must do according to the wave-theory, as just seen, of 5,000,000,000 tons. While the tenuity of substantial emanations is practically unlimited, so far as human intellect can conceive, physical and mechanical results, such as compressing the air or overcoming the inertia of bodies, changing them from a state of rest to a state of motion, are definitely and

determinately limited and bounded by the strength of the being or motor employed! As well might we suppose it possible for a man to knock into fragments a range of mountains and scatter the particles over miles of territory by a single blow of his hand as to believe it possible for an insect to perform the work ascribed to it by the advocates of the wave-theory.

It is only our intense ignorance of the inscrutable *tenuity* and incommensurable *penetrability* of the intangible substances of Nature everywhere around us, and even within us, which could persist in causing such inquiries as the one just answered. When we come to accept Nature's unsolvable mysteries—among them her recondite and intangible though substantial entities, such as sound, light, heat, &c.—with less of scientific egotism and more of that wholesome faith in the rational hypothesis of an intelligent First Cause, the world will not be so apt to continue for centuries hugging to its embrace, under the name of "science," such a stupendous philosophical monstrosity, and, at the same time, such a pitiable fallacy as this Undulatory Theory of Sound; but with expanded freedom of thought to look into, or at least toward, the Unknowable Essence, and to conceive Him as manifested in His works,—with less of veneration for scientific formulas and with moderated respect for canonized authority in theoretical science, we might reasonably expect in the near future to solve mysteries as profound as a planetary ellipse, and overthrow scientific theories as well established as those of sound, light, and heat.

But I have not yet dismissed my favorite locust. I have other uses for it, and propose to make it serve me in overthrowing the wave-theory in yet two or three different ways which physicists will hardly fail to appreciate.

As I have just had the pleasure of applying its stridulation to the innocently appearing figures and data of Professor Mayer, and of demonstrating by them that this insect has a physical strength in compressing the air equal to 5,000,000,000 tons mechanical force, I now propose to apply the same music to the figures of Professor Tyndall on the heat hypothesis of Laplace, and will show results in the corporeal energy of this contemptible insect which will throw Professor Mayer and his "$\frac{1}{5}$" additional "density" completely into the shade. I propose to use nothing in this analysis of Professor Tyndall's position except substantial and unquestioned figures and facts, mostly furnished by himself.

The reader, I trust, has not forgotten the emphatic citations from the *Lectures on Sound*, quoted a few pages back, in which this learned physicist explicitly tells us that the "heat" generated by the propagation of a sonorous wave through the air, adds about "one sixth" to the velocity of such sound, and thus accounts for the discrepancy of 174 feet a second discovered by Sir Isaac Newton.

This heat solution of Laplace, it must not be overlooked, is a vital feature of the wave-theory of sound; for, without this formulated augmentation of temperature by the passage of the wave itself in squeezing the air into a "condensation," the theory confessedly falls to the ground, since the observed velocity of sound contradicts it by 174 feet a second, as proved by Newton, and whose calculation all physicists admit to be correct. It therefore becomes essential to the existence of the current hypothesis of sound that the solution invented by Laplace should pass the ordeal of this *stridulation*, or otherwise the bottom falls out of the theory which it professes to rescue from the fatal figures of Newton.

The resort to *heat* by Laplace, in order to add to the elasticity of the air and thus increase the velocity of sonorous propagation, grew out of the observed fact that the general augmentation of the temperature of a mass of atmosphere—as, for instance, by the action of the sun—increases its elasticity, and thus adds to the velocity of sound passing through it. Thus, sound is known to travel about 100 feet a second faster in the heat of summer than in the severest cold of winter, owing solely to the difference in temperature. I will here requote one of the passages referred to, that its teaching may be fresh before the mind of the reader:—

"This *change of temperature produced by the passage of the sound-wave itself*, virtually augments the elasticity of the air, and *makes the velocity of sound about one sixth* greater than it *would be if there were no change of temperature.*"—*Lectures on Sound*, p. 46.

It is impossible to misunderstand the general bearing of this statement, namely, that the effect of a sound in passing through the atmosphere is to squeeze its particles into *condensations*, and thus generate heat enough to add "one sixth" to the velocity of sound, and make up this deficiency of 174 feet a second. Hence, it follows, as the sound of the locust travels with the same velocity as any other sound, it must also generate the same quantity of heat by the compression of the air, or otherwise the tone of this stridulation would fall short of the uniform velocity of sound.

Now, on this universal assumption of physicists and the unquestioned teaching of the wave-theory, that the passage of a sound-wave through the air augments the temperature of the compressed half of such wave sufficient to add 174 feet a second to its velocity, is it possible to arrive at the exact number of *degrees of heat* thus required to produce such augmentation? Is it, then, possible to ascertain the exact amount of *compression* necessary to generate this quantity of heat? And, finally, can we not then arrive determinately at the physical strength of the insect which produces a *pressure* sufficient to generate that amount of heat? I assume that all these conditions are possible, and that Professor Tyndall himself gives us the figures, in the most concise language, by which at least a part of the facts can be determined, while he gives us a sure clue to the remainder. He says:—

"At a temperature of half a degree above the freezing point of water the velocity is 1,089 feet a second; at a temperature of 26.6 degrees it is 1,140 feet a second, or a difference of 51 feet for 26 degrees, that is to say, *an augmentation of velocity of about two feet for every single degree centigrade.*"—*Lectures on Sound*, p. 25.

No one can misunderstand this. Hence, in order to add "one sixth," or 174 feet a second, to the velocity of sound, the locust must necessarily generate sufficient heat to raise the temperature of the *condensed half of its sound-waves* 87 degrees cent., which is half of 174 feet, or *two feet* velocity "for every single degree centigrade."

Here, then, we have no difficulty in gradually approaching the solution of the problem for which we set out, namely, to ascertain from Professor Tyndall the physical strength of this locust, according to the wave-theory, in so compressing four cubic miles of atmosphere, or at least the one half of it, as to raise its temperature 87 degrees, or one degree centigrade for each two feet of velocity thus added.

It only remains now to ascertain what amount of compression or mechanical *squeezing force* must be exerted upon these four cubic miles of atmosphere to raise the temperature of one half of its mass 87 degrees, or enough to add 174 feet a second to the velocity of sound; for, it

must not be overlooked that *one half only* of the air is heated above the normal temperature by this squeezing process, while the other half is just as much depressed by the rarefactions. Hence, in estimating the amount of heat the sound of the locust generates, we must be careful to confine our calculation to *one half* of the mass of air permeated by the stridulation, or otherwise we might unintentionally do injustice to this carefully formulated and purely scientific theory!

But I am obliged here to digress a little from the main inquiry, as to the physical strength of the locust according to the facts and figures of Professor Tyndall, though I will soon return with an important collateral fact somewhat elucidated by the digression.

I acknowledge that it will seem a little queer to the unscientific reader how the velocity of sound can be increased by the heat of the "*condensations*," when the "associated *rarefactions*" are just as much *colder* as the condensed portion is *hotter*, since the one would seem naturally to *retard* the sound-pulse as much as the other could *accelerate* it. This, however, is a small-sized problem to the wave-theory compared to some of the difficulties it is obliged to encounter, as the reader no doubt begins to realize. Professor Tyndall appreciates this difficulty, and tries to parry it in his explanation of Laplace's law. He admits if the air were permanently parcelled off into strata alternately hot and cold, in the same manner as it is moulded and divided up by a sound-pulse into condensations and rarefactions, that an extraneous sound passing through these hot and cold layers would receive no augmentation of velocity.

How, then, the common sense of the reader would naturally prompt him to ask, does the law of Laplace make a sound travel any faster on account of this heat and this cold, the one a stand-off to the other, and both equally balanced in the "condensations and rarefactions"? It is not at all clear to the writer how this can take place, even with Professor Tyndall's explanation before him, even supposing such condensations, &c., actually to exist, for a very definite reason, which will soon be given; but the explanation given by the theory amounts to about this: The condensed half of the wave being *hotter* than the normal air increases the elasticity and augments the spring-force of this condensed portion of the atmosphere, which gives greater velocity to the air-particles in their oscillations to and fro; while the rarefaction, being colder, has less elasticity, and thus withdraws resistance or opposing spring-force to the air-particles as they are driven backward from the condensation. In this way the velocity of the particles is increased both by the heat and the cold. The hypothesis of Laplace is surely as accommodating as one could ask.

The whole matter, however, is purely chimerical and absurd, since both Professors Tyndall and Helmholtz have told us that the actual distance the air-particles travel in these oscillations to and fro must necessarily be almost infinitesimally small, possibly not the hundredth or the five hundredth part of an inch. To make these hypothetic oscillations of the air-particles to and fro amount to anything appreciable in the generation of heat and cold, which must be the case in adding 174 feet a second to the velocity of sound, they must necessarily travel more than an infinitesimal distance. And here is where the theory contradicts and annihilates itself utterly, by teaching in the most explicit language that the air-particles do travel a long and measurable distance to and fro, —that the condensations and rarefactions

are actually produced by the *travel* of the air-particles — first forward, causing the *compression*, while leaving a partial vacuum which becomes the rarefaction, and then returning, which again produces a condensation in the space just occupied by the rarefaction, — thus alternately converting the same air-particles into condensations and rarefactions *by traveling the entire distance back and forth from rarefaction to condensation, and vice versa.* The language of Professor Tyndall can leave no doubt on this matter:—

"As the pulse advances it *squeezes the particles of air together.*"

"You ought to see mentally the air-particles when *urged outwards* by the explosion of our balloon *crowding closely together;* but immediately behind this *condensation* [Mark it, the "condensation" is caused by the travel of the air-particles in being "urged outwards" and "*crowding closely together,*"] you ought to see the particles *separated more widely apart.* You ought, in short, to be able to seize the conception that a sonorous wave consists of two portions, in one of which the air is *more dense* and in the other of which it is *less dense* than usual."

"Figure clearly to your minds a harp-string vibrating to and fro; it advances, and causes the *particles of air* in front of it to *crowd together, thus producing a condensation of the air.* It retreats, and the air-particles behind it *separate more widely, thus producing a rarefaction of the air.*"—*Lectures on Sound*, pp. 5, 28.—*Heat as a Mode of Motion*, p. 225.

Thus, all the way through the writings of this physicist the *condensation* of the air is caused by the *travel* of the air-particles, while the *rarefaction* is produced by the same travel in leaving a partial vacuum; and, as the same atmospheric space which is now the condensation instantly becomes the rarefaction, and *vice versa*, it follows irresistibly that there is no way of creating alternate rarefactions and condensations in the same mass of air every time a wave passes *except by the same air-particles traveling back and forth the entire distance from rarefaction to condensation*, and *vice versa*, as the two change places.

Let it thus be remembered that the distance the air-particles travel in producing these supposed condensations and rarefactions can not be infinitesimal, if there is any truth in the theory, because their *travel* to and fro creates these condensations and rarefactions, and hence they are obliged to pass the whole distance thus signified, which is simply *half a wave-length*, as is perfectly plain.

Is it not, then, clearly manifest from the foregoing quotations that there can be no condensation of the atmosphere unless the air-particles themselves travel, and thus *crowd* and *squeeze* together as far as the condensation extends, in order to produce it? I have already shown, in various ways, that there is no spring-force in the air by which a pulse can be driven a single inch beyond the actual travel of the air-particles themselves, owing to the exceedingly slow motion of the fork or string and to the extreme mobility of the air, neither of which seems ever to have entered the minds of these savants.

Now, what is the distance, according to the wave-theory, which these air-particles have to travel in order to pass from the rarefaction into the condensation? I have said it must be *half a wave-length*, of course. Professor Tyndall says:—

"The *length of a wave* is measured from the *centre of one condensation to the centre of the next one.*" [See list of quotations, page 79.]

From the middle of a rarefaction, therefore, to the middle of a condensation is half a wave-length. It is thus a simple matter to determine the actual distance the air-particles oscillate "to and fro" in squeezing the air together, and thus forming these "condensations and rarefactions."

The wave-length of a sound depends

on its pitch, or, which is the same thing, on the number of waves per second sent off from the sounding body. If it is a very high sound, like that of the high D of the piccolo flute (4,752 vibrations a second), the length of the wave is less than *three inches*, as can be seen by dividing the number of vibrations as above into the velocity of sound, or 1120 feet a second; whereas, the lowest tone of the organ, as stated by Professor Blacerna in his recent work on sound, has 16 vibrations to the second, and a consequent wave-length of 70 feet! It thus follows that in the sound of such an organ-pipe the air-particles are obliged to travel 35 feet and back 16 times each second, in order to pass from the space occupied by the center of the rarefaction to the center of the condensation and back. They would thus move with a velocity in one direction of 560 feet a second, or at the rate of 381 miles an hour, which would produce a tornado of more than double the velocity necessary to sweep a village into ruins! If there was the least truth in the wave-theory, the sound of a church-organ should get up a cyclone which would blow a cathedral into atoms!

I do not propose to misrepresent these learned physicists in the least in stating the legitimate and preposterous effects of the wave-theory. In fact, it is difficult to misrepresent the theory, say what you will about it, for, in some of its contradictory aspects it will be sure to justify you. I admit frankly that it would seem absolutely to defy belief that any pretended scientific theory should teach in this nineteenth century such a transparent impossibility as that the stridulation of an insect should shake four cubic miles of atmosphere into condensations and rarefactions, and so compress one half of it by squeezing its particles together as to generate this calculated heat of Laplace sufficient to add 174 feet a second to the velocity of sound; and I would not at all blame the reader if he should throw down this volume, charging me with the foulest misrepresentation of these eminent scientists, unless I should continue to demonstrate my assertions beyond the possibility of doubt by quotations from their works couched in such explicit and unmistakable language as to render misconstruction impossible.

I admit the justice and fairness of this course on the part of the reader, and shall therefore continue to fortify every position I take, so that in the end the learned authorities from whom I quote and whose theory I am reviewing shall have no reason to complain. Professor Tyndall says, and I wish the reader to carefully note it:—

"All that you have heard regarding the transmission of a sonorous pulse through the air, is, I trust, still fresh in your minds. As the pulse advances *it squeezes the particles of air together*, and *two results follow from this compression of the air*. Firstly, its *elasticity is augmented* through the mere augmentation of its *density*. Secondly, its elasticity is augmented *by the heat developed by compression*. . . . Over and above, then, the elasticity involved in Newton's calculation, we have an *additional elasticity* due to the *changes of temperature produced by the sound itself*. When both are taken into the account, the calculated and the observed velocity agree perfectly."—*Lectures on Sound*, p. 28.

This is too plain to require comment. But here, remember, as I have already intimated, Professor Tyndall does not teach that the *average temperature* of the atmosphere is changed in the least by this compression or squeezing of the air-particles together. He carefully guards against such a result as too superficially absurd to be taught even by the wave-theory. He has provided against this in a score of places by reiterating, as already quoted so often, that each condensation of a sound-wave is accompanied by a counterbalance

in the shape of an "associated rarefaction," and hence that in the latter the temperature is as much depressed as it is raised in the former, thus keeping the average temperature the same. He remarks:—

"The average temperature of the air is unchanged by the waves of sound. We can not have a condensed pulse without having a rarefied one associated with it. But in the rarefaction the temperature is as much lowered as it is raised in the condensation."—*Lectures on Sound*, p. 29.

This really seemed to be quite a necessary precaution on the part of the wave-theory, or otherwise it would be impossible for a katydid to stridulate without making the surrounding atmosphere so nearly incandescent that nobody could live in it! Hence, the necessity of rarefactions as *cold* as the condensations are *hot*.

But what does this precaution amount to, after all? We here have it distinctly taught that every particle of the air through which a sound passes is first *heated* to this very temperature requisite to add 174 feet a second to the velocity of sound before it can be cooled by the associated or succeeding "rarefaction"! And I have just shown, from Professor Tyndall, that, in heating a given mass of the atmosphere ordinarily, as by the effects of the sun, the same as if the whole mass were a condensation, it must actually be raised 87 degrees centigrade (156.6 degrees Fahrenheit) to add the 174 feet a second, or at the rate of one degree to each two feet of additional velocity! Thus, one half of the entire atmosphere throughout the four cubic miles is heated all the time and the other half cooled all the time while the locust is stridulating, though there is a transition and a transference of the heat from one to the other half constantly taking place, according to the wave-theory. Yet this assuredly can not make the amount of heat and compression less than one half what it would be if both halves of the atmosphere were heated at once.

But here I meet with a difficulty in my calculation, and the only one I have yet encountered. Professor Tyndall does not tell us what amount of "*pressure*" to the square inch is necessary to generate a definite amount of heat, or to raise the mercury in a centigrade thermometer, say, *one degree*. This was a great neglect, and an almost unpardonable oversight, under the circumstances. He explicitly tells us how many degrees of heat it takes to add a given number of feet per second to the velocity of sound when the whole atmosphere is heated, as I have already quoted, namely, 87 degrees centigrade for 174 feet, or one degree for each two feet of velocity. He is also very careful to tell us that the "condensation" of a sound-wave really does generate the requisite heat, by *squeezing the air-particles together*, to add these 174 feet a second. But he there stops, leaving us entirely in the dark as to how much this *pressure* actually amounts to in pounds and ounces! Had he told us this, we should be able to know all about the strength of the locust in one minute.

During his lectures on *Heat as a Mode of Motion* (page 82, first edition), he shows how much *weight* an inch-column of air will support while being heated up to any number of degrees, and thus kept at constant volume, without any change in its density. But this is a very different thing from the generation of heat by squeezing the air-particles together and thus augmenting its *density* as well as its *elasticity*, the same as sound-waves are claimed to operate.

He even goes so far as to show his audience how to generate this heat by the *compression of the air* in a glass tube, and actually does generate heat enough to ignite a piece of amadou by a quick and

powerful motion of the piston! Still, he remains stoically taciturn upon this paramount question as to the *amount* of pressure to the square inch, in avoirdupois, which would be required to raise the mercury, for example, a single degree.

This is the very thing, above all others, he should have attended to in his lecture, and thus have enabled his hearers and afterward his readers to form some sort of an estimate of the mechanical force exerted to send off a given system of sound-waves, thus to produce their condensations, and thus to generate the required heat for the 174 feet a second additional velocity, according to the formula of Laplace.

Professor Mayer was not afraid! He pluckily came right out and told us in the plainest vulgar fractions that a given sound in passing through the atmosphere and producing its condensations actually increased the "density" of the "compressed half" of the wave "$\frac{1}{6}\frac{1}{9}$" over the normal density of the air, which left it a simple mathematical problem to calculate the physical strength of the locust in thus increasing the "density" of the one half of four cubic miles, which we have readily found to be 5,000,000,000 tons! But it really looks as if Professor Tyndall was afraid. If he had known how much mental anxiety he would have saved the writer by giving this small piece of information, he would surely not have been so selfishly inconsiderate as to withhold it.

Seriously, why was it that Professor Tyndall so signally neglected to give this important basis of calculation while discussing the very question where it would so appropriately have come in? Either he did not know himself how much pressure to the square inch of air was necessary to generate one degree of heat, or else he knew and did not care to tell his audience and readers! To suppose that he knew, but intentionally suppressed this important piece of information, at this critical juncture of his course of lectures, when he could so easily have imparted the valuable intelligence in the compass of a single short sentence, would be extremely ungenerous. I shall therefore assume that *he did not know*, and had not even an approximate idea as to the *physical pressure* it takes in pounds and ounces to raise an inch-column of air one degree centigrade, even when the air is confined within a tube so that it can not exercise its *mobility* and get out of the way, *to say nothing of the inconceivable difficulty of producing such compression in the free air!* I adopt this charitable view, on the supposition that had he been aware of this mathematical fact he might have spoiled a splendid lecture by suddenly discovering, on imparting the information to his audience, the utter baselessness and absurdity of the whole wave-theory, and unceremoniously have left the platform in mortification and disgust. I am sorry, in one sense, that the thing did not occur; for, had the idea flashed across his mind at that stage of the investigation, being but the first lecture of his course, and had the actual physical truth of the matter impressed itself upon him, as it will soon be impressed on the reader, I have faith enough in the intrinsic candor of the man to believe he would have at once abandoned the wave-theory as a monstrous scientific fallacy; and, in all probability, the writer of this review would have been spared the unpleasant task of holding up to the light the escapades and fiascos of his fellow-workers in science, by having his labors anticipated in a much more elegant and accomplished manner.

I may add here, in extenuation of the manifest lack of knowledge on the part of

this eminent lecturer, that I have sought in vain among my scientific friends for the same information as to the amount of pressure to the square inch of atmosphere which would be necessary to raise the temperature one degree, while I was equally unsuccessful in consulting authorities, after examining all the works on pneumatics within my reach. I was at last compelled, as a *dernier ressort*, to construct an instrument especially adapted to the purpose of testing this important scientific question,—important both to me in the present discussion, and to the future status of the wave-theory, as well as to the cause of science generally. I will briefly describe the instrument, which is exceedingly simple, and then give the result of the experiment.

It consists of a glass tube of any convenient length, so it is long enough to admit a small thermometer at the bottom, and of a diameter equal to one square-inch cross-section, into which a piston is accurately fitted so as to work air-tight, by means of which the atmosphere may be compressed to any required extent. In making the test I had only to drop the thermometer into the tube, which, being wholly inclosed within the compressed air would sensitively respond to the generated heat for any given movement of the piston.

The result was that on suddenly pushing down the piston a distance equal to one half the depth of the tube (thus giving the other half of the column two atmospheres, or a pressure around the thermometer of about 15 pounds to the square inch), the mercury indicated an elevation of about two and a half degrees centigrade; but as the radiation of the heat through the surrounding tube would be probably equal to its action on the glass of the thermometer, I called the heat actually generated five degrees by a pressure of 15 pounds to the square inch, in order to do ample justice to the wave-theory.

We thus experimentally and mathematically supply the deficiency caused by the inexcusable neglect of Professor Tyndall, and arrive, at least, at the approximate pressure in pounds necessary to raise the temperature of the condensed half of a supposed air-wave 87 degrees centigrade, which we are assured by Professor Tyndall is the augmentation required to add 174 feet a second to the velocity of sound. Of course, this is on the basis that each supposed air-wave is inclosed within a tube and acted on by a piston.

The question may be simply stated as follows: If a cubic inch of air requires 15 pounds pressure (reducing it to one half its bulk) to raise its temperature 5 degrees, how much pressure will it require to raise the temperature of the same cubic inch of air 87 degrees? The result can be obtained thus: $87 \div 5 = 17$ (rejecting fractions) $\times 15 = 255$ pounds. Thus, if there is any truth in the wave-theory, we have in plain figures arrived at the astounding fact that a sound of any kind in passing through the air must produce an atmospheric pressure in the condensed portion of its waves of 255 pounds to each cubic inch in order to raise its temperature 87 degrees centigrade, which, as we learn, is necessary to add 174 feet a second to the velocity of sound, and thus save the wave-hypothesis from utter destruction at the hands of Sir Isaac Newton!

In this simple experiment we have completely remedied the defect of Professor Tyndall's lecture by getting at the approximate if not actual pressure produced on the condensed half of the sound-wave in order to generate this required heat of Laplace, the very point above all others he should have been particular about

explaining, so that the unscientific reader might be able to ascertain exactly how many *tons pressure* upon the atmosphere of his sleeping apartment a *mosquito*, for example, exerts by serenading him with its hateful music! The Professor ought to thank the writer for correcting this important defect in his book, and for thus having furnished him the proper scientific data for his next course of lectures on sound. For, as all sounds travel 174 feet a second faster than they would if there were no heat generated by the *condensations*, or if there were no *squeezing of the air-particles together* by the passage of the sound-wave, it follows that the mosquito's sound is likewise augmented in velocity in the same way and to the same degree; and, as we have just found that it takes 255 pounds pressure on a cubic inch of air to raise its temperature 87 degrees (the required heat for 174 feet additional velocity), any reader can easily make the necessary calculation as to the absolute mechanical pressure which a mosquito must produce throughout a room of given dimensions in order to generate sufficient heat to thus add "one sixth" to the velocity of its sound.

Let us see. As our experiment demonstrates 255 pounds pressure to the cubic inch as the mechanical force necessary to generate the required 87 degrees of heat, it follows, as a mosquito can be heard in a still night throughout a room ten feet square, it must therefore exert this amount of pressure on *one half* of all the cubic inches of air in the room, since one half is compressed while the other half is rarefied. The room contains 1,728,000 cubic inches, the compressed half of which (864,000) multipled by 255 pounds pressure makes the mechanical energy of this insect 220,000,000 pounds, or a physical force exerted on the atmosphere of the room by the motion of its wings of *one hundred and ten thousand tons!* No advocate of the wave-theory can successfully contradict this result.

The reader need not take these figures on my authority, but can make the calculation for himself, taking only the undisputed data furnished by the authoritative physicists from whom I have quoted, in connection with the amount of pressure necessary to raise the temperature of air 87 degrees, as determined by scientific experiment. He will thus form an accurate and comprehensive idea of the physical strength of this *dipterous proboscidian*, according to this highly philosophical theory which has stood "unshaken" for hundreds if not thousands of years!

Applying the same data to the sound of the *locust*, which permeates *four cubic miles* of air instead of that contained in an ordinary bedroom, the reader at once sees the almost infinitely ridiculous and tantalizing character of the result. Yet, as preposterous as it is, it is no more so than the wave-theory, which furnishes the undeniable basis for the calculation. Professor Mayer's estimate, based on the important discovery which he announces, namely, that sound compresses one half of the wave enough to add "$\frac{1}{679}$" to the normal "density" of the atmosphere, only puts the physical strength of this insect at the modest amount of *five thousand million tons;* whereas the calculation of Professor Tyndall, based on the estimated heat which this pressure must necessarily generate to meet the requirements of Laplace, throws these figures utterly into the shade, making the physical energy of the locust equal to 132,566,207,938,560,000 pounds, or, in round numbers, 66,000,000,000,000 tons, being exactly *thirteen thousand two hundred and fifty-six* times greater in mechanical effect than the estimate of

his American collaborator! These learned physicists can settle the matter between them.

But here I imagine the reader saying: "Although you have shown from the highest authorities that the compressed half of the atmosphere through which a sound passes is really *raised in temperature*, according to the wave-hypothesis, *by the squeezing of the air-particles together;* and although you have proved beyond question that this theory teaches as one of its fundamental principles that the heat thus generated is necessary to make up the discrepancy of 174 feet a second in the calculated velocity of sound, as discovered by Sir Isaac Newton; and notwithstanding you have shown from Professor Tyndall that where the atmosphere is warmed in a mass, as by the action of the sun, it requires one degree centigrade for every two feet velocity added, or 87 degrees for this deficit of 174 feet;—still, are you not mistaken about applying the same ratio of augmented heat to the compressed half of the sound-wave? Is it not possible that a much less elevation of temperature than 87 degrees would suffice for heating these condensations, and making good this deficiency, according to the formula of Laplace and the solution of the problem as expounded by Professor Tyndall?"

I am willing, for the sake of the argument, to concede the possible correctness of this objection, and to agree that Professor Tyndall does not say that the same degree of augmentation is requisite in both cases. Yet reason certainly tells us that if there is any difference at all, the compressed half of the sound-wave should require the greater augmentation of heat to affect this 174 feet velocity, since it is always found in close juxtaposition with a chilled "rarefaction," which Professor Tyndall assures us is just as much *colder* than the normal atmosphere as the "condensation" is *hotter!*

The bare fact that this learned scientist, in all this discussion of Laplace's solution, occupying some eight or ten pages of his book, does not say a single word as to how many degrees of heat these condensations generate which adds 174 feet a second to the velocity of sound, in connection with the important consideration that he distinctly teaches in other places that the air, if heated by the sun, would require 87 degrees centigrade to make up this deficit of 174 feet a second, is a sufficient proof to every fair-minded man that he intended the reader to understand—if he knew himself, and if he intended to convey any definite idea on the subject—that the amounts of heat requisite for a given augmentation of velocity would be the same in both cases, or otherwise he would have pointed out the difference between them. Will not the intelligent judgment of every unbiassed physicist acquiesce in this as the only logical conclusion? On the supposition that Professor Tyndall really possessed the knowledge, the fact of his silence on this vital question as to the exact amount of heat generated in the compressed half of a sound-wave can be only accounted for on the ground that he wished and expected us to understand that the "condensation" required the same augmentation of heat by pressure to add 174 feet a second that the entire atmosphere would require if heated by the sun, as he had so fully explained in other places.

But I am willing to be accommodating to any reasonable extent, since I feel entirely able to make any concessions which a candid physicist would be willing to ask, and still annihilate this preposterous formula of Laplace, so conspicuously put forward and advocated by Professor Tyndall

as lying at the foundation of the wave-theory, since without these "condensations and their associated rarefactions," with their resultant heat and cold, he frequently gives us to understand that sound-waves could not exist.

I am therefore ready to suppose that instead of the compressed portion of the sound-wave being raised in temperature 87 degrees with a squeezing force of 255 pounds to the cubic inch in order to add this required 174 feet velocity, it is only necessary that it should be raised *one* degree! I wonder if Professor Tyndall and my doubting reader would be satisfied with this reduction? If not, no philosopher shall excel me in scientific liberality, and I will therefore concede, to oblige this hypothesis, that the augmentation of heat in the compressed half of the wave, which adds "one sixth" to the velocity of sound, instead of being 87 degrees, as it ought to be, is *but the one millionth part of one degree!* Will this be sufficient? If Professor Tyndall were present and should require it, I would gladly reduce it still further, for I am certain that any possible reduction he would be willing to ask, as a physicist, would still make the solution altogether too *hot* for the wave-theory!

On this new basis, then, that the *one millionth part of one degree* is all the heat there is contemplated in this famed solution of Laplace, and all the heat there is generated in these boasted "condensations" of the wave-theory of sound, and that this almost inconceivably minute augmentation was all Professor Tyndall had in his mind as being sufficient to add "one sixth," or 174 feet a second, to the velocity of sound (which is entirely insupposable on its very face), and we still find, by incontrovertible figures, that the locust exerts on the atmosphere permeated by its sound a mechanical pressure of *seven hundred and fifty-eight thousand tons*, or a physical force equal to that of all the locomotives in the United States! Are physicists ready to accept this absolute showing of the wave-theory after thus modifying the true calculation which the hypothesis warrants, by *eighty-seven million subdivisions?*

All these calculations, as before intimated, are based on the mechanical experiment of generating heat by compressing the air in a tube when so confined that its mobility can not come into play. If I should assert that the same movement of the piston which generates five degrees of heat in the atmosphere of the tube, would not, if made in the open air, produce the thousandth part of one degree in augmentation, or one 5,000th part as much, owing to the mobility of the atmosphere and its freedom to get out of the way and thus escape compression, I would only assert what the intuition of every physicist would indorse as undeniably true. If this is a correct representation of the matter, then it follows that the foregoing calculations present less than *the one five thousandth part of the actual absurdity of the wave-theory!*

These are not misrepresentations, nor are they even exaggerations of this unfortunate hypothesis. Taking any of the assumed facts put forward and relied on by physicists as fundamental to this theory, and it is almost impossible, using them as a basis of calculation, to draw any deductions or employ any figures which will exaggerate the incongruity of the hypothesis. It is therefore extremely difficult to do the theory injustice, say what you will about it, for, when looked at in the light of reason and with the slightest respect for the laws of mechanics or the relation subsisting between mathematics and philosophy, the supposition that an insignificant insect, *by moving its legs in the free air*,

can actually produce such an atmospheric compression as to generate any appreciable heat at all, even an inch around it, to say nothing of so augmenting the temperature throughout four cubic miles as to add 174 feet a second to the velocity of sound, becomes too infinitely ridiculous and insane a supposition to admit of being discussed with any degree of patience. Yet, under the circumstances, I have tried to keep cool even while battling with such a scientific monstrosity, since the theory has to be discussed and its foundationless character pointed out, owing to the fact that it is advocated as science by every physicist who has written on the subject, taught as science in our schools and colleges, and is honestly believed in as science by the ablest and most scrutinizing intellects of the world. Still, with all my efforts to the contrary, when seriously controverting such Mother-Goose nonsense under the disguise of natural philosophy, I can not help feeling at times an indefinable sensation of disgust mingled with astonishment. I shall nevertheless continue on in the work of fighting as one that beateth the air, perhaps as much to the disgust of modern physicists as to myself. For the reader must be aware, unless I have been guilty of the most deliberate and barefaced falsification of the eminent authorities from whom I have quoted (a question admitting of easy verification or disproof), that there is no possible way for them to escape the merited condemnation and even ridicule of future scientists except by publicly acknowledging themselves mistaken, and thus summarily renouncing one of the most transparent fallacies ever taught as science.

Conclusive, however, as have been the foregoing arguments, they will be more than paralleled in effectiveness by those soon to follow,—showing that in numberless ways, and viewed from every conceivable standpoint, the same uniform impossibilities come to the surface. It is not possible, in fact, to look at this fundamental idea of the wave-theory, namely, that a sound-pulse is constituted of an atmospheric "condensation and rarefaction,"—an assumption, by the way, on which the entire hypothesis hinges,—without seeing "absurdity" written all over it.

As one illustration of what I have just said, I would name the fact that Professor Tyndall distinctly though unwittingly teaches, as the necessary result of such a "condensation and rarefaction," that *two unison sounds must travel together with considerably greater velocity than either one of them would travel alone!* He teaches this, as I will now demonstrate, because the very idea of a sound-wave, constituted of a *condensation* and *rarefaction* of the air, involves it; and as both Professors Tyndall and Helmholtz tell us that the only sound-wave possible to exist consists in this *condensation* and *rarefaction* of the atmosphere, as already quoted (see page 125), it follows that the above palpable contradiction of the observed velocity of sound turns out to be a feature essential to the existence of the wave-theory. Let us now examine the evidence on which my position is based.

In the first place, Professor Tyndall tells us that two unison sounds traveling together, with their waves *coinciding*, must positively *quadruple* their *loudness* by quadrupling their *condensations* and *rarefactions;* and by thus making these characteristics *fourfold*, they quadruple the amount of *heat* generated in the compressed portion of the wave as well as quadruple the amount of cold developed in the rarefied portion. And as I have already shown, from both Professor Tyndall and Laplace, that an ordinary sound generates, by con-

densing the air, *heat* enough to add 174 feet a second to its velocity, then, evidently, if two sounds together produce *four times the loudness* and *four times the condensation* or *compression* of the air, it must generate four times the amount of *heat* and *cold*, and consequently must add *four times* this augmentation of velocity, or, in other words, must add four times 174 feet per second! Is not this unavoidable?—that is, if Professor Tyndall teaches, as I have asserted, that two unison sounds produce four times the *condensation* of the air that one does?

I now invite the reader to the proof, which is too plain to be misunderstood:—

"It is easy to see that the forks may so vibrate that the *condensations* of the one shall *coincide* with the *condensations* of the other, and the *rarefactions* of the one with the *rarefactions* of the other. If this is the case, the two forks will assist each other. The *condensations* will in fact become *more condensed* and the *rarefactions* more *rarefied*, and as it is upon the difference of *density* between the condensation and rarefaction that *loudness depends*, the two forks, thus supporting each other, will produce a sound of greater intensity than that of either of them vibrating alone."—*Lectures on Sound*, p. 258.

This, as far as it goes, is exceedingly concise and to the point. What it lacks in positive proof will soon be supplied. Mark, however, the teaching of this citation. Two unison sounds traveling together, so that *condensations* coincide with *condensations* and *rarefactions* coincide with *rarefactions*, not only make the condensations "more condensed" and the rarefactions "more rarefied," but the "loudness" is thereby increased in the same proportion, since "*it is upon the difference of density . . . that loudness depends.*" But how much is this "loudness" and "density" increased by two systems of waves thus coinciding? Professor Tyndall shall answer:—

"If in two systems of sonorous waves *condensation coincides* with *condensation* and *rarefaction* with *rarefaction*, the sound produced by such coincidence is *louder* than that produced by either system taken singly."—"If the two sounds be of the *same intensity, their coincidence produces a sound of four times the intensity of either.*"—*Lectures on Sound*, pp. 284, 285.

Hence, we have here the conclusive proof of my position, namely, that two sounds traveling together, with their waves coinciding, must necessarily produce *fourfold* the *condensation* of either traveling alone, since the Professor distinctly tells us that the *loudness* or *intensity* of the sound is quadrupled, while at the same time assuring us that it is upon the *difference of density* that *loudness* depends. Now, as the heat generated by these condensations is exactly in proportion to the "density" or *compression* of the air, as all physicists agree, and since the augmentation of velocity, according to Laplace, by which 174 feet a second is added to the speed of sound, is caused by the *heat* generated in these condensations, it follows irresistibly that since the *loudness*, the *density*, and the *heat* must all be quadrupled, this augmentation of velocity (174 feet a second) must also be quadrupled, making this added velocity on account of two sounds traveling together 4 times 174, or 696 feet, which, added to Newton's calculated velocity (916 feet), actually makes the velocity of the two sounds united 1612 feet a second at the freezing temperature, instead of 1090 feet, as all observation proves! These are figures which will neither *lie* nor *contradict* themselves, whatever the wave-theory may be in the habit of doing.

Thus, it unanswerably follows, if these *condensations* and *rarefactions*, being the very foundation of the wave-theory, really exist at all, that two sounds coinciding must necessarily travel together 522 feet a second faster than either sound can travel singly! But since all observation shows that there is not the slightest difference in

the velocity of sound, whether a single tone or a dozen tones pass through the air at one time, it demonstrates that no such thing as *condensations* and *rarefactions* occurs in the propagation of sound, thus shattering in another way the very foundation of the theory. Is it possible that any inductive course of reasoning can be more logically clear and demonstrative?

It would really seem that a physicist of such reputed caution in his investigations of science as Professor Tyndall, and who has so often helped other people out of scientific pitfalls and quagmires, would have been able to detect the monstrous character of the fallacy into which he has here inadvertently slipped. One would have thought that so shrewd a scientific thinker, when formulating this proportionate relationship between the "density" of the air, the loudness of tone, the generation of heat by these condensations, and the augmentation of velocity by this heat, all directly connected together and dependent the one upon the other, would have seen their suicidal effect just pointed out, by the very mental effort required to put the erroneous proposition into form. The very fact that he did not detect the self-annihilating character of the hypothesis while writing it out, preparatory to his lecture, only goes to illustrate the blinding effect of a false theory even on the greatest of intellects.

But we have not yet reached the culmination of this error, nor have we even begun to unfold its astonishing results. Even Professor Tyndall can hardly help being amused at the laughable predicament in which his logic has involved the wave-theory. Let the reader carefully follow me for a little, and see some of the beautiful scientific consequences of this hypothesis which has stood unshaken for so many centuries.

As it is upon the *difference of "density"* that "*loudness depends,*" (see last quotations,) it follows that just in proportion as the loudness of a tone increases, exactly in that proportion will the air-waves be condensed, exactly in that proportion will the heat be augmented, and exactly in that proportion will the velocity of the sound be augmented. No one can doubt this as being the unavoidable teaching of the theory when its different members are articulated.

Take, for example, a tuning-fork, as possessing a remarkable diversity in range of intensity,—from almost inaudibility, as when held in the hand, to a tone at least of *a hundred times the loudness* when placed on its resonant case, as any acoustician will admit, since it can be heard at a hundred times the distance.

Now, as the fundamental law of the theory assures us that the faintest tone of this fork, as when held in the hand, must necessarily generate sufficient heat by compressing the air to add the required 174 feet a second, or otherwise the velocity of its sound would not conform to observation, it follows that its full tone on its resonant case, if a hundredfold in loudness, must generate one hundred times as much heat by producing one hundred times as much "*compression*" or "*density*" of the air, which unavoidably leads to the conclusion that such a tone must receive one hundred times this additional augmentation of velocity, or, in other words, must have added 100 times 174 feet a second to its normal velocity of 916 feet, as calculated by Newton when no generated heat is included in the estimate, making such aggregate velocity 18,316 feet per second! Any tyro in mathematics can verify this computation by merely passing these figures in review.

What, now, can physicists say in reply

to this *reductio ad absurdum?* If they admit that one hundred times the *loudness* is caused by one hundred times the "*density*" or compression of the air, as they are forced to do, since "it is upon the difference of *density* that *loudness* depends," then, as the amount of heat generated also depends on the amount of this density or compression of the air, the same as the amount of added velocity depends upon the amount of heat generated, there seems to be no possible escape from the foregoing general conclusion, namely, that the velocity of sound must increase exactly in the ratio of its loudness, which flatly contradicts observation! A startling illustration of this fallacy will be adduced at the close of the next chapter, furnishing a demonstrative overthrow of the wave-hypothesis, which no man can gainsay.

But even this logical example of *reductio ad absurdum* is but a small fraction of the trouble in which these physicists have involved themselves and their theory by attempting to build upon this fundamental error of "condensations and rarefactions," and in assuming to utilize their hypothetic heat and cold to get rid of Newton's tantalizing discrepancy. I have another legitimate and irresistible deduction to make from this foundation-law of the theory which must settle even Professor Tyndall, unless the figures already adduced on the stridulation of the locust have paralyzed his mathematical and mechanical susceptibilities.

The reader must not for a moment lose sight of the fact, during the progress of the argument, that this physicist distinctly tells us, and repeats it in many forms, that it is upon the difference of "*density*," or the *compression* of the air by a sound-wave, "that *loudness depends*," and that it must be also upon this same difference in "density" that the generation of heat and the consequent augmentation of velocity depend. If the augmentation of velocity is caused, as the theory teaches, by the augmentation of heat generated by the condensation of the sound-wave, on which *loudness* depends, does it not necessarily follow that the augmentation of velocity and the loudness of sound must keep up a corresponding ratio of increase or decrease? This must be so, or else there is not the least foundation for the formula of Laplace, and no truth in the hypothetic *condensations* of the air and their resultant *heat*, as assumed by Professor Tyndall. But if the augmentation of *velocity* corresponds to the augmentation of *heat*, as Laplace and Tyndall assume, and if the augmentation of *heat* corresponds to the increase of *density*, on which *loudness* also depends, then evidently the various augmentations form a logical chain from one to the other which can not be broken without severing the wave-theory from its base. This relationship being unavoidable, if there is any truth in the assumption of "condensations and rarefactions" and their resultant heat and cold, it is impossible to ignore the conclusion that the velocity of every sound must exactly correspond with its intensity, or, in other words, must increase or decrease with its loudness. Hence, we are brought to the most astounding development of the wave-theory, namely, that since the loudness of sound decreases as the square of the distance from its source, as Professor Tyndall assures us, its velocity must also decrease in like proportion!

I now propose to let this high authority on sound state this ratio of decrease in loudness in his own way, which must necessarily give the corresponding decrease in the condensation produced by the sound-wave, in the heat produced by the condensation, and in the augmentation of

velocity produced by the heat, after which it will take but a few moments to point out the fatal effect of his figures. I quote, as usual, from his *Lectures on Sound*:—

"You have, I doubt not, a clear mental picture of the propagation of the sound from our exploding balloon through the surrounding air. The *wave of sound expands on all sides*, the motion produced by the explosion being thus diffused over a continually augmenting mass of air. It is perfectly manifest that this can not occur without an *enfeeblement of the motion*. Take the case of a shell of air of a certain thickness with a *radius of one foot*, reckoned from the centre of explosion. A shell of air of the same thickness, but of *two feet radius*, will contain *four times the quantity of matter;* if its radius be *three feet* it will contain *nine times the quantity of matter;* if *four feet* it will contain *sixteen times the quantity of matter*, and so on. Thus the quantity of matter set in motion augments *as the square of the distance* from the centre of the explosion. The *intensity* or *loudness* of sound *diminishes in the same proportion*."—*Lectures on Sound*, p. 10.

The above can not be misunderstood. The loudness of any tone four feet from the sounding body, according to this law, is but *one sixteenth* as great as directly at the sounding body. Hence, the "density" or "condensation" of the air, and the generation of heat, as well as the resultant augmentation of velocity, are all reduced in the same ratio. This is perfectly manifest, since the augmentation of velocity depends upon the amount of generated heat, the heat depends upon the amount of compression or "density," while "it is upon the difference of *density* that loudness depends." Now, all we have to do is to estimate the decrease in loudness by this same ratio, "as the square of the distance" from the sounding body to the limit of audibility in case of any sound, and we can determine the exact difference in its "condensation" of the air at its start and at its termination, since the decrease in "density" corresponds exactly to the decrease in "loudness;"—we can also determine the exact difference in the amount of heat it generates at its start and also at its extreme limit of audibility, because the ratio of decrease in heat depends upon the ratio of decrease in compression;—and finally, we can also determine the exact difference between the velocity of any sound at its start and at its point of final inaudibility, because the decrease in augmented velocity depends on the decrease in augmented heat, exactly the same as heat depends on the *compression* of the air-wave, or as loudness depends on this "density"!

These premises and conclusions are as immovable (assuming the truth of the wave-theory) as the principles and laws demonstrated by the Copernican System of Astronomy; and, on the supposition that the wave-hypothesis is true, the above chain of ratios must hold good in all its details. Let us now apply this self-evident logic of the theory to the well-known velocity of sound, and see its annihilating result.

According to this law laid down by Professor Tyndall, a sound, after passing a distance of 100 feet from the sounding body, would have but one 10,000th the intensity or loudness as at its source, since you have simply to multiply 100 or any other number by itself, the same as Professor Tyndall multiplied 4 by itself in order to determine this ratio of decrease for any distance. It follows, therefore, if Professor Tyndall is right, that the steam siren (employed along the coast in our signal service), which can be easily heard at sea a distance of ten miles, or 52,800 feet, when the conditions of the atmosphere are favorable, would actually possess, in round numbers, but the one 2,000,000,000th as much intensity or *loudness* at a distance of ten miles as at the start! Using Professor Tyndall's measure of "*feet*," as he

does, in ascertaining the ratio of this sound's decrease (which we must do, of course, when such high authority prescribes it), we have only to multiply the 52,800 feet into themselves to determine this proportion of decrease in intensity, as the square of the distance from the source of the sound, thus obtaining the infinitely incredible if not preposterous result demonstrated above. But, for the present, let us accept these figures as correct, since they legitimately belong to the wave-theory, and see what they will do for the hypothesis.

Since the sound of the steam siren at a distance of ten miles must necessarily have, according to the above ratio, but the one 2,000,000,000th as much "*loudness*," it can accordingly generate but the one 2,000,000,000th as much *heat*, since the *heat* and the *loudness* alike depend on the "density" or the *compression* of the air, and must therefore exactly correspond to it in these respects and to each other. And, finally, the sound at that distance would receive but the one 2,000,000,000th as much augmentation of *velocity*, according to Laplace, on account of this reduced augmentation of *heat*, as at its source, where it is, of course, 2,000,000,000 times as loud, causing 2,000,000,000 times as much density or compression of the air, and consequently generating 2,000,000,000 times as much heat! Are physicists prepared for this?

Possibly, if I should invert this statement of the problem, beginning ten miles away from the steam siren, and then trace the sound backward toward its source by applying the same law to find the *increase* by which Professor Tyndall determines the *decrease*, since they are evidently the same in ratio "as the square of the distance," it might be possible to make the infinite audacity and nonsense of the wave-theory more intelligible to these astute physicists whom I have the honor of reviewing. Let us look at it in this light for a moment, and note the consequences.

At the extreme limit of the ten miles we will suppose, as we are of course obliged to do to accommodate this hypothesis, that the sound of the siren, being still distinctly heard, must necessarily produce *sufficient condensation* of the air to generate *sufficient heat* to add this required 174 feet a second to its velocity, or otherwise the sound would not travel according to observation; and, what is worse than that, it would contradict Professor Tyndall and overthrow the formula of Laplace which accounts for "one sixth" of the velocity of sound, or 174 feet a second, by this generation of heat.

If, then, the sound, ten miles away from the siren, still generates *heat* enough to add this 174 feet a second to its velocity, which it must do if there is any truth in the wave-theory, it follows, as a self-evident proposition, since the sound increases in loudness as we trace it backward toward its source by Professor Tyndall's law, "as the square of the distance," that it increases in its augmentation of *heat* and *velocity* in the same proportion!

There is no escape from this, for we can almost use the Professor's own words, and say: At 2 feet from this ten-mile limit, passing toward the siren, the sound is 4 times as loud; at 3 feet it is 9 times as loud; at 4 feet it is 16 times as loud; at 10 feet it is 100 times as loud; at 100 feet it is 10,000 times as loud; and at 1,000 feet it is, of course, 1,000,000 times as loud. Yet 1,000 feet nearer the siren, at such a remote station (less than the *fiftieth* of the distance) would evidently not make a difference in the loudness of the sound which could hardly be detected by the most sensitive ear, though Professor Tyndall's

highly scientific (!) formula makes the sound increase to *one million times the intensity* in this comparatively trifling space! Can a theory be worthy of this enlightened age, or make any claim upon the intelligence of the reader as a scientific hypothesis, which depends for its existence on the inculcation of such a monstrous fallacy of science as this ratio of decrease in sound, gravely formulated by this eminent physicist?

But continuing to trace the increasing sound backward toward the siren, we not only have it 1,000,000 times as loud, according to this brilliantly formulated ratio, when we have gone only 1,000 feet nearer to the source of the sound, but, as shown when pointing out the proportion of decrease as we receded from the siren, the sound unavoidably becomes 2,000,000,000 times as loud directly at the instrument as it is ten miles away. Then it necessarily follows that it must produce 2,000,000,000 times as much *compression* or "*density*" of the air at the instrument (since "it is upon the difference of *density* that *loudness* depends,") as it does ten miles away,—that it must generate 2,000,000,000 times as much *heat* at the instrument as it does ten miles away; and, finally, that the augmentation of velocity caused by such generated heat, according to the hypothesis of Laplace, must be 2,000,000,000 times as great at the instrument, or, in other words, it must produce an augmentation of 2,000,000,000,000 times 174 feet a second, which, independent of the normal velocity without heat (916 feet), absolutely makes the velocity of sound as it leaves the mouth of the steam siren, 348,000,000,000 feet, or 66,000,000 miles a second, *being more than three hundred and forty-seven times the velocity of light!* Are physicists prepared for this? Whether they are or not, it is the unexaggerated teaching of the wave-theory, to which Professor Tyndall is irrevocably committed by his ratio of the increase or decrease of loudness as the square of the distance from the sounding body.

No man who accepts the current hypothesis of sound as expounded by Professors Tyndall, Helmholtz, and Mayer, and in fact all who have written on the subject, can call in question the legitimacy or logical necessity of the results just arrived at, or deny but that they are the unavoidable outgrowths of the wave-theory. However fabulous the foregoing array of figures may seem, we are nevertheless obliged to accept it as representing the well-authenticated facts of philosophy and science so long as the current hypothesis of sound is looked upon and permitted to exist as a scientific theory. Shall it continue to be so looked upon and be so permitted to exist? is the important question here submitted for the decision of the scientific world.

At this juncture of the discussion an opportunity offers, which, perhaps, may not so readily occur again, for a brief exposition of the new hypothesis of Substantial Sonorous Pulses, in order to show how beautifully and consistently it solves this problem of the decrease of intensity in Sound, Light, and Heat, as the true square of the distance from their source.

This conception that sound consists of substantial corpuscles instead of being constituted of the undulatory motions of the *medium* through which it passes, was fully elucidated in the discussion of sonorous reflection and the falling pitch of a passing locomotive-whistle at pages 117, 122, 123, 124.

According to the views there presented, it is but a simple matter to mentally view the particles of sonorous substance radiating from a sounding body in all directions

becoming less and less in number, or, in other words, becoming sparcer and sparcer the farther they advance, as the square of the distance from the center. Neither is there any necessity for supposing that such sound-atoms cease in their travel or retard in their velocity in the slightest degree when they cease to be audible, or, in fact, until they reach the extreme limits of the medium which conducts them. But as it requires a certain quantity or number of these particles to come into contact with the tympanic membrane in order to affect audition, it rationally follows that the *range* of a sound, or the distance at which it can be heard from its source, depends upon the density or number of these particles generated and set free by the sonorific body, or, in other words, depends on the compactness or nearness together of these sonorous particles at the commencement of their radiation, which also necessarily determines their comparative nearness together at any particular distance from their source.

It is perfectly evident, if sound consists of substantial corpuscles, as my hypothesis assumes, that a feeble sound at the start must be such because the sound-particles generated are few in number and consequently scattering, so that but a small number can enter the aural passage even when the ear is held near the sounding body; whereas, a loud sound at the commencement, or near the sound-producing instrument, is exactly the converse of this: the sonorous particles are densely compacted because a greater quantity is generated, owing to the molecular action which produces them being more effective or productive; and hence, in radiating and separating as the square of the distance from their source, they can necessarily pass to a considerable distance without being sufficiently thinned out or separated to appreciably weaken their effect on the sensitive membrane of the ear.

But carrying the idea still further, the most densely compacted mass of sound-corpuscles which may be supposed to collect about the mouth of a powerful steam siren will nevertheless, at the proper distance from it, produce a feeble tone, owing to the particles becoming so sparce or widely separated that but few of them can enter the ear at one time, and can thus produce but slight effect upon the tympanic membrane,—till finally, at a sufficient distance from their source, the particles will necessarily have become so separated and distributed over the continually augmenting mass of air that even if the auricular passage is not missed entirely a sufficient number can not enter it to affect audition, unless they should be converged into the ear by some kind of a funnel-shaped device such as an ear-trumpet. (See page 123.) Notwithstanding this extreme limit of audibility and apparent termination of the sound, it is easy conceiving, as every way probable, that all the original corpuscles, which produced such an intense effect near the instrument, may, as just remarked, continue to pursue their course through the air at their normal velocity, still more widely separating as the square of the distance, and not cease their journey till they have reached the extreme limits of the atmosphere.

This corpuscular hypothesis involves even more than has yet been explained. In addition to this weakening of the intensity of sound as the distance increases from its source, in consequence of the sonorous particles becoming sparcer or scattered by radiation over a wider and wider range of atmosphere, it is even conceivable that the corpuscles themselves may be larger or more massive in one case than in another, and that each sound-

particle may itself be susceptible of becoming subdivided almost to infinity by giving off scintillations of its sonorous substance in all directions while passing through the air, the same as meteors have often been seen to do.

Thus, a feeble sound at the start, as in the tone of a *mosquito* or of a *bee*, may depend for its extreme faintness on the finer or smaller grade of sonorous corpuscles thus generated as well as on their fewness in number, which, supposing the corpuscular hypothesis true, would seem to be not only probable but reasonable.

Added to this, I have no hesitancy in believing that as a sound-pulse advances the gradual weakening of its tone (instead of being a less and less *motion of the air* as the wave-theory teaches, and which has been shown to be infinitely impossible by the singing of a locust,) may be and probably is due to the decrease in size as well as number of the sonorous atoms which constitute the sound and enter the ear.

I may even assume, in connection with the secondary or scintillating radiations of which I have spoken, the rational probability that the primary streams of sound-corpuscles as they leave the instrument may even emit a number of delicate secondary systems of sonorous particles in periodic pulses of distinctly different and *more rapid* vibratory rates, each system maintaining at the same time a relative concordant periodicity to the primary system of corpuscles,—while two instruments sounding together in the relation of some proper chord, as *third* or *fifth*, might even generate another and independent system of periodic pulses of a *slower vibratory rate* than either of the primary systems! This may not at present be intelligible to the reader, but I throw out the bare statement of the hypothesis here, as I shall revert to it before the close of this chapter in connection with another feature of the wave-theory which will beautifully illustrate what is here but darkly hinted. I hope, therefore, in view of its important future application that the reader will carefully re-peruse this paragraph before passing on, that it may be well impressed on the memory. I will only add here, if it be true at all that sound is constituted of substantial sonorous particles, then the secondary systems of radiating corpuscles, which I have assumed, if needed to explain the various phenomena of sound, would be neither insupposable nor improbable.

The truth is, the novelty of the corpuscular hypothesis constitutes the principal objection to its acceptance. We have been so constantly through life habituated to consider nothing as substance unless corporeally tangible that the mind naturally hesitates in conceding the substantivity of anything which eludes the senses as palpable material, or which will not submit to chemical analysis. But the world is growing, and despite the efforts of would-be science to keep it in its swaddling-clothes, seems destined to grow on till its present scientific raiment shall not only have become too small for it, but shall have also become so ludicrously threadbare and rent that true philosophy and science will be ashamed to look upon its semi-nudeness. In view of this encouraging tendency of the world to grow instead of retrograde, the writer proposes in a humble way not only to add what he can to the fertilizing and fructifying elements which may tend to accelerate its growth, but to lend a sartorial hand from time to time in helping to replenish its now scanty and tattered scientific wardrobe.

Returning to the assumption of sonorous corpuscles as the true solution of sound-

propagation, it is easy to conceive the idea that at ten miles away from the steam siren, for example, we hear its sound faintly, not only because the sound-particles have become so scattered that only a few of them can enter the ear, but also because what few of them do enter have become so reduced in size by the constant emission of secondary radiations during their journey that they make but a slight impression on the tympanic membrane,—while we also hear the sound of the *gnat*, at a distance of only *six inches* from it, on precisely the same principle and for the same reason. In both cases the number and size of the sound-corpuscles, coming in contact with the sensitive membrane of the ear, determine the intensity of the tone; and the reason why we hear the sound of the *midge* as feebly at a distance of six inches as we do that of a *steam siren* at a distance of ten miles, is because the midge generates sonorous particles in number and size as much less than those produced by the siren as six inches are less than ten miles! Can any hypothetic solution of a scientific problem be more beautifully simple and consistent than this? And does not this view of sonorous propagation appeal for its probable correctness to the intelligence and scientific intuition of the reader? By the side of it, viewed only as a provisional hypothesis, I venture to assert that the supposition of an all-pervading *ether* as being a real substance circulating freely among the molecules of the diamond, which is now universally accepted by scientists, would be at once rejected as improbable were the two hypotheses submitted with their claims side by side to a competent and judicial scientific mind,—that is, on the supposition that both were equally novel. While this hypothetic *ether* is admittedly not known to exist by any scientific experiment or chemical process, it is at the same time wholly useless in Nature and in science, since every phenomenon occurring in *light*, as shown in the fourth chapter of this book, can be more readily explained by supposing the light-corpuscles themselves, in being propagated through space, to take the form of *waves* or *pulses*, than to ignore their existence by substituting this secondary substance (luminiferous ether) to be thrown into undulations, which but duplicates the mystery rather than simplifying the problem.

Not so, however, with these hypothetic sound-corpuscles. Although it is true that they can not be demonstrated to exist by direct scientific experiment or chemical analysis any more than can this so-called *luminiferous ether*,—standing thus far on an equal footing,—yet, as has been abundantly shown, while they meet every conceivable difficulty encountered, they are the only imaginable means left for explaining sonorous generation and propagation if the wave-theory breaks down, as break down it must, and consequently without recognizing the presence of such substantial sonorous pulses sound-phenomena must forever go without solution. I do not think I shall be charged with undue self-confidence or egotism in expressing the conviction that during the preceding arguments air-waves have been demonstrably shown to be inadequate to meet this case or to account satisfactorily for the hearing of sound at a distance. I need only remind the reader, as a proof of this statement, of the astounding fact of an insect converting four cubic miles of air into "condensations and rarefactions," with sufficient heat generated by the motion of its legs to add "one sixth" to the velocity of sound,—requiring, as was mathematically shown, thousands of millions of tons pressure,—to justify all I can say as

to the utter insufficiency of the wave-hypothesis. Hence, the actual existence of substantial sonorous corpuscles, though of almost infinite tenuity, becomes a necessity of science, and thus solves the problems of sound generation and propagation by the exclusion of wave-motion, the only other conceivable hypothesis.

By the foregoing illustrations it can now be readily comprehended, on the supposition of a sound-pulse being constituted of substantial particles, how the entire range of the sound of a *gnat*, for example, may be confined within a single foot, though its sonorous corpuscles are radiated in the same manner, propagated at the same velocity, and governed by the same law of decrease in intensity, as are the sonorous discharges emitted from a steam siren. Both are controlled by the same law of decrease—as the square of the distance from the source—when properly understood. The sound-particles from the midge scatter and diffuse themselves throughout their limited range, becoming sparcer and sparcer, the same exactly as do those from the steam siren, while the intensity of its sound decreases from its greatest audibility to nothing within this trifling circumscription, just because the corpuscles being small in size and few in number become so reduced in bulk and widely separated within a single foot that a sufficient number can not concentrate within the aural passage to sensibly act on the auditory nerve.

In contrast with this simple and beautiful eclaircissement we have only to juxtaposit the wave-hypothesis by assuming that the tiny midge throws the air into physical waves constituted of "condensations and rarefactions," each one of which so compresses the air as to generate heat sufficient to add one sixth to the velocity of its sound, and the difference between the two solutions as to their probable correctness scarcely needs an argument.

Thus, while the beauty and consistency of this solution of sonorous propagation can hardly fail to meet the requirements of science, so far at least as beauty and consistency go, the new hypothesis also agrees admirably with other well-known natural phenomena resulting from the radiation and diffusion of substantial corpuscles, and in connection with which no kind of wave-motion of the air or of any other substance has ever been suggested.

Take, for example, a small rubber balloon filled with some kind of highly pungent odor, which, on being liberated in a still room of sufficient size, will furnish a complete illustration of the manner in which substantial sound-corpuscles may be supposed to radiate. Though controlled by a different law of conduction and traveling with a different velocity, yet the odor on being discharged will at once commence to propagate itself from particle to particle of the atmosphere and at considerable velocity, extending over a wider and wider range, and, as in the case of the diffusion of sonorous corpuscles, the fragrance will become less and less pungent as the square of the distance from the odorous center, growing weaker exactly in the ratio as the particles of the perfume scatter and become sparcer, by which means fewer fragrant corpuscles come into contact with the sensitive olfactory nerves.

Thus Nature has furnished us with a "mode of motion" which all science acknowledges to be constituted of real substantial corpuscles, though of such incomprehensible tenuity as to utterly baffle the imagination in attempting to conceive of them as substance at all, as was so fully illustrated by the hound and the fox. (See page 135.)

As intimated in another chapter, physicists have shown a want of shrewdness and business sagacity almost unparalleled in ever admitting odor to be a substantial entity, unless they wished to cripple the wave-theory of sound, since it is clearly susceptible of solution by means of some sort of hypothetic *odoriferous ether* which could easily have been invented, and which might assume the form of undulations as the air is drawn into the nostrils! What an oversight in physicists, that they did not think of it! There are really more good reasons, when we come to look at it, to be urged in favor of wave-motion in the case of odor than in the case of sound, since it is always connected with and accompanied by a rippling stream of air passing into the nose, whereas no such a plausible argument can be adduced in favor of undulations entering either the ear or the eye, since they have no basis in a stream of air or of any other substance moving along the aural passage, or pouring through the opening of the iris.

The radiations of sound-corpuscles and the decrease in loudness as the square of the distance from the sounding body, are governed by the same ratio precisely as shown in the case of *light*. In either case the decrease in intensity results from the same cause—the separation of the corpuscles over a wider and continually augmenting range of atmosphere. The reason why a carbon point, when intensely heated, as in a Drummond light, can be seen so much farther than the light of a candle-wick of the same size, is because the one generates a vastly greater number of luminous corpuscles than can be produced by the other, and possibly corpuscles of a larger size. And although the luminous atoms radiate in the same manner in all directions as do the corpuscles of sound, becoming sparcer and sparcer the farther they advance, according to this law,—*as the square of the distance from the source*,—yet the particles of light being more compact and vastly more numerous at the carbon point than at the candle-wick, it requires but the mental effort of a child to comprehend that at a definite distance—say a quarter of a mile away—the light of the candle might scarcely be visible, because its particles being fewer in number at the start would necessarily become more diffused and less in number in the space occupied by the eye, and consequently a less number of light-corpuscles would strike the retina; whereas the luminous atoms generated by the carbon point, being greater in number and more densely compact at the start are necessarily not so sparcely scattered at any single point a quarter of a mile distant, and hence a greater number would enter the eye and affect the retina at that station, and thereby cause the carbon light to appear the brighter. What possible solution of these wonderful phenomena, based on the undulatory movement of an all-pervading "*ether*," can be so beautifully consistent and clear?

But here a marked difference in the propagation of light and sound comes to the surface, which alone refutes the idea of both being wave-motion, even if one is, for the reason that the *waves of ether* and the *waves of air* should produce at least analogous results, since both are substances according to science, so called. Instead of being alike, their action is so obviously unlike and opposite that the judgment of every unbiassed mind, on observing the difference about to be pointed out, would at once decide that if one was wave-motion the other could not be.

I refer to the patent fact that sound can be heard even with one ear closed and the open ear turned directly away from the sounding body, and even when shielded

from it by a large obstructing surface like that of a building, though, of course, the sound is not so distinctly heard as if the ear opened directly toward the sonorific body and without any intervening impediment; whereas light can not swerve to the right or to the left the smallest fraction of an inch, and can not be seen at all, even in the slightest degree, unless it enters the eye in a *direct line* either from the luminous body or from some reflecting surface.

If *air-waves* can lap around the head and enter the ear on exactly the opposite side, then *ether-waves*—if there is such an all-pervading substance as *ether*, and if there is any truth in the undulatory theory of light—should do the same thing, and thus enable us to see a candle at a distance in a dark night with the back of the head turned directly toward it! The two results are thus so diametrically opposite that the supposed wave-motion of two perfectly analogous substances—*air* and *ether*—can not explain both.

Even in the case of sound it is impossible to account for the phenomena of hearing, when the ear is turned directly away from the sounding body, by the supposed dashing of air-waves, as is clearly shown in the case of water-waves, and the complete protection afforded against their effects behind a projecting rock even of small dimensions. By means of such a rock that portion of the wave striking it is utterly broken and destroyed; and if any agitation of the water takes place behind the rock it is not the original wave which laps around the rock at all, but an irregular secondary or resultant tremor caused by the crispations of the water to the right and left produced by the broken ends of the passing waves.

Sound, however, acts in no such a way, and therefore can not be the result of wave-motion. If the listener is screened by an impenetrable wall, for example, or a building, the sound passes around it and enters the ear in its perfect form both as to pitch and quality, being only reduced in intensity; and if it consists simply of air-waves, as the current theory teaches, then these waves, unlike those of water, can lap around the building, enter the ear at an exactly opposite direction, and retain their perfect form and outline, though broken, distorted, and stopped by the obstruction, which is clearly an impossibility.

This single fact that sound is perfectly unbroken or undistorted, retaining its quality and pitch absolutely when the listener is stationed directly behind an obstructing wall, while a water-wave is completely shattered and destroyed by an obstructing rock without any power of inflecting around it, alone condemns the atmospheric wave-theory of sound, since every physicist who has written on the subject tells us that water-waves and atmospheric sound-waves are *exactly alike.* I do not exaggerate by italicising the last two words of the preceding sentence. A single citation from Professor Helmholtz, the leading physical investigator of Germany, will fully sustain this assertion:—

"The *process in the air is essentially identical with that on the surface of water.* . . . The process which goes on in the atmospheric ocean about us is of a *precisely similar nature.* . . . The *waves of air* proceeding from a *sounding body* transport the tremor to the human ear *exactly in the same way as the water transports the tremor produced by the stone.*"—*Sensations of Tone*, pp. 14, 15.

Hence, as the action of a sound-pulse is thus proved to be entirely different from the action of a water-wave,—the one retaining its perfect form and symmetry after passing an obstruction, while the other is entirely broken and obliterated,—it becomes a scientific demonstration that sound is not constituted of air-waves at

all, nor propagated by means of them, since this highest living authority assures us that they are "essentially identical," "precisely similar," and act "exactly in the same way" as water-waves! This alone breaks down the wave-theory, if there was not another argument against it.

But the reader asks: "Does not this objection against the possibility of sound consisting of wave-motion, because it can inflect around an obstruction, militate with equal force against your own hypothesis of corpuscular emissions? If air-waves can not inflect, passing, for example, around a building, and thus enter an ear turned in an opposite direction, as would seem to be the case judging from the action of water-waves, how can sonorous corpuscles, radiating from a sounding body in straight lines, pass around a building and enter an ear under precisely similar circumstances?"

This would, at first sight, seem to be a serious objection to the corpuscular hypothesis; and, unless susceptible of being fairly explained, would be alone sufficient to condemn it.

While this perfect facility with which sound inflects, passing around intervening obstacles, necessarily overthrows the wave-theory,—based, as it is, on the undulations of a corporeal substance like our atmosphere, and acting in all respects like water-waves, I will now try to show that it does not necessarily break down nor even weaken the assumption of substantial sonorous discharges, constituted, as I assume, of radiating corpuscles.

It is easily conceivable that the particles of an incorporeal substance (if such substances can really exist, of which I have elsewhere given, as I consider, ample proof,) may not only radiate in direct lines, but, as recently intimated, may throw off secondary corpuscles in the form of scintillations, and that these again may radiate other and still lesser corpuscles, each system of which would be governed by the same law of diffusion and conduction, and thus travel through the conducting medium at a velocity exactly uniform with that of the primary corpuscles.

By means of such a subdivision of the original corpuscles of sound while they are being propagated through the air, with the secondary systems of lesser particles radiating in all conceivable directions, it is not only supposable and possible for such offshooting systems of corpuscular emissions to completely permeate the air on the opposite side of any obstructing object, but it rationally and philosophically accounts, at the same time, for the weakening of the intensity of sound under such circumstances, just about to the extent universally observed, while maintaining the pitch and quality of the fundamental tone unimpaired, as will be hereafter explained which can not be predicated of wave-motion with the undulations, which are supposed to give shape to the sound, broken and distorted as they necessarily must be after striking an impediment which crosses their path.

We can thus not only imagine the primary lines of corpuscles darting away from the sounding body in infinite numbers, but can mentally see each of these original particles becoming itself a separate center of sonorous radiation, and by thus watching its progress can see it continually emitting, as it travels through the air, these secondary systems of corpuscles, while these in turn give birth to a third, these to a fourth, and so on *ad infinitum* so far as human imagination can follow them! By these secondary systems of corpuscles generating other offshooting systems, each constituted of smaller and smaller particles and all succeeding each

other with such relative periodicity to the primary system of corpuscles as shall maintain the characteristic quality of the fundamental tone (to be fully explained at the close of this chapter), it is not at all difficult to see that the air may be permeated with sound throughout its most labyrinthian meanderings, the corpuscles passing by means of these succeeding secondary radiations over and around all kinds of obstructions, while, as before explained, the diminution of intensity would seem to exactly correspond to such superadded but constantly weakening corpuscular radiations.

Thus, while this hypothesis answers the purpose, fully accounting for the hearing of sound directly behind an obstructing wall, it remains an unanswerable fact that there is a spot in the water behind every obstructing rock of any considerable size at which no movement whatever of the interrupted waves can be perceived, even if we admit that such waves may partially lap around the rock and cause irregular crispations inside of the direct line of their course, which, as we see in the case of the supposed waves of *ether*, they can not and do not do in the slightest degree. Even, therefore, admitting this objection to be a possible difficulty in the way of the corpuscular theory, the weight of evidence is clearly against the wave-hypothesis, since the compound systems of radiating corpuscles will meet the case with a rational solution, while wave-motion will not meet it at all.

But the reader may ask, how about light? If sound can inflect and be heard distinctly behind an obstructing wall, why should not *light?* And why should any opaque body produce a shadow, since there can be no complete shadow in the case of sound? I answer that while my hypothesis of secondary corpuscular radiations explains the phenomena of sound, accounting satisfactorily for its power of inflection and its corresponding diminution of intensity after being thus inflected, *light* does not require any explanation of this kind at all. No solution of the sort is necessary, because light does not inflect, and therefore needs no solution on my theory to show why it does not. I have only to assume, as observation shows, that as a ray of light, passing through the air, is invisible at right angles, hence its corpuscles are devoid of secondary radiative power, and that this evidently is the reason why it can not bend around an obstructing body. While, therefore, I do not need to explain light at all, to adapt it to the hypothesis of corpuscular radiations, the wave-theory does need to explain both light and sound, since the action of sound, by inflecting without being distorted or marred, flatly contradicts wave-motion as seen in water, while light, by being devoid of inflective power, flatly contradicts sound, by showing that it can not be wave-motion if sound is. My solution of the difference between light and sound teaches that while sonorous corpuscles in passing through the atmosphere have this peculiar power of radiating secondary systems of corpuscular emissions, thus enabling sound to inflect and fill its proper place in the polity of Nature, light-corpuscles have no such radiative power, and do not need it, filling up their mission by their wonderful power of reflection. Hence, there is no inflection in the case of light. This natural difference between light and sound corpuscles is no more anomalous or surprising than the well-known fact that sound will freely pass through wood, which is entirely impervious to light, while both light and sound will pass through glass, which is a perfect bar to the corpuscles of electricity!

Before returning to the main question

I must not neglect to point out the superficiality, not to say absolute fallacy, of this *ratio of decrease* in sound-intensity, *as the square of the distance from its source*, laid down by Professor Tyndall, to which I have already incidentally referred, and on which the novel calculations recently made touching sound-velocity were based. But in exposing this fallacy and thus being obliged to show that this eminent physicist has unconsciously perpetrated one of the most glaring and astonishing scientific errors on record, it is nothing against him, individually considered, since every authority who has written on sound, light, or heat, including Professors Helmholtz and Mayer, assumes the same view and reasons from the same erroneous basis of calculation. It will take but a few paragraphs to expose and correct this fundamental error in science, assumed as it is in all works on natural philosophy, and thus show the reader what kind of so-called scientific information is being sown broadcast through the land for the enlightenment of our college students, and also to what kind of scientific instructors we are expected to look for accurate views of philosophy.

I now ask by what scientific authority does Professor Tyndall adopt "*feet*" *as the measure in estimating this ratio of decrease* in the loudness of sound? The reader has not forgotten his language, recently quoted. He says:—

> "If its radius be *three feet* it will contain *nine times* the quantity of matter; if *four feet* it will contain *sixteen times* the quantity of matter, and so on. . . . The *intensity or loudness of sound diminishes in the same proportion.*"

Why did not this careful physicist, if he is as careful as he is reputed to be, adopt *meters*, or *rods*, or *inches*, or *furlongs*, or *miles*, or *leagues*, as his *measure*, instead of "feet"? Possibly we shall find out the reason after a little. Had he employed *rods*, for example, as his *measure* for determining this decrease in loudness as the square of the distance from the sounding body, in the place of *feet*, we would find the sound of the steam siren at a distance of ten miles diminished in loudness only the one 10,000,000th instead of the one 2,000,000,000th, as recently seen to be the case when "feet" were employed as the measure; and would thus have approached just two hundred times nearer to the truth, since the supposition of any sound being distinctly audible after being reduced to the one 2,000,000,000th of its normal intensity, is so preposterous that it only needs to be stated to be refuted.

But suppose, instead of *feet* or *rods*, Professor Tyndall had accidentally stumbled upon *inches* as his measure, which, if he had made it the subject of thought at all, he had exactly the same right to adopt. His language would then have read like this:—

> "If its radius be three *inches* [from the center of the explosion] it will contain *nine times* the quantity of matter; if four *inches* it will contain *sixteen times* the quantity of matter, and so on. . . . The *intensity or loudness of sound diminishes in the same proportion.*"

It would really seem that had this scientist accidentally written *inches* instead of "*feet*," while preparing his lecture, he would have at once seen the infinite nonsense of the whole formula, and would thus have overthrown his ratio while he was writing it out.

Let us suppose the sound of the steam siren to diminish for ten miles as the square of the distance from the sounding body, and that we hold Professor Tyndall rigidly to the correctness of his mode of computing the ratio of proportionate decrease by compelling him to employ *inches* instead of "feet" as his measure. Then, instead of finding the sound at the ten-mile

station possessing the one 2,000,000,000th of its original intensity, as it nccessarily must have when "feet" are employed, it actually possesses but the one 400,000,000,000th as much intensity as at the start, or, in other words, it is but the one 200th as loud as it would be by adopting "feet" as the measure! Of course Professor Tyndall never thought of this, and I have no doubt the idea that it makes the least difference what measure is employed in determining this proportionate decrease in the intensity of sound, will be news to him! If it is not news to him, then he manifestly practiced an imposition upon his audience.

Now I will not here deny but that sound may diminish in loudness as the square of the distance from its source, under some sort of restricted measurement. But I ask, *As the square of what distance?* Surely not necessarily the same measure of distance employed in determining the quantity of air contained in a shell of a given thickness and at a given radius! Professor Tyndall sees no distinction here; but after correctly determining the quantity of matter in the various shells of air as the square of the distance, making it at 2 feet 4 times the quantity; at 3 feet 9 times the quantity; at 4 feet 16 times the quantity, "and so on," he adds: "*the intensity or loudness of sound diminishes in the same proportion.*" Yet we see by applying his measure of "feet" to the sound of the siren for a distance of ten miles we get one result, making the intensity decrease 2,000,000,000 times, while by applying *inches*, which we have the same right to do, we get an entirely different result, making the intensity decrease 400,000,000,000 times in the same distance! Surely both are not correct, while it is no doubt evident, even to Professor Tyndall by this time, that neither of them can be.

Perhaps we may aid this learned physicist by helping him to a simple rule for determining this ratio of decrease in the intensity of sound. In the first place, we may state it as a truism which no one will question, *that the measure to be employed in computing such proportional decrease in the intensity of particular sounds, if we estimate by the square of the distance at all, must always and of necessity vary exactly in proportion to the intensity of the different sounds at the start, or, in other words, as the range of the different sounds varies!*

Thus, for example, a very soft or feeble sound, though it may decrease according to this law, as the square of the distance from its source, till it becomes entirely inaudible, the same exactly as a loud sound diminishes, yet manifestly the measure to be employed in estimating its comparative decrease must be small in proportion to that of a loud sound. Instead of feet, meters, rods, or furlongs, in such a case it might require inches, quarter inches, or even lines, to get the proper result. Another sound of greater range, or of greater intensity at the start, might have its proportionate decrease in intensity approximately computed by employing "feet" as the measure,—while a very loud sound, such as that of the steam siren, having a range of ten miles, would evidently require a long measure to even approximate the true proportion. The superficiality, in a case of this kind, of using "feet" as the measure of computing the decrease, which Professor Tyndall makes alike applicable to the intensity of all sounds, without any discrimination, has been fully shown.

Let us now suppose the measure suitable for a sound having the range of the steam siren to be *half miles* instead of *feet* or *inches*. The statement of its ratio of decrease in loudness would then read some-

thing like this: At *two half miles* from the instrument the intensity of the sound would be but *one fourth* what it is as it leaves the siren; at *three half miles* the intensity would be but *one ninth;* at *four half miles* the intensity would be but *one sixteenth*, and so on; and at *twenty half miles* the intensity would have diminished, by such a measure of ratio, to *one four hundredth* of what it was at the start, which would manifestly approximate the correct proportion of decrease at that distance, instead of putting it at the preposterous reduction of one 2,000,000,000th of its original intensity, as the accidental measure of this eminent authority would necessarily make it.

I say *accidental*, because it is entirely certain, in reading his statement of this law governing such ratio of decrease in loudness "as the square of the distance," already quoted, that he had not the most remote idea that it would make any difference what measure was employed in computing such comparative decrease,—supposing, as any one can see by reading his statement, that the result would be exactly the same whether he used *miles*, *rods*, *feet*, or *inches*, or otherwise he would surely never have employed "feet" without some sort of qualification as to the range of the sound to be taken into account, thus committing himself, as he has done, to a fallacy in science of which he will be ashamed as long as he lives.

As a proof that this view of the matter is correct, it is evident if Professor Tyndall had been explaining the decrease in the intensity of light, as the square of the distance from the *sun*, he would never have used "feet" as the measure! Why? Because he would have intuitively felt, possibly without asking the reason why, that a mathematical progression based on so small a measure for such an enormous distance would have been simply ridiculous! Yet he tells us that,—

> "The action of *sound* thus illustrated is *exactly the same as that of light and radiant heat.* They, like sound, are wave-motions. Like sound they diffuse themselves in space, *diminishing in intensity according to the same law.*"—*Lectures on Sound*, p. 13.

In estimating the ratio of decrease in the intensity of the sun's light, as the square of the distance, this physicist would probably not think of using a less measure than *miles;* yet even this would be vastly too small to express the true ratio of decrease, as it would make the proportion of solar light on the earth but the one 9,000,000,000,000,000th of its intensity at the sun, which is an almost infinite exaggeration of the facts in the case. Instead of the measure for properly expressing this ratio being *miles*, if it were *million miles* it would be much more nearly correct, thus making the intensity of the sun's light on the earth but the one nine thousandth of what it actually is in contact with the photosphere of that luminary.

But the clearest demonstration of the superficiality of Professor Tyndall's use of "feet" in his ratio for determining the decrease in a sound's intensity (leaving us to infer that the same measure was applicable to all sounds) is the fact that *the entire range of many sounds is less than a foot!* The music of the midge, for example, as recently stated, is inaudible at the distance of a foot, though intensely audible if performed, as it often is, near the entrance to the auricular passage.

Now, this sound, like all others, decreases in loudness according to the same uniform law, call it "as the square of the distance from its source" if you like, to the extreme limit of its audibility, which it does as literally and truly as does the sound of a steam siren with its effective

range of ten miles. Yet how laughably absurd it would be to apply Professor Tyndall's measure of "feet" to the music of these ephemera! Let us try it: If the distance from the midge be *two feet the loudness of the sound will be one fourth;* if the distance be *three feet the loudness will be one ninth;* if the distance be *four feet the loudness will be one sixteenth, and so on!* Yet the sound entirely ceases within a single foot, and thus passes through all the gradations of decrease "as the square of the distance;" and even through a greater progression of diminution within this foot than the sound of the fog-horn passes through in a range of ten miles, since it is still distinctly heard at that distance! To employ "feet," therefore, in computing the ratio of decrease in the loudness of the sound of a *gnat* would be a measure about as much out of proportion one way as it would be enormously too small when applied to the sound of the *steam siren.* It is therefore manifestly evident that these beautiful distinctions, equally applicable to decrease in the intensity of sound, light, and heat, which seem so self-evident that a schoolboy who had used a slate and pencil for a single month ought to have noted them, never entered the mind of this eminent lecturer, who is quoted as standard authority in physical science all over the land, and whose works on sound, light, and heat are so eagerly sought for by scientific students among all nations that they have been already translated into the principal languages of Europe!

It is thus seen that the amplification of the wave-theory at every turn, even in the hands of its ablest exponents, necessitates the employment of laws, formulas, and ratios, which, when analyzed, are found not only to be pitiably insufficient, but completely subversive of undeniable facts of science and well-known principles of mechanics.

Though I have been thus forced into a digression from the main argument based on the supposition of 'condensations and rarefactions," in order to explain the corpuscular hypothesis, and also to correct Professor Tyndall's misapprehension as to the proportional diminution of sound-intensity, thus reducing the decrease in the sound of a steam siren from one 2,000,000,000th of its intensity, according to his ratio, to about one 400th, still it does not weaken the argument drawn from such diminution, by which I showed a corresponding decrease or increase in sound-velocity. It only brings the fatal effect of the heat hypothesis of Laplace within the comprehension of the mathematician. It still remains an unanswerable fact, if there is any truth in the solution of Laplace or in the idea of "condensations and rarefactions" of the air produced by sound, that the velocity of sound and the loudness of sound must correspondingly increase and decrease together, since the augmentation of velocity depends upon the amount of heat generated, just as the heat depends upon the amount of the condensation, while *it is also upon the difference of density that loudness depends.* Hence, the heat solution of Laplace based on such condensations of the atmosphere must necessarily be a fallacy.

As all physicists will admit that this discrepancy of Newton overthrows the wave hypothesis unless it is susceptible of a satisfactory scientific explanation which will reconcile it with the observed velocity of sound, and since the heat solution of Laplace—the only one ever claimed to meet the difficulty—turns out to be not only no solution at all, but an unmitigated scientific excrescence, literally lugged into the theory to meet a desperate emergency,

may we not fairly conclude that, as the question now stands, the discrepancy of Newton still remains unimpaired, and consequently that the wave-theory now occupies the anomalous position of an edifice whose foundation is utterly shattered?

Even if the unanswerable difficulties in the way of this hypothesis of Laplace now being presented had never been named or thought of, the supposed *relation of density to elasticity* as the law which determines the velocity of sound through all bodies, and on the analysis of which Laplace formulated his solution, can be shown beyond all question to have no foundation in science or in fact, being purely chimerical, and contradicted by the observed velocity of sound through various well-known substances in addition to our atmosphere, so signally demonstrated in Newton's calculation to be in direct opposition to the law. This relation of the *density* of a body to its *elasticity* as the basis of sound-velocity through all bodies, like the wave-theory which it supports, is a mere hypothesis fabricated and formulated for a specific purpose out of a few superficial observations,—invented, in fact, to aid wave-motion by systematizing its principles, the bottom of which is shown, the moment it is held up to the light, to have fallen out in the time of Sir Isaac Newton. If there were nothing else to prove my assertion true, that single demonstration of Newton, in his careful analysis of the density and elasticity of the air, shows that this universal medium of sound-conduction is diametrically opposed to the hypothesis, unless aided by the heat solution of Laplace, which, when examined, turns out to be grotesquely impracticable, having been formulated, as just shown, without the shadow of science or reason to justify it, since there is neither condensation nor heat produced by sound.

At the time Newton made this discovery, physicists who advocated the wave-theory of sound appeared intuitively to agree among themselves that if this single discrepancy in their formula could, by hook or by crook, be reconciled, and the difficulty successfully explained away, their theoretic coast would be clear, and that all other bodies or substances whatever as sound-conductors could be readily made to fall into line and quiescently conform to this law of density and elasticity. Yet one would have supposed, after Newton had thus shown by undeniable figures and facts that this law of velocity was wrong as related to atmosphere, by a palpable discrepancy of 174 feet a second, that physicists would have weakened sufficiently at least to look around them and see if it were not possible for other bodies through which sound travels to show like indications of rebellion against their law. Instead of doing so, they bent all their energies to the one task of overcoming this single admitted contradiction of the wave-theory as based on the known elasticity and density of the air, making all sorts of ingenious suggestions without success, till at last the scientific mountain, having labored, brought forth this contemptibly small and ludicrously deformed mouse of Laplace!

Professor Tyndall briefly states this law of density and elasticity as applied to the air, which is equally applicable to all other kinds of sound-conductors, as follows:—

> "The velocity of sound in air depends on the *elasticity* of the air *in relation to its density*. The *greater* is the *elasticity the swifter is the propagation;* the *greater* the *density the slower is the propagation.*" —*Lectures on Sound*, p. 45.

Now, as a matter of course, if a body could be found having *great density* and *no elasticity*, it is clear, if there is any foundation for this law, sound should not travel

through such a substance at all, since this is evidently what the law means if it means anything. Such a body we have in *lead*. It is not only among the *densest* of metals, but is almost entirely devoid of elasticity (as much so nearly as a mass of putty), according to every known definition of the term *elasticity* given in our dictionaries. Yet it is a fact, as admitted by Professor Tyndall himself (*Lectures on Sound*, p. 39), that sound travels through *lead* with a velocity of over 4,000 feet a second, or nearly four times its velocity in air! What, then, becomes of this formidable law based on the relation of density to elasticity?

I see no way for scientific investigators to get over this new *leaden* difficulty, unless some modern Laplace will invent another hypothesis, based, say, on the peculiar molecular structure of this metal, and show by some sort of an elaborate formula that a sufficient amount of *electricity* is generated by the passage of a sound-wave through it to counterpoise this lack of elasticity! Possibly the facility with which lead fuses might interfere somewhat with the generation of a sufficient electrical current to meet the conditions of the new hypothesis. At all events, it could be easily modified in half a dozen ways to make a much more plausible showing than the original Laplace made in adding 174 feet a second to the velocity of sound in air on the ground of the generation of heat by sonorous "condensations and rarefactions" which never had an existence, and never can have, except in the highly wrought fancy of physicists.

But supposing this formula to be adjusted to suit the molecular structure of *lead*, there would be a similar trouble at once with pure *gold* and *copper*, which are likewise practically devoid of elasticity, though they are among the densest of metals. Yet this same high authority assures us that sound actually travels through *gold* at a velocity of 5,000 feet a second, and through *copper* at a velocity of 11,000 feet, or ten times its velocity through the atmosphere, which is known to be among the *most elastic* and *least dense* of physical bodies! (See *Lectures on Sound*, p. 39.)

The truth is, this so-called "law" as the basis of sound-velocity, formulated on the *relation of density to elasticity*, is as fallacious as is the wave-theory built upon it, and the two hypotheses therefore are well matched, being equally destitute of scientific foundation. Hence, we are again brought around, almost unexpectedly, to the same great scientific and natural fact that sound travels through all bodies with a velocity and facility exactly commensurate with their conductive quality, whatever that may consist in, depending on molecular structure,—that is, the relative position and arrangement of their ultimate atoms,—and perhaps other conditions at present unknown, the same as those under which electricity travels and by which it is governed, though each acts under the control of laws peculiar to itself. No man can tell why electricity passes through *copper* or *silver* with greater facility than through *iron* or *platinum;* nor can any one formulate a law of elasticity, or density, or compressibility, or porosity, or ductility, or malleability, which will explain why electricity will not pass, for example, through glass at all, which is the best known conductor of sound, so far as velocity is concerned.

These laws of conduction, radiation, diffusion, attraction, repulsion, &c., as before remarked, are among the unknown, and, at present, unknowable mysteries of Nature. Whenever we shall accept the great fundamental truth that we are surrounded with substantial but incorporeal

entities, such as light, heat, sound, electricity, magnetism, gravitation, &c., whose laws and principles of operation, as inscrutable as their author, lie hidden in the Ultimate Causation of all things, the relations of which, as well as their modes of operation, can only be apprehended by mortals in the contemplation of their corporeal results through experiment and observation, we shall then have arrived at a much better mental condition for the attainment of true scientific knowledge than by assuming pretentious laws and formulating elaborate hypotheses for the explication of the unsolvable mysteries of Nature, and which, as recently witnessed, contravene not only the unalterable decrees of mathematics, but render nugatory the stubborn facts of mechanics exemplified in the constant experience of every living creature.

When the discrepancy, of which I have been speaking, of 174 feet a second between the observed and the calculated velocity of sound, was first discovered by Sir Isaac Newton, he should have at once abandoned the undulatory theory of sound as a practical absurdity, contradicted in its fundamental principles by the observed facts of Nature, and thus have saved the world the demonstrated result not only of sound traveling at a velocity of 66,000,000 miles a second, as logically deduced in the case of the steam siren, but the infinitely impossible performance of an insect shaking four cubic miles of atmosphere into "condensations and rarefactions" by the movement of its tiny legs in the free air, thus exerting a mechanical force of 5,000,000,000 tons, according to the plainest vulgar fractions furnished by Professor Mayer, or 66,000,000,000,000 tons, as shown by the indisputable heat and pressure figures of Professor Tyndall made necessary by the solution of Laplace.

No! Instead of doing such a sensible thing as at once giving up the hypothesis as untenable, Newton took it for granted that nothing but the wave-theory would answer the purpose, or have any effect in solving the problems of sound, since it was at that time, as it is now, the universally accepted hypothesis; and hence he began to cast about for some sort of explanation of this discrepancy which might reconcile it with the observed velocity of sound, and which, as already seen, finally culminated in the enormous folly of Laplace's solution, involving the actual generation of heat, by the singing of a locust, sufficient to raise a full head of steam in *twelve hundred million locomotive-boilers at one time*, as any mathematician can calculate by transferring the heat thus generated in the condensed half of the air to the proper number of cubic feet of water!

A more astounding want of philosophical sagacity than was thus exhibited by Newton and his contemporaries in not giving up the wave-theory as a fallacy of science, after its foundation had been swept away, is not on record, and it will be so regarded by future physicists while books are read.

But here, unexpectedly, this locust can render me another little service by showing how easy it is for a false theory to contradict itself when it comes down to the discussion of details. I have already given numerous examples of this kind from the writings of these eminent physicists whom I have the honor of reviewing; but those are only mere specimens of what may yet be expected, and of which these works on sound are necessarily full from beginning to end. This is no exaggeration; for it is practically impossible for the ablest advocates of the theory, in writing an extended treatise on the subject, to discuss the details of one branch or one class of phenomena, without flatly contradicting the

principles, ratios, and laws enunciated when treating on another, owing to the inherent incongruity necessarily subsisting between the different elements of every erroneous hypothesis. Of this the reader, if not already convinced, will be amply assured as the review progresses.

I now propose to prove, by Professor Tyndall himself, that this insect, which can be heard a mile in all directions, and which has been so provokingly used against the wave-theory, *can not by any possibility stir the air more than a few feet around it.* In doing so, it will be seen that it does not require the overwhelming mathematical arguments here being presented to shatter the hypothesis. I only need to let this most popular exponent of the theory speak out, as he plainly does in numerous places, and then array his language in proper order before the reader to annihilate the very foundation of the wave-hypothesis.

The reader no doubt remembers that when this lecturer was trying to explain to his audience the principles of resonance, and how it was that a sounding-board augmented the tone of a string (examined at page 82), he gave a demonstration of the well-known fact that a string stretched over rigid pieces of iron, unconnected with wood, produces no sensible effect upon the auditory nerve even half a dozen feet from it, however vigorously it may be caused to vibrate. He then undertakes to explain this to his audience, and the reason he assigns why we hear no sound is that a harp-string or piano-string is too "thin a body" to produce any "sensible" effect upon the "*air*"! As this argument on resonance is important, and conclusively wipes out the wave-theory when applied to the stridulation of the locust, I will requote his words consecutively, that the reader may not fail to see their force. He says:—

"It is not the *chords* of a harp, or a lute, or a piano, or a violin, *that throw the air into sonorous vibrations.* It is the large surfaces with which they are associated, and the air inclosed by these surfaces."—*Lectures on Sound*, p. 88.

I now ask Professor Tyndall why it is that the vibrating string, "swiftly advancing," as he says in another place, *carving* and *moulding* the air into "sonorous waves," and sending them off in the form of "condensations and rarefactions" at a velocity of 1120 feet a second, can not at this particular juncture "*throw the air into sonorous vibrations*" *at all?* He answers:—

"The *amount of motion communicated by a vibrating string to the air is too small to be perceived as sound even at a small distance from the string.*"

"The *sonorous waves which at present strike your ears* do not proceed immediately from the string. The *amount of motion* which *so thin a body imparts to the air is too small to be sensible at any distance.*"—*Lectures on Sound*, pp. 87, 125.

This suicidal admission establishes precisely what I have been all the time contending for since the commencement of this chapter, namely, that "so *thin* a body" as a *string* or a *tuning-fork*, especially with such a trifling aggregate velocity as only *seven or eight inches a second*, can not by any possibility drive air-waves even "*a small distance*" *from such string or fork!* Here it is unwittingly admitted to be true, since "the *amount* of *motion* which so *thin a body imparts to the air is too small to be sensible at any distance*"!

Notwithstanding these contradictory admissions, with which a schoolboy could overwhelm the undulatory theory, this great physicist teaches, as he is compelled to do unless he utterly renounces air-waves as the means of sound-propagation, that a *locust*, weighing not a *hundredth part* as much as a harp-string which produces the same tone, and having no strong man's fingers to pluck it, and thus "mould," "carve," and "send" off aerial undulations,

is capable, while sitting on a green leaf, and without any "large surfaces" to act as sounding-boards, by the simple movement of its tiny, threadlike legs, of generating an atmospheric disturbance which fills four cubic miles with "condensations and rarefactions," the atmospheric pressure of which generates heat sufficient to add 174 feet a second to the normal velocity of the sound throughout this vast area! Was there ever a more ridiculous position overthrown by a more maladroit and suicidal self-stultification?

Instead of physicists any longer teaching atmospheric wave-motion as the true cause of sound-propagation, let it now be proclaimed to the scientific world that this "highest living authority" on sound, as Professor Youmans designates him, in the most unmistakable language, has abandoned the wave-theory, and has admitted that a locust does not and can not produce its wondrous stridulation, heard a mile in all directions, by means of air-waves, unless he shall publicly repudiate his statements just quoted, namely, that "The *amount of motion which so thin a body imparts to the air is too small to be sensible at any distance*," or "*too small to be perceived as sound even at a small distance from the string*" or insect!

He surely will not pretend to claim, after these reiterated and voluntary statements, —admissions of facts in regard to the string and its limited tone which are patent, undeniable, and unavoidable, on his part,— that the *legs* of a locust can produce any more effect on the air than can a harp-chord of a hundred times the size and a thousand times the weight If not, what then becomes of the helpless wave-theory, deserted by its best friend and ablest defender? If he utters the truth in what he here says, and repeats in different forms in regard to a powerful sonometer-string, namely, that "the amount of *motion* which *so thin a body imparts to the air is too small to be sensible at any distance*," and "*too small to be perceived as sound* ☞ *even at a small distance from the string*," can it possibly be true, or anything short of an unmitigated falsification of science and fact, when he teaches, as he is obliged to do unless he renounces the wave-theory, that the *legs* of an insect, moved with less than a thousandth part of the *vis viva* applied to the string, actually hurls the air into waves which are "*perceived as sound*" a mile away, and which fills *four square miles with* "*sensible*" *sonorous pulses?* And, finally, has not Professor Tyndall flatly admitted that the sound of this insect is not and can not be produced by any undulatory movement of the air possible to be produced by "so thin a body" as the legs of a locust? And if so, is it not an unconditional surrender of the wave-theory, and an unintended confession that the whole hypothesis is a pure fallacy of science? If this is not what his admissions amount to, under the most liberal construction, then I confess I have no correct understanding of the English language.

I now make the unqualified assertion, which I believe the unbiassed judgment of the reader can but approve, that there is not a man living competent to reason on any question of science, or qualified to draw a logical conclusion from established premises, who, with these admissions of Professor Tyndall as his guide, can believe it possible for a locust to stir a single cubic perch of atmosphere by the motion of its threadlike legs, to say nothing of its ability to churn into "condensations and rarefactions" four cubic miles of air, not only causing its particles, as Professor Mayer expresses it, to "swing to and fro with the motions of pendulums," but to generate sufficient heat to add "one sixth" to the velocity of its sound!

To suppose any man capable of believing, after the foregoing citations (supposing Professor Tyndall's views correct as to the effects on the air of a vibrating string), that so diminutive a creature as a locust can actually convert such a vast atmospheric area into "condensations and rarefactions," exerting a pressure sufficient to generate the heat involved in the hypothesis of Laplace, would be to suppose him hopelessly insane and mentally irresponsible for his acts.

The reader may now pertinently ask how it is possible that a pretended scientific theory, so utterly devoid of foundation in fact and so ridiculously absurd in reason and philosophy as the foregoing arguments appear to make this, should have continued to exist from generation to generation, and to be accepted as true science by the most enlightened and critical minds of the world, in all ages. Why, he may appropriately inquire, has not some one else, of all the thousands who have investigated this question, made the important discovery, if discovery it be, that the wave-theory is a baseless fallacy, with all these mechanical facts and fundamental considerations as open to examination and as susceptible of being understood by every other physicist as by the writer of this monograph?

I can only say, in reply to this natural inquiry, that the blinding effect of a universally accepted theory, however false and absurd, handed down from one generation to another, indorsed by the authority of the greatest intellects, and the tendency of such a theory to stifle doubt and paralyze critical investigation as to the foundation on which it rests, and thus to prevent the origination of any inquiry concerning its conflicting phenomena, except so far as to harmonize them with its admitted scientific basis, is one of the most singular, as well as one of the best established psychical facts in the history of intellectual progress.

The Ptolemaic theory of astronomy, which made the earth the center of the universe, and taught that the sun, moon, and stars revolved around it every twenty-four hours, and which had stood for two thousand years comparatively unchallenged, just because each preceding generation had passed it along to the next without calling its fundamental principles in question, though philosophers of every age, from the time of the Ptolemys down, had been terribly puzzled over its contradictory details, furnishes a vivid illustration of the tendency of any theory, which has existed for centuries, to close up, by the accumulating debris of ages, all the passages which at its commencement may have led to the subcellar and to its very foundation-walls.

This very difficulty, which so puzzles the reader, as to how it is possible for the wave-theory to have remained unshaken for so many generations, without a single physicist venturing to call it in question or expose its self-evident absurdities, and yet that it should be all the while false and without the least foundation in fact or science, was precisely the argument made use of in the time of Copernicus and Gallileo in favor of still continuing to adhere to the Ptolemaic hypothesis! Gallileo replied to this reasoning that the truth or falsity of the new hypothesis must be judged by the weight of facts and the force of mathematical deductions, and not by superficial appearances or the plea of authority based on what philosophers may have taught in ages past;—that some one had to be the first to discover any new scientific truth, and especially to find out the true relations existing between the earth and the other members of the solar

system, and their relation one to another, and that Copernicus, out of all the millions who had thought upon the subject, happened to combine the particular qualifications and to be trained with the proper educational advantages which enabled him to break through the film of false reasoning and to grasp the key which opened the door into the avenue leading to the true solution of the problem. The scientific conflict was severe; but the Copernican theory finally prevailed, and is now universally believed, notwithstanding the specious argument of the philosophers of that day based on this always unsafe criterion of venerated authority.

So, I predict, will the corpuscular hypothesis of sound finally triumph over the venerable wave-theory, without a tithe of the conflict or enduring doubt which characterized the decadence and final dissolution of the Ptolemaic system; and with no decree, civil or ecclesiastical, to check the outward strides of the one or bolster up the waning fortunes of the other. In this view I confidently look forward to the near future, when it will be as rare a circumstance for a physicist to express a belief in atmospheric waves as the true mode of sound-propagation, as it is now to hear any man pretending to a scientific education suggest the possibility of the earth being stationary and flat instead of being a revolving globe!

For an astronomer at this day to be obliged to reason with a pretended philosopher who could really assume, on account of mere appearances, that the earth necessarily stands still, and that the millions of celestial bodies actually revolve about it every twenty-four hours; and to be compelled to seriously go into the details of argument with such a mind, after knowing what an astronomical student must necessarily know about the motions of the heavenly bodies and the infinite impossibility of such a supposition being true;—and feeling, as he would be forced to feel, that a man pretending to the least degree of scientific education must be absolutely without excuse for holding to so stupid an idea in this age of general intelligence, requires about the same degree of patient equanimity of temper, and shows a parallel example of the mingled commiseration and astonishment which the writer of this review is compelled to cultivate and to feel while patiently pointing out the self-evident fallacies and inconsistencies of the wave-theory of sound, and the pitiable involvement of these eminent scientific investigators who are so misguided and self-deceived as to advocate it.

Should any physicist a hundred years hence happen to be so illy informed and so far behind the age as to believe in and advocate the preposterous positions involved in the current wave-theory of sound, the educated scientist of that epoch in attempting to set him right will then feel about the same indefinable sensation of pity mingled with disgust that the astronomer of to-day feels when hearing some scientific lunatic urge, as is sometimes the case, that the earth can not revolve on its axis, because, if it did so, it would overturn the water-bucket; or that the writer of this review is compelled to feel while trying to convince Professors Tyndall, Helmholtz, and Mayer that a locust can not, by moving its legs, throw four cubic miles of air into "condensations and rarefactions," and thus exert a mechanical pressure of thousands of millions of tons!

The lesson taught us by the humiliating fact of the long-enduring sway of the Ptolemaic system of astronomy, while all the time absurdly false, should warn us against taking anything in science on trust, or believing it to be true just because it is sanc-

tified by the indorsement of a long and immortal line of scientific names,—especially while anything about it has not been subjected to the most scrutinizing scientific research. The creed to which I have sworn fidelity, and to which I have affixed my hand and signet, though a negative creed, is nevertheless my Bible in all scientific matters, namely, not to accept anything as philosophical or scientific truth, or to allow it the weight of a feather in my convictions, because it has been believed in or advocated by any man or set of men, however renowned their names may be.

A pet bear, it is said, can be so long accustomed to being chained to a stake that it will continue on to circle in the same beaten path without thinking of venturing beyond the limits of its wont, even for days after its chain has been removed. There have been scientific pet bears in all ages, and I fear the race has not yet become extinct.

An illustration of the force of habit and the influence of traditional authority handed down from predecessors by which we are many times led to accept the greatest of absurdities without calling them in question, is given in a story told of a certain commandant of an old fortification somewhere I think in Germany, who, on assuming command of the station, found that every morning and evening, as regularly as the sun rose and set, a soldier was stationed as guard, by the subordinate officer, over a certain piece of ground near the mote. The commandant, though struck with the circumstance, supposed it to be all right, and therefore did not require an explanation, but proceeded to attend to his daily routine of duties. At length, continuing to observe day after day this singular and apparently uncalled-for changing of guard, he concluded to inquire the cause of so strange a custom. But on questioning his staff-officers they were unable to give him any information on the subject. He then called up an old sergeant who had been stationed at the fort for many years, but his inquiries met with the same result. The sergeant informed his superior that when he came there it was customary to place a guard over that piece of ground every morning and evening, and that the sergeant who had preceded him for years told him, on being transferred, that it had been the custom since his first entrance into the service.

At last the commandant began an examination of the records kept by his predecessors, when, finally, to his astonishment, he ascertained that forty years previously a certain officer in charge of this fort had brought his family to reside with him during the summer,—that, for their comfort and convenience he had planted this patch of ground with *cabbages*, and that some neighboring *cows* being in the habit of breaking into his garden through the frail fence, he had deemed it expedient to station a guard to keep them away! But notwithstanding the neighboring farm-house, and with it the cows, had long since disappeared, and although no cabbages or other vegetables had been grown upon this spot of ground for forty years, yet the succeeding officers in charge, year after year, without inquiring into the reason why, but faithful to the traditions of their predecessors, and alone from the force of habit and out of respect to authority, had continued the practice of mounting guard over this vacant cabbage-patch because it was customary to do so!

In about the same manner, and for reasons not a whit better, Newton, Laplace, Helmholtz, Tyndall, and Mayer have continued year after year and generation after

generation to place the wave-theory on duty just because the custom was inaugurated by Pythagoras 2,500 years ago, and wave-motion made to stand guard over one of his superficial observations,—while modern physicists, with their immeasurable scientific advantages, could have easily seen, had they exercised their reason and examined the records of Nature, that the *cows* and *cabbages* of that ancient philosopher, if they ever existed, have long ago disappeared, leaving no use whatever for the wave-theory of sound to be placed on guard.

But even yet I have not extracted my strongest and most conclusive argument out of that valuable *locust*, which has been stridulating so unpleasantly in the ears of physicists, and playing such tantalizing havoc with the wave-theory during so many pages of this chapter. I now have another service for it to perform, which will so completely overthrow the assumption of atmospheric sound-waves as apparently to end the controversy on the subject, and in such a way as would even seem not to admit the intervention of a quibble to save the hypothesis from destruction. I make this somewhat confident prefatory remark at introducing this argument in order to prepare the reader for what may be safely termed *demonstrative evidence* against the wave-theory, even if any ambiguity may have been imagined as attaching to previous arguments. I am willing, so far as the truth or falsity of the wave-hypothesis is concerned, to entirely ignore the preceding considerations, as if they had no existence, and let the theory stand or fall on the merits of the single argument now to be presented, to which I especially invite the attention of the three eminent authorities whose writings I have the honor of reviewing.

There is not a physicist, ancient or modern, who has written on sound, but teaches in unequivocal language that the *tympanic membrane* is actually *shaken* or caused to *vibrate* by sonorous pulses through the dashing of air-waves against it, driven off from the sonorific body; and that this vibration of the "drum-skin of the ear," as Professor Helmholtz terms it, swinging in synchronism with these beating waves, is the way we hear sound, and the only means by which sonorous impressions are conveyed to the auditory nerve, and through it carried to the brain, and there translated into the sensations of tone.

To the well-informed student of the physical sciences I would need to present no proof of a statement so universally verified by the writings of authorities treating on this subject; but I am writing for the unscientific masses as well, and shall therefore present a few concise extracts from Professors Tyndall and Helmholtz, that no reader shall say I assume the question to be proved. Professor Tyndall remarks:—

"Thus is sound conveyed from particle to particle through the air. The particles which fill the *cavity of the ear are finally driven against the tympanic membrane*, which is stretched across the passage leading to the brain. This *membrane*, which closes the drum of the ear, *is thrown into vibration*, its *motion* is *transmitted to the ends of the auditory nerve*, and afterwards along the nerve to the brain, where the *vibrations are translated into sound*."

"Thus, also, we send out sound through the air, and *shake the drum of the distant ear*."—*Lectures on Sound*, pp. 4, 5.

This language can not be misunderstood. There is nothing figurative, poetical, or ambiguous about it. He means by "vibrations" the actual displacement of the bending portion of this membrane, or its literal *oscillation, inward and outward*, as each successive air-wave strikes it. As a proof that such is his meaning, he repeats this

fundamental doctrine of tympanic vibration in so many ways that we are left without any doubt on the subject. Take the following:—

"Imagine the first of a series of pulses which follow each other at regular intervals, *impinging upon the tympanic membrane. It is shaken by the shock;* and a body once *shaken* can not come instantaneously to *rest.*"—"Every *wave* generated by such *vibrations bends* the tympanic membrane *once in* and *once out.*"—*Lectures on Sound*, pp. 49, 69.

This, also, is concise and to the point. A sound, to reach the brain at all, and there be translated into its proper sensation, must do so by first acting on this drum-skin of the ear,—bending it "once in and once out" for "every wave generated." It matters not how *faint* this sound may be or at what *distance* away from its source it is heard; we only hear it by the oscillations of this membrane, if the wave-theory be true, for this great authority assures us that "we send out sound *through the air*, and *shake the drum of the distant ear.*"

Professor Helmholtz, who, as I have already hinted, stands first among all the authorities on sound, fully corroborates this view. In fact, he is the main source of authority from which Professor Tyndall and all minor writers on sound draw most of their inspirations. I will quote a sentence or two from him to show that his views correspond in every respect with those of Professor Tyndall:—

"A periodically oscillating sonorous body produces a *similar periodical motion, first in the mass of air and then in the drum of our ear, and the period of these vibrations must be the same as that of the vibration in the sounding body.*"—"We have already explained that the mass of air *which sets the tympanic membrane of the ear in motion*," &c. —*Sensations of Tone*, pp. 16, 45.

I could quote hundreds of passages to the same effect from various authorities, including Professor Mayer, had I space to spare or were they necessary. I simply assert, as all scientists well know, that this is not only the uniform teaching of the current sound-theory, but it is the very foundation on which the wave-hypothesis rests, since it is perfectly manifest if the tympanic membrane does not vibrate in periodicity to aerial undulations that atmospheric sound-waves are wholly useless as the mode of sound-propagation.

This fundamental doctrine, therefore, of the vibratory motion of the tympanic membrane in response to sound, however feeble or at whatever distance from its source it may be heard, is vital to the wave-theory, and no physicist will hesitate a moment to admit that the two must stand or fall together. If, therefore, I shall be able in this argument to demonstrate that the tympanic membrane does not and can not vibrate at all in response to sound, and that it is not so intended to vibrate in the slighest degree, it is clear that the wave-theory falls to the ground. I first propose to demonstrate this by the stridulation of the locust.

First of all, this "drum-skin of the ear," it must be distinctly understood, is a physical, ponderable body, stretched across and closing the auricular passage, and hence must have a certain definite amount of *weight* or *inertia*, and must therefore necessarily require a definite and calculable amount of *mechanical force* to displace it, even if freely suspended in the air, to say nothing of the extra force which would be required to bend it "once in and once out" at every wave, and thus overcome its tensive resistance in addition to its weight. I shall at present only consider the question of *inertia;* and I care not how trifling that may be in the case of a single "drum-skin," it answers my purpose just as well, as the reader will soon see.

A single tympanic membrane can easily

be weighed on any druggist's scales, and the weight accurately ascertained and recorded. Take that portion of the membrane free to bend in and out by alternate external and internal pressure, and it is found to be equal to about a quarter of an inch square in superficial area, and averaging about a sixty-fourth of an inch thick. In order to meet this case with unquestioned facts and figures, I have taken the trouble to secure a perfect specimen of this membrane, though somewhat less in weight than in a living subject, and I find its actual weight to be a fraction over half a grain,—making, in round numbers, 16,000 of such drum-skins to the *pound* avoirdupois. Here, then, is a mathematical basis for arriving at definite mechanical results in regard to the physical strength of this locust, which can not be gainsaid or doubted.

In the next place, I have easily ascertained, as the reader can also do, that a single specimen of this "drum-skin" can be stretched within the equivalent space occupied by a cubic quarter-inch block, leaving an abundance of room on either side for it to vibrate to and fro by the action of sound, if it does ever so vibrate. We have, then, only to suppose one tympanic membrane accurately and sensitively located in the space of each cubic quarter-inch throughout the four cubic miles filled by the sound of the locust, and as certain as there is any truth in the wave-theory of sound, all these membranes must be thrown into vibratory motion, if stretched with the same tension as they are in human ears, because it is perfectly evident that an ear, if present at any quarter-inch throughout this mass of air, would hear the sound of the stridulation, which, according to this theory, could only occur by the *shaking* of this "drum-skin"!

Now, by a simple calculation, which any schoolboy can verify, I find that there is room enough in this area, in round numbers, for 65,000,000,000,000,000 of these tympanic membranes thus tensioned, which, divided by 16,000, the number contained in a pound, gives us a ponderable mass of 4,000,000,000,000 pounds, or *two thousand million tons* of tympanic membranes which this trifling insect, according to the wave-theory of sound, is capable of throwing into rapid vibratory motion by the mechanical operation of moving its legs! Is such a result reasonable or possible? Is it not rather an infinite impossibility, and the theory which teaches it an unmitigated imposition upon the intelligence of mankind?

It must be remembered, while contemplating this unavoidable consequence of wave-motion, that the locust is not only made capable of moving these 2,000,000,000 tons of physical matter by throwing the four cubic miles of atmosphere into undulations, but this entire mass of supposed drum-skins has to be moved from a state of rest by overcoming or annihilating its *vis inertia*, carried a certain distance, brought to rest, and again started, and so on at the rate of 440 such stops and starts a second, this being the number of air-waves sent off by the insect, according to its pitch of tone, it being the middle A of the piano or that of the second string of the violin. To say that a pretended scientific theory which teaches the possibility of such a mechanical result is an infinite fallacy, is to employ tame language in regard to it.

There can be no mistake about the foregoing calculation, and hence no way for physicists to escape the annihilating consequences to their favorite theory of sound-waves, logically deduced from it. They can not say that the sound of this species of locust is not heard throughout this area,

as this is a patent fact admitted by the greatest living naturalists, including Mr. Darwin. They can not deny their own uniform teaching that the only way sound is heard at all is by the tympanic membrane being bent "once in and once out" by each separate sound-wave. They can not call in question the self-evident fact that if an ear were to be stationed at any cubic inch or quarter-inch of space throughout this area it would distinctly hear this sound. Hence, the calculation I have made is based on correct mathematical and mechanical principles; and, unless Professors Tyndall, Helmholtz, and Mayer are prepared to accept the result, and believe that an insect by the simple movement of its legs in rasping the nervures of its wings is capable of shaking *two thousand million tons of physical matter*, as heavy and as difficult to shake as that much *lead*, they must of necessity abide the only logical consequence, and abandon the wave-theory as an unspeakable scientific fallacy!

This calculation, involving the idea of shaking *two thousand million tons* by means of the physical strength of an insect incapable of stirring a single ounce weight is no doubt entirely beyond the mathematical comprehension of the reader. In fact, it is difficult to grasp the idea, so as to realize it in its true signification, of what a single *million* amounts to. To simplify the problem, I will try to bring the matter temporarily within human conception, and at the same time do away with the necessity of imagining tympanic membranes stationed in what may be supposed impossible positions, such as at every quarter-inch, so that even this apparent exaggeration shall not furnish ground for a quibble, by which to weaken the overwhelming nature of the argument.

In taking a milder view of the mathematical and mechanical consequences of the problem, we will first suppose that, according to the wave-theory, when one man hears the sound of this stridulation his two tympanic membranes, weighing but *one grain*, are actually shaken. This quantity is so trifling that these investigators, never stopping to calculate where it leads, naturally feel perfectly at ease in assuming it, or taking it for granted. I would really like to have the opportunity of asking Professor Tyndall, in an innocent kind of a way, without him suspecting what I was driving at, how much weight he supposes a common locust capable of shaking, and keeping it up for one minute, at the rate of 440 oscillations a second. I think he would not venture to suggest over one *ounce*, if that much, as this would be more than fifty times its own weight. Suppose he even put it at an ounce. Then how easy it would be to explode the wave-theory by showing him that if 8,000 men should stand together around this locust and listen to its stridulation, their 16,000 tympanic membranes, actually weighing *one pound* avoirdupois, must necessarily be bent "once in and once out" 440 times a second, if there is any truth in the wave-hypothesis! How would it be possible for this great physicist to reply?

Then, as these 8,000 men can conveniently stand on half an acre of ground, and as there are over 5,000 half-acres within the four square miles permeated by the sound of this insect, it becomes evident to a schoolboy that men enough might stand within the limits of this area, and all listen to the locust at the same time, to have their *five thousand pounds of tympanic membranes* oscillated or bent "once in and once out" 440 times a second while the stridulation continued! Thus, taking the mildest and most unexceptionable view possible, this insect, which no one could believe capable of stirring a

single ounce, is actually demonstrated, according to this theory, to shake a weight of 5,000 pounds continuously for a minute! The unanswerable character of the argument is thus brought within the comprehension of all, and shown to be beyond the power of any believer in the wave-hypothesis to controvert.

What now say these learned physicists? To admit that this insect could not shake 5,000 pounds of tympanic membranes, or the fifty thousandth part as much, at one time, as they would be honestly obliged to say, would be to abandon the wave-theory. To say, in defiance of reason, that such a result is possible, and that a mere insect could accomplish a mechanical effect evidently beyond the physical strength of a powerful horse, would be to excite the contempt of the whole educated world.

I have said that this argument, based on the movement of the tympanic membrane as the effect of sound, is the most conclusive reason against the wave-theory to be drawn from the stridulation of this locust, because the drum-skin of the ear is not an intangibility, or a something which can not be seen, weighed, and handled, but is a palpable, ponderable body, having a certain actual, determinate weight, and requiring a definite and determinate amount of *vis viva*, or mechanical force, to put it into motion, as literally and truly as if each tympanum were a mass of rock or iron. Whatever vague scientific delusion, therefore, we may have indulged as regards sound causing some sort of an indefinable tremor of the atmosphere, or system of aerial undulations, at whatever distance heard,—innocently supposed to require no appreciable mechanical force,—it is all swept away by the actual oscillation of this stubborn and ugly mass of 5,000 pounds of animal fiber, which would balance the scale if tested against 5,000 pounds of granite rock! And just as certain as a locust has not the physical power to shake that quantity of *granite* by kicking against it or rasping its legs across it at the rate of 440 vibrations a second, just so certain is the whole wave-theory a shallow and transparent scientific blunder.

Although I have modified this argument and the original calculation, temporarily, by limiting the weight of tympanic membranes to the number of men who can actually stand together and listen to the stridulation, making in this way only 5,000 pounds which this insect has to shake (evidently *fifty thousand times more than it can accomplish*), yet it is clearly manifest that my first estimate was unmistakably the correct one; for, if one tympanic membrane at any single point of the atmosphere within the four cubic miles is shaken by this sound, *it is manifestly because the atmosphere at that particular point is so agitated mechanically as to cause the drum-skin to vibrate, or otherwise it could not shake;* and hence the same agitation must necessarily occur at every other point of the atmosphere where this tone is heard, which would also equally shake a tympanic membrane if it should be there present! Thus I demonstrate, beyond all controversy, that my first calculation was correct, and that this stridulation of an insect must necessarily exert a mechanical force upon the atmosphere, by the movement of its legs, of *two thousand million tons*, if there is the slightest foundation in science or in fact for the wave-theory of sound!

These are no fancy figures of the *ad captandum vulgus* type, but the logical results of mechanical and mathematical necessity, as much so as are the figures employed by the astronomer in calculating an eclipse, or by the mechanic in estimating the weight of a steam-boiler. I therefore ask, is the

reader prepared to accept such an unavoidable mathematical and mechanical result as reasonable or probable? If not, then the wave-theory, which teaches, as its most vital principle, that we can only hear sound by the vibration of the tympanic membrane, falls hopelessly to the ground, and must henceforth be relegated to the limbo of exploded scientific speculations.

The quotations I gave from these highest living authorities at the commencement of this argument (page 175), in which the theory teaches that we hear sound by the tympanic membrane bending "once in and once out" as each sound-wave strikes it, and by which such oscillations are transferred to the auditory nerve, and conveyed "afterwards along the nerve to the brain, *where the vibrations are translated into sound*," can not be explained away, nor can their disastrous effects on the wave-hypothesis be weakened in the slightest degree; neither can the result, mathematically demonstrated, by which an insect is made to exert a mechanical force of 2,000,000,000 tons, be jostled or impugned by any scientific figuring in the power of physicists, without a total abnegation and renouncement of the wave-theory.

In view, therefore, of the utter impossibility of any kind of a reply being made to this argument which will give a lease of life to the wave-hypothesis, one can hardly help sympathizing with these authors who have so ruinously involved themselves and their theory in the self-stultifying citations I have made. Favored indeed may be considered that physicist who has not been tempted at some evil hour of his life to write a book on sound, and thus to hopelessly compromise his reputation for scientific sagacity by committing himself to this unfortunate and inexcusable blunder of tympanic vibration.

At this point a single word with my scientific young friend, with whom I have so often discussed these questions, who admits that the wave-theory, with its condensations, rarefactions, and generation of heat sufficient to add one sixth to the velocity of sound, is an almost infinite fallacy, but who still believes it impossible but that *some sort of motion of the air must take place whenever sound is heard!*

Now, to settle that difficulty once for all, I will say that if there is a motion of any kind among the particles of the air as the effect of sound, it must be manifestly a movement synchronous or in periodicity with the vibration of the sounding body which generates the tone, or otherwise the tone does not cause it. No one can avoid this conclusion. Professor Helmholtz teaches this in the plainest language:—

"A periodically oscillating sonorous body produces a *similar periodical motion, first in the mass of air* and then in the drum of the ear; and the *period of these vibrations must be the same as that of the vibration in the sounding body.*"—*Sensations of Tone*, p. 16.

This being so, it amounts to exactly the same thing as the wave-theory; for, as the sound of the locust could be heard throughout every quarter-inch of the four cubic miles, *if an ear were present*, it follows that every particle of air throughout this area must keep up some kind of a vibratory motion, pendulous with the source of the sound, as long as the stridulation of the insect continues; and whether this tremor be in the form of a wave, having a supposed condensation and rarefaction, with one half of it above and the other half below the normal temperature of the air, or not, it involves the same mechanical impossibility of actually displacing and overcoming the inertia of four cubic miles of air 440 times a second, as demonstrated above.

And, what is worse, the separate molecules of the atmosphere which are dis-

placed throughout this area, having no normal pendulous swing or vibrational number of their own, or any other oscillatory motion, only as they are forced from their state of rest by directly having their inertia overcome, must evidently be moved bodily, if at all, and brought to rest 440 times a second, without the slightest aid from the periodicity of *pendulous momentum*. The normal pendulous swing of any responding body can only come into play when the motile or exciting pulses synchronize with such fixed and definite normal oscillation; or, in other words, a responding body must be suspended or tensioned to make that determinate periodic time, which, as reason must teach us, the air-particles can not and do not individually possess. Hence, their displacement, even if it be not wave-motion, with "condensations and rarefactions," involves the absolute overcoming of the inertia of the four cubic miles of atmosphere 440 times every second while the sound continues, without any pendulous assistance whatever.

But even if it were supposable that the elementary air-particles might possess a normal pendulous swing or vibrational number of their own, it is evident that there could be but *one such normal vibrational rate*, in which case they could only give pendulous assistance to one single definite pitch of tone, or that pitch which happened to be in unison with their own normal swing!

Denying wave-motion, therefore, with its "condensations and rarefactions," and its acknowledged impossible generation of heat and elasticity in the air, while yet insisting on some other kind of vibratory motion, which involves the same thing in effect, by the shaking and displacing of four cubic miles of atmosphere, the inertia of which has to be overcome and restored 440 times a second by the stridulation of the locust, does not seem to help the difficulty in the least. My young friend, let me say to you, frankly, if you must believe in some sort of an infinitely absurd hypothesis, stick to the venerable wave-theory, as you will then have the satisfaction of knowing that you are in company with the best scientific minds of all ages.

But I am not yet through with this vital feature of the wave-hypothesis, namely, the shaking of the tympanic membrane by sound, as the reader will discover before this chapter is ended. I am prepared to show that sound does not and can not, in the nature of things, cause this membrane to oscillate at all or stir in the slightest degree, and that it is a foundationless error to suppose that Nature intended us to hear sound by any such an impossible synchronous oscillation of this so-called drum-skin of the ear.

True, a membrane not in unison may be forced into an unsympathetic tremor by the incidental air-waves generated by a sounding body in close proximity to it. Even the tympanic membrane might be so coerced; *but this is not the effect of sound*, but of an incidental movement accompanying it, and can not take place at a distance, *as in the sympathetic action of unison bodies.* But physicists, as usual, make no distinction here. Professor Helmholtz, speaking of the sympathetic response of the drum-skin of the ear, says: "the period of these vibrations must be the same as that of the vibrations in the sounding body."

Now, it needs no argument to prove that if we hear sound at all by means of the synchronous oscillations of the drum-skin, as this citation clearly asserts, *that it would be only possible to hear tones of one single pitch*, or within a shade of that one pitch, since a stretched membrane, whether it be a "drum-skin" or a drum-head, can only oscillate sympathetically, by means of

sound-pulses which proceed from a unison or very nearly unison instrument.

But here comes the complete overthrow of the theory; for, as the tympanic membrane practically receives and transmits to the brain, through the auditory nerve, every conceivable shade of pitch, from 30 vibrations to 5,000 vibrations in a second, and one as effectively as another, it is perfectly clear that this can not be accomplished by its synchronous and sympathetic oscillation, since, as shown, it is not possible for it to have more than one single tension, or respond sympathetically to more than one single determinate pitch of tone, or thereabout.

This manifest impossibility of the responsive oscillation of the tympanic membrane to a thousand different periodic rates of air-waves or sound-pulses, when no other conceivable membrane or musical instrument will respond to more than one fixed and determinate rate, must strike every mind, competent to reason on the subject at all or capable of drawing any rational conclusion from premises, as an acoustical demonstration that we do not and can not hear sound by means of the sympathetic oscillations of this membrane, as the wave-theory is unavoidably compelled to maintain. Is not this clearly unanswerable?

But the impossibility of tympanic vibration does not even stop here. Its infinite absurdity will now be made more manifest than ever. Professor Tyndall tells us that,—

"The *same air* is competent to accept and transmit *the vibrations of a thousand instruments at the same time.*"—*Lectures on Sound*, p. 257.

Manifestly the only way we can know that the same air is competent to "transmit the vibrations of a *thousand instruments at the same time*" is by hearing them all "at the same time"; and I presume Professor Tyndall has an auditory apparatus capable of hearing that many all at once, or he would not have made this broad and definite statement. Reducing this "thousand" somewhat, I have, myself, listened to a large orchestra, composed of fifty or sixty instruments, all sounding their respective parts at one time, while no two of them were giving out tones exactly of the same pitch and intensity. According to the wave-theory, each instrument was sending off a different system of air-waves, each system causing the same air-particles to oscillate at an independent rate of vibration, and each driving the same air-particles through an independent and different width of amplitude, according to its loudness. And all these diverse rates of wave-motion and conflicting amplitudes of the same air-particles must take place, remember, in the aural passage, not more than a quarter of an inch in diameter, and each tone be produced by a separate system of waves, if the theory has any foundation in fact.

But even this is not the culmination of the impossibility. The fifty different and independent systems of air-waves, acting each with an independent rate of wave-motion and width of swing, transmit their conflicting impulses to the small area of this membrane at the same time; and, in order to produce the impression of the fifty different tones, this membrane must at the same instant necessarily go through with fifty independent rates of vibratory motion, with fifty distinct but independent amplitudes, involving the ridiculous impossibility of the same drum-skin moving in at least half as many different directions, with half as many different velocities, and throughout half as many different and conflicting distances, at one and the same time, since it must bend "*once in and once out*" as each wave strikes it, according to

the high authority of Professor Tyndall! As the intuition of a child must at once pronounce this impracticable, it follows that sound can not be heard and is not intended to be heard at all by the synchronous vibration of the tympanic membrane; for it is certain that all of these fifty tones make each a distinct individual impression on this organ, since I found no difficulty whatever in following any instrument I chose to select, or in hearing its notes separately and distinctly by a proper act of attention.

Now, as this small membrane absolutely and unmistakably received and literally transmitted to the brain all these diverse tones, and, as the unpoetical Tyndall puts it, one "thousand" separate tones at one time, is the reader prepared to admit that it did so by sympathetically and mechanically oscillating in that many different directions, at that many rates of velocity, and throughout that many different distances, at the same time, and thus to indorse the wave-theory? To accept such a physical impossibility is to wipe out all known mechanical laws and scientific principles of motion at a single sweep. Remember the words of Professor Helmholtz, already quoted:—

"It is evident that *at each point in the mass of air* [It is even more impossible, applied to the mass of the tympanic membrane itself,] *at each instant of time*, there can be *only one single degree of condensation*, and that the particles of air can be moving with *only one single determinate kind of motion*, having *only one single determinate amount of velocity*, and passing in *only one single determinate direction*."—*Sensations of Tone*, p. 40.

No wonder, then, in view of the absolute necessities of the wave-theory, and the unavoidable fact, if it be true, that a "thousand" separate systems of air-waves congregate in the aural passage at the same moment, each with an independent rate of vibration and different degree of amplitude, that Professor Tyndall should break out as he does:—

"When we try to visualize the motions of that *air*—to present to the eye of the mind the battling of the pulses direct and reverberated—*the imagination retires baffled at the attempt*."—*Lectures on Sound*, p. 257.

But I shall take occasion to revert to this argument again, before the close of the chapter.

Let us now turn for a moment and take a look at the natural and unavoidable effect of the detailed carrying out of an erroneous theory, namely, *self-contradiction*. Although Professor Helmholtz is universally regarded as one of the most profound and careful thinkers on whatever branch of physical science he touches, and one the most likely to make this theory of atmospheric sound-waves hang together if there is any intrinsic coherence in it; and although, as seen by recent quotations, he teaches, with Professor Tyndall, and in the most unmistakable terms, that sound can only be heard by the vibratory motion of the tympanic membrane caused by the synchronous dashing of air-waves against it from a sounding body, it is nevertheless a fact as gratifying as it is natural that at certain lucid moments he intuitively contradicts himself, and thus utterly overthrows the impossible hypothesis of tympanic vibration as well as that of wave-motion. This happens, however, when he is casually directing his attention to another phase of the sound-question, namely, the office filled by Corti's arches, as they are called, and the elastic microscopic appendages of the auditory nerve ramifying the labyrinth. He then apparently forgets this theoretical disturbing power of a locust's feet, capable of throwing four square miles of atmosphere into "condensations and rarefactions" with a mechanical force sufficient to "shake" at one time *two thou-*

sand million tons of drum-skins, and sensibly gives the following death-blow to the theory he has worked so long and so earnestly to establish. Mark his words:—

"In this *transference* of the vibrations of the air into the labyrinth, it is to be observed that though the particles of the air themselves *have a comparatively large amplitude of vibration*, yet their *density is so small* that they have no very great moment of inertia, and consequently when their *motion is impeded by the drum-skin of the ear* they are not capable of presenting *much resistance* to such an *impediment*, or of *exerting any sensible pressure against it*."—*Sensations of Tone*, p. 199.

How, then, in the name of science and common sense, is the stridulation of an insect to "shake" the drum-skin of the ear and cause it to oscillate, when its sound-waves are not capable of "exerting *any sensible pressure* against it"? And if it can exert no "sensible pressure" against one drum-skin, then will this lucid and authoritative writer on physical philosophy try to inform the unscientific reader how a locust can so drive off the air-waves by simply moving its feet as to set into motion 2,000,000,000 tons of such drum-skins at one time, bending *each membrane "once in and once out"* 440 times a second, yet at the same time without "exerting any *sensible pressure* against it"? A more pitiable and hopelessly suicidal self-stultification does not occur in the writings of any philosopher, ancient or modern. As a stand-off, therefore, to the universal teaching of physicists that the tympanic membrane vibrates in response to sound, as the means by which the sensations of tone are transferred to the auditory nerve and thence conducted to the brain, and as a final and unanswerable overthrow of the wave-theory of sound, I only need to quote these memorable words of this greatest living acoustician and sound expert:—

"*In this transference of the vibrations of the air into the labyrinth. . . . When their motion is impeded by the drum-skin of the ear they are not capable of presenting much resistance to such an impediment* ☞ *or of exerting any sensible pressure against it.*"

Had Professor Helmholtz been a convert to the corpuscular hypothesis of sound, and had he been attempting authoritatively to annihilate the wave-theory in a single sentence, and thus undo all he has ever done or said in favor of it, he could not have used language more directly to the point than the words recorded in the above citation.

Notwithstanding this authoritative assurance that air-waves driven into the auricular passage by means of sonorous vibrations may strike against the "drum-skin of the ear" without making any "sensible" impression upon it, yet by some kind of scientific hocus-pocus this author manages to effect what he calls a "transference" of these aerial "vibrations" through this tympanic membrane "into the labyrinth," thence to the auditory nerve, and through its multitudinous appendages finally to the brain, where the same "vibrations" which are stopped by this "impediment" of the "drum-skin of the ear"—exerting no "sensible pressure against it"—are translated into sound!

Can anybody help Professor Helmholtz? If not, will somebody try to tell the unscientific reader what he is driving at? Why is it that he so persistently labors through forty or fifty pages of his book trying to devise some means of effecting a "transference" of these supposed aerial undulations through this "drum-skin of the ear" to the auditory nerve, when there is not the least use in the world for any such complicated operation, or even for any vibratory motion of the air or its "transference" through the drum-skin, as he might easily know if he would exercise his great faculties for one minute in the right direction, instead of working with

might and main to ignore the simplest scientific truths in order to work out this impossible problem of wave-motion, and make it appear consistent? I deny emphatically that this physicist, if he were definitely asked, could give the slightest plausible reason for such "transference," or show any necessity for this hypothetic vibratory motion being carried to the auditory nerve in order to convey to the brain the appropriate sensations of tone.

We all know, and Professor Helmholtz evidently knows, that the infinitesimal and practically imponderable atoms of *odor* actually come into contact with the sensitive membrane of the nostril, that their impression is then transferred through it to the olfactory nerve, and thence conveyed along this nerve to the brain, where it is translated into the sensation of smell, independently of any oscillation of the nose or its membranes, without the assistance of any kind of wave-motion either of the air within the nostril or outside of it, and without the "transference" of any "vibrations" whatever to this nerve! If these corpuscles of a *real substance*—acknowledged to be such by the whole scientific world—can, by simple contact with one of the sense-membranes, have their impression transferred through it to the corresponding nerve, and thus conveyed to the brain without air-waves or hypothetic odoriferous vibrations, then, prythee, thou learned physicist, why all this labored effort in transferring sonorous impressions through the sensitive membrane of the ear by means of impossible undulations and useless vibratory motions, when the beautiful hypothesis of substantial sonorous corpuscles solves the problem exactly in the same way?

If substantial radiations of fragrance, intangible to any sense save one, can propagate themselves through the atmosphere by an unknown law of conduction and diffusion, without aerial or any other kind of undulatory motion, and be thus brought into direct contact with the sensitive nasal membrane, and through it have their impression transferred to the olfactory nerve, and thus conveyed along this nerve to the brain, producing the sensation of smell, without the "transference" through such membrane of any kind of external waves or vibratory motions, can it be considered an impossible or unreasonable assumption that sound also may consist of corpuscles alike intangible to four of the senses, be propagated by somewhat similar laws of radiation and conduction, make their characteristic impression on the membrane of the ear, and finally through it be transferred to the brain by an analagous process? Let the impartial scientific student and physical investigator decide.

If there were no other argument in favor of the corpuscular hypothesis of sound and its unbounded superiority in every respect over wave-motion in solving sonorous problems, this simple analogy existing between the sensations of sound and odor ought to be sufficient to satisfy any reasonable mind, especially taken in connection with these self-annihilating efforts of physicists in maintaining the wave-theory.

The erroneous assumption that sound is conveyed through the atmosphere by means of aerial undulations, the folly of which must by this time begin to be evident to the mind of the reader, has led to all this lamentable waste of time, ink, and paper, on the part of this accomplished German investigator, whose works in other departments of science, as well as in this, give evidence of great mental activity and profundity of thought. It is a real pity, therefore, that Professor Helmholtz had not first of all brought to bear his analytical and splendid mathematical powers on

the fundamental facts and principles of the wave-theory itself, and thus have shown its complete fallacy as a scientific hypothesis, which he certainly would have done had the question flatly presented itself to his mind. Had he been fortunate enough to have made this discovery, or even to have obtained an inkling of it, while writing out his *Sensations of Tone*, he would then never have been confronted with these self-stultifying facts of his theory, or have committed himself to the labor of accomplishing a "transference" to the auditory nerve of air-waves which do not exist; or, if they do exist, meet with an irresistible "impediment" in the "drum-skin of the ear," against which they are incapable "*of exerting any sensible pressure.*"

How a theory, involving, as it necessarily does, these constantly recurring self-contradictions, or such manifest mechanical impossibilities as giving to a locust the physical strength of *two thousand million horses*, could ever have found a lodgement in the intellects of such careful investigators as Professors Tyndall, Helmholtz, and Mayer, is more than I can bring myself to imagine. Yet this very mechanical miracle of an insect, by the motion of its legs, shaking *two thousand million tons* of tympanic membranes by *bending* them "*once in and once out*" 440 times a second,—infinitely more impossible, apparently, than raising the dead,—is subscribed to without the least mental reservation by the very men who laugh at the idea of any supernatural work, or of any mechanical result being effected through miraculous interposition or without an adequate physical cause; and who even do not hesitate to ironically propose a physical *praying test*, covertly to gratify their contempt for believers in the miraculous origin of the Christian religion!

This chapter, extended as it is, would be incomplete without a brief examination of the remarkable phenomena of *over-tones*, *resultant tones*, &c., so elaborately and critically treated in the great work of Professor Helmholtz on sound, called the *Sensations of Tone*, already so frequently referred to and quoted from during the progress of this review.

In addition to the acoustical importance of these most complex of all the problems connected with sound production and propagation, they appear to be regarded by physicists as specially illustrative of wave-motion and its effects, and as clearly explicable on no other hypothesis,—while to the casual observer, after reading the explanation of Professor Helmholtz, it would be regarded as futile in the extreme to attempt their solution on the hypothesis of corpuscular emissions, as here maintained. I therefore deem it a fitting subject, in connection with one or two collateral questions, on which to devote a few pages in bringing this long chapter to a close.

Over-tones, or "*partial tones*" as they are sometimes called, are faint secondary sounds of a higher pitch than the primary or fundamental tones which generate them, and are heard by a cultivated ear, and by a proper act of attention, accompanying the sounds of strings, pipes, reeds, &c. They are always the effect of a single primary tone.

Another class of secondary sounds are called *resultant tones*, or *differential tones*, which occur as the result of a chord, such as a *third* or a *fifth*, and are faintly heard as low, droning sounds, always deeper than the lowest note of the chord which generates them, and often as much as three or four octaves deeper than the lowest generating note. It is maintained by Helmholtz, and no doubt correctly, that

the vibrational number of this resultant tone is always equal to the difference between the vibrational numbers of the two generating tones. That is, if the two notes of the chord are fifty vibrations apart, whatever portion of the audible register they may occupy,—even if one is five hundred and the other five hundred and fifty vibrations a second,—the resultant tone will have but fifty vibrations in a second, or the number constituting the difference between them. Hence, he calls them "differential tones."

This eminent investigator devotes much time and many pages of his work to the analysis and elucidation of these secondary sounds, and may almost be said to be the discoverer of them, since he is the first to classify them and point out the true mode of recognizing them, and thereby of demonstrating their actual objective existence in the air, thus meeting the common objection that they are only the effect of the imagination.

Among the various means employed and illustrated by this author for detecting these secondary sounds, and thus proving their objective existence, is an invention of his own which he calls a *resonator*, which enables the investigator to vastly augment the intensity of any particular tone he chooses to examine, while other tones not in unison with the air-chamber of the resonator will be excluded, or at least will not be augmented.

In using the resonator, it is first tuned to the exact pitch of the over-tone we may wish to isolate and hear, so that its column of air will sympathetically vibrate to that particular pitch of tone, while the absence of sympathetic vibration for any other note prevents, as just remarked, its augmentation, and thus enables the entire attention to be concentrated upon one tone at a time. By holding the focus-nozzle of the resonator to the ear, and directing its open mouth to the sounding string, the special over-tone with which it is in unison will be distinctly heard, as if it were the fundamental tone, even when the most sensitive ear would have failed to detect its presence without this augmenting device. In this manner, with a special resonator tuned for every possible theoretical over-tone, the presence or absence of any such tones may be absolutely known, and recorded.

These secondary sounds are much more numerous and distinct in connection with the tones of some instruments than others, particularly in connection with the primary tones of bowed strings. So rich are these in over-tones that this physicist, as he assures us, has detected as high as *eighteen*, generated in connection with a single fundamental tone, each over-tone of a separate pitch and different degree of intensity—*the loudness diminishing as the pitch becomes higher*, until they finally become inaudible even when the ear is aided by the best resonator. How much higher these partial sounds may extend beyond the register of audibility, it is, of course, not known, though the possibility of their almost infinite extension and corresponding diminution in intensity will be apparent when their true corpuscular origin is understood.

The principal object this investigator appeared to have in view, in thus analyzing and demonstrating the existence of these over-tones, was not only to prove the actual presence of such secondary sounds, but by means of them to account satisfactorily for the *quality* of tone, or that peculiar something which is sometimes designated as *timbre* or *clang-tint*, by which we can instantly distinguish the sound of a violin, for example, from that of a flute, or the note of a clarionet from that of a

trumpet, even when the sounds are of the same pitch and of the same intensity. It is but fair to say that his reasons for the actual existence of these secondary sounds, as well as for their effect, as being the true cause of the *quality* of tone in different instruments, are unquestionably good and sufficient.

I do not, therefore, call in question or doubt the truth of the existence of these secondary tones, which, in a violin-string, correspond in pitch to its so-called harmonics, some ten in number, and which, as musicians know, are made by bowing lightly while barely touching the various nodes of the string with the finger. But while I admit the fact of their existence, and their effects, I do not believe in the cause which this great physicist assigns for their generation, or the manner of their propagation through the air. I go even further, and deny *in toto* that the wave-theory of sound can even remotely account for their existence, or explain a single phenomenon connected with their occurrence. I now propose to examine briefly the solution offered by Professor Helmholtz, and adopted from him by all modern physicists, after which I will attempt their true solution on the corpuscular hypothesis.

He starts out with the assumption, or what he designates as a "law," that since the *rate* of vibration in the sounding instrument causes the *pitch* of tone, and the *amplitude* of vibration or width of swing causes the *strength* of tone, as universally admitted, so the *form* of the vibration, or the peculiar motion assumed by the sounding body, must cause the *quality* of tone. And as the *quality* of tone results directly from the combination of these *over-tones* with the primary tone, hence the *form* of the movement of the vibrating instrument must necessarily generate these secondary tones! And, of course, as all tones must be propagated by means of corresponding air-waves, it follows, if the current hypothesis be true, that the peculiar *form* of vibration in the violin-string, for example, which generates its ten different over-tones must necessarily be transferred to the air, which faithfully transmits the same vibrational form in ten superimposed systems of waves to the tympanic membrane, which finishes the work begun by the string by acting out the same tenfold vibrational form, and thus transfers the ten separate sounds to the auditory nerve! This concisely and truthfully gives the view of this eminent investigator, almost in his own language.

The Professor insists upon this so-called "vibrational form" of the string, and of the superimposed systems of air-waves as the proper cause of the generation and propagation of these secondary tones, which determine the quality of sound, as a necessary and even unavoidable conclusion, *since there is nothing else left to produce them* after assigning the *pitch* of tone to the rate of vibration, and the *strength* or intensity of tone to its amplitude! Hence, he argues, by excluding every other adequate cause, we logically prove that the *quality* of tone must result from the *form of vibration.*

Now, if the premises were correct—that every other assumption had been exhausted as a supposable cause for these over-tones—then his logic would be good. I deny the correctness of the premises, and will state the "law" in such a way as to involve what I hope to show to be the correct solution of this problem. It is as follows:—

As the *rate* of vibration causes the *pitch* of tone, and the *amplitude* of vibration causes the *strength* of tone, so the *product* of vibration—or the character of the sonorous corpuscles generated—causes the *quality* of tone! Consequently these over-

tones must be produced by the action of the sound-corpuscles themselves. I appeal to the candid reader at the very start, and on the bare statement of the "law" as I have given it, if it does not strike the mind much more like a rational solution of these over-tones, which cause the quality of sound, than the supposition that a string actually goes through at one time with ten different rates of vibratory motion per second, which must be included in this idea of "form," each motion of a distinctly *different amplitude* or *width of swing*, to produce the different degrees of pitch and loudness, and then transmits this "vibrational form" to the tympanic membrane by means of a tenfold undulatory motion of the air carved and moulded into ten separate but superimposed systems of waves, in each one of which the same air-particles must necessarily pass through ten distinct rates of vibratory motion at one time! This must necessarily be the case, because, in each separate wave, Professor Tyndall assures us, the particles of air constituting it make a "*small excursion to and fro*," which is called "*the amplitude of vibration*," and therefore ten sounds, with ten separate systems of waves passing through the same atmosphere at the same time, however superimposed, must cause the same air-particles to make ten different excursions "to and fro," each excursion of an independent rate per second, and each excursion driving the same air-particles through a *different distance* or *width of amplitude*, since the ten sounds are all of different pitch and of different intensity! I ask if this correct but condensed view of the wave-hypothesis is not more difficult to believe, as the true cause of these ten different over-tones passing off from the same string at the same time, than to suppose, as I have assumed, that the substantial sonorous pulses contain within their corpuscles the intrinsic elements which constitute these tones of different pitch and intensity? However it may strike the reader at present, I venture to assure him that it will seem far the more rational view before he has finished this chapter.

The foregoing presentation of the impossible motions of the air involved in ten separate systems of waves necessary for the propagation of ten separate tones through the same atmosphere at the same time, is no exaggeration of the real difficulty which lies in the way of Professor Helmholtz and his attempted solution of over-tones by means of ten so-called superimposed systems of air-waves.

I have already shown, by an abundance of citations, that there is no possible way for the sound of a string, however complex, to be heard, according to the wave-theory, but for the tympanic membrane to take on a vibratory motion corresponding to the "vibrational form" and "number" of the string in producing such tone; and no way for the tympanic membrane to be thrown into this complex vibration but by the dashing of an equally complex combination of air-waves against it. Thus, the string must first of all assume the ten separate vibrational movements at one time to make these ten tones; then send them through the air in ten separate but superimposed and conglomerated systems of air-waves, having each a separate vibrational rate and width of amplitude, though combined somehow into one system; and finally, as they strike the drum-skin of the ear, that membrane must literally reproduce this vibrational form by taking on ten separate systems of vibratory motion, having ten vibrational numbers or rates of oscillation per second, and ten antagonistic amplitudes or widths of swing at the same time! Is such an infinitely inconceivable physical and mechanical op-

eration as I have here described possible or even supposable? And, in view of its utter impracticability, even disguised under so-called "superposition," is not almost any other hypothesis, which pretends to offer a solution of the problem, comparatively safe? At all events, whether or not any other explanation shall be made entirely satisfactory, air-waves and tympanic vibration have already been shown in various ways to be unreasonable and impossible in the very nature of things.

But we are constantly met in the writings of Professors Helmholtz and Tyndall with what they call, as already hinted, the "superposition" of a number of systems of waves, thus blending them into one system, embracing, as they express it, the "algebraical sum" of all the different aerial motions! Now, all this sort of language only serves to cover up the difficulty without affording the least explanation. When asked to tell how such a thing is possible, they explain it in their usual lucid manner by saying that the air-particles act "according to the law of the *parallelogram of forces.*" These mysterious phrases constitute their stock in trade on this subject, and answer for a universal solution. If they stumble upon the undeniable fact that a score of distinct tones of different pitch and of different intensity can enter the aural passage undistorted, and be heard separately at the same time; and if the query propounds itself how twenty different systems of air-waves can all clash in this narrow aperture, no larger than a quill, and yet remain undistorted, and each separate tone be heard as if it alone was present, these learned physicists appear to fold their arms, shut their eyes, and reiterate "superposition," "algebraical sum," "parallelogram of forces," and expect the reader to be satisfied!

All their reference, for aid and comfort, to water-waves, with small systems of undulations crawling over the surfaces of large billows, which they constantly resort to, amounts to nothing in this case, as they will see to their astonishment at the close of the next chapter. Waves of sound do not act on the *surface of the atmosphere at all*, and can not be made to do so unless we can construct some kind of a Jacob's ladder to reach forty-five miles high.

Both these writers tell us, in a score of places, that sound-waves can only consist of "condensations and rarefactions of the air," each tone having a degree of condensation corresponding to the width of its amplitude (loudness) or rate of oscillation "to and fro" (pitch). Hence, such a thing as *crest* or *sinus* is out of the question in so-called air-waves; and therefore the superposition of small crests upon the surfaces of large ones, to which reference is made in water-waves, forms no manner of illustration of the intermingling of air-particles in these so-called "condensations and rarefactions."

Of course, the common-sense reader would say, if we can hear twenty distinct sounds at one time, which we certainly can, and which is proved by the fact that we can isolate any particular tone out of that number to which we direct special attention, then it must follow that within this narrow aperture of the ear there are twenty different degrees of condensation of the same air-particles at the same time, or else that many sounds could not co-exist in the aural passage on the principle of air-waves. Would not this be the only sensible and logical conclusion? Professor Helmholtz emphatically admits that such multiple *condensation* of the same air-particles at the same time is impossible:—

"Two different *degrees of density*, produced by two different systems of waves, *can not co-exist in the same place at the same time.*"—"It is evident

that at *each point in the mass of air, at each instant of time, there can be only one single degree of condensation.*"—*Sensations of Tone*, pp. 40, 42.

Hence, inevitably it follows, if a sound-pulse is constituted of a distinct *condensation* and a *rarefaction*, that but one sound can exist in the aural passage at one time; for there can be no "superposition" of *condensations* or of the mere *squeezing of the air-particles together*, whatever "algebraical sum" or "parallelogram of forces" may be brought to bear on the proper crests and sinuses of water-waves. Think of twenty distinct tones from as many different orchestral instruments, all occupying one small column of air an inch long and the size of a straw, that each sound is constituted alone of such a "condensation and rarefaction," and that these twenty different degrees of *density* and as many different degrees of *rarity* are all acting at one instant on this same trifling mass of air, thus making twenty separate impressions on the auditory nerve! Can any intelligent mind accept the idea that this conglomerate mixture of *density* and *rarity*, and it alone, acting on these air-particles, is sufficient to account for twenty defined and distinctly audible musical sounds?

In the whole of Professor Helmholtz's work on sound, it is a fact that he makes but one single weak attempt to explain what he means by this "superposition" of two systems of air-waves, or what we are to understand by this "algebraical sum" of the aerial motions constituting a number of such separate systems. His attempted explanation is apparently so cautiously outspoken and so rich in scientific poverty that I can not help quoting it. Yes, I will quote the whole of it, constituting all there is to say about this "algebraical sum" of the different motions acting on a separate "particle of air," to which I ask the reader's attention:—

"The displacements of the particles of air are compounded in a similar manner [to water-waves]. If the displacements of two different systems of waves *are not in the same direction they are compounded diagonally;* for example, *if one system would drive a particle of air upwards, and another to the right, its real path will be obliquely upwards towards the right. For our present purpose there is no occasion to enter more particularly into such compositions of motion in different directions.*"—*Sensations of Tone*, p. 42.

Here the reader has all there is to be said in elucidation of this fundamental principle of the wave-theory, which necessarily requires the same "particle of air" situated in the aural passage to embody in itself the "algebraical sum" of all the motions of twenty distinct systems of waves sent off from an orchestra of that many instruments, each system having a different width of swing and different number of oscillations per second,—one system driving the particle of air upward, another perchance downward,—one sending it to the left, another to the right,—one hitting it "obliquely," another "diagonally,"—the whole twenty systems making it the battledore and shuttlecock of this contradictory hypothesis, which, after it has been acted on by all these systems at one time and in twenty different directions, with that many different velocities and throughout that many different distances, is still capable of transmitting the result to the auditory nerve in twenty distinct and symmetrically formed musical sounds, as the "algebraical sum" or "superposition" of all these contradictory motions! No wonder the "parallelogram of forces" has to be called in to aid such a muddle as this. Yet this is "science"!

I do not intend that the reader shall overlook what might be strictly called a scientific *dodge* resorted to by Professor Helmholtz in the last quotation. After elaborately showing how two systems of water-waves can collide and be superim-

posed by the crests of one system being added to those of another, he instantly shifts the solution when he comes to treat of sound from the *waves* to the *particles* constituting them. He does not say a word about the *particles* constituting water-waves, or their "real path" under the action of two forces, since their motion is entirely a different thing from that of the onward moving swell constituting the wave proper, to which he gave his whole attention. He dwells lengthily on the superposition of little water-crests compounded with larger crests, *without reference to the motion of the particles of water constituting them*, but the moment he comes to apply the analogy to sound he drops the combined movement of the air-waves and goes to work to show how a single "*particle of air*" may be driven "upward" by one system of waves, and "to the right" by another, which two forces compounded or "superimposed" will send this particle "obliquely"! Why this sudden shifting from the motions of *water-waves* and their "superposition" to the motions of *particles of air* constituting sound-waves? *Evidently because no such thing as air-waves has an existence in any true sense, as compared to water-waves or any other proper wave-motion.* True science does not require temporizing dodges or shifts of any kind.

But look again at this singular passage last quoted. Instead of telling us, as he does, that "if one system would drive a *particle of air upwards* and *another to the right, its real path will be obliquely upwards towards the right*," why does he not try to tell us what would be "its real path" if one wave should strike it and drive it upward, and another should strike it at the same time and drive it downward,—if one wave should send it to the right and another to the left,—if one should hurl it "obliquely" and another at the same instant should hit it with equal force and drift it "diagonally" in an opposite direction,—and if the twenty systems of waves should all act on the same principle, each manipulating the same "particle of air" in the aural passage, and all combining to send it in ten opposite directions at the same time? He prudently avoids any such self-stultifying inquiry as this, and wisely concludes—"*For our present purpose there is no occasion to enter more particularly into such compositions of motion in different directions.*" This is a specimen of so-called modern science, which claims to grapple fearlessly with the most abstruse and difficult problems!

The truth is, the particles of air in the aural passage, when twenty diverse systems of sound-waves are entering the ear at the same time, if there is any truth in the wave-theory, are just as liable to be hit and driven in ten directions diametrically opposed to ten other impulses, and thus to stand perfectly still under their equally compounded blows, as to move at all in any direction or to any extent! What, then, becomes of the twenty tones? They are all silenced, of course, as they can only be heard by the periodic oscillations of the air-particles in their "excursion to and fro" constituting their respective systems of waves. But since there would be no motion of the air-particles under the counteraction of ten equal forces in opposite directions, the twenty tones, as any one must see, would necessarily cease. Is it possible that our hearing of twenty different sounds from an orchestra of that many pieces depends upon any such acoustical contingencies as this accidental commingling of waves here pointed out? Yet even this possible neutralization of aerial motion, under counteracting impulses, is also included in such meaningless verbiage as "superposition" and "algebraical sum."

In view of all these contradictory results of wave-motion, is not the corpuscular assumption, that the twenty distinct sounds of different pitch and different intensity enter the ear by means of twenty corresponding systems of substantial sonorous pulses, infinitely more consistent, beautiful, and every way reasonable? That it is so will even yet be made entirely clear before this chapter is finished.

To show that I do not deal in guess-work when speaking of *ten* partial or over-tones heard in connection with the primary tone of a violin-string, each of a different pitch and of a different degree of intensity or loudness, I will give the exact words of Professor Helmholtz:—

"When a string is excited by a violin-bow, and speaks well, *all the upper partial tones* which can be formed by a string of its rigidity *are present, and their intensity diminishes as their pitch increases.* [That is, they grow weaker as they get higher.] . . . The upper partials in the compound tone of a violin are heard easily, and will be found to be strong in sound if they have been first produced as so-called harmonics on the string by bowing lightly while gently touching a node of the required partial tone. The strings of a violin will allow the harmonics to be produced as high as the sixth partial tone with ease, and with some difficulty *even up to the tenth.*"—*Sensations of Tone*, p. 133.

I have not, therefore, misconceived nor misrepresented the explanation of over-tones as given by this authority. As each one of the ten harmonics of a violin-string is produced by touching the proper node, and thus physically and mechanically throwing the string or a particular section of it into a corresponding *rate* and *amplitude* of vibration, it follows, if the solution of Professor Helmholtz is correct, that these ten harmonic over-tones are actually produced in connection with the primary tone in the same manner, by eleven (including the primary) systems of vibratory motion of the string and its various sections progressing at the same instant, each of different amplitude and at a different rate of oscillation per second! And, as before observed, since no sound can be heard without a corresponding system of air-waves and a corresponding system of tympanic oscillations, there is no possible escape from the conclusion that the same string, the same air-particles, and the same tympanic membrane, must be capable of eleven different and antagonistic amplitudes and rates of oscillation at the same instant! I again ask is such a thing as this possible? To show that it is not, Professor Helmholtz, as already quoted, unmistakably gives his testimony as follows:—

"*Any particle of air can, of course, execute only one motion at one time.*"—"It is evident that at each point in the mass of air, at each instant of time, there can be *only one single degree of condensation*, and that the particles of air can be moving with *only one single determinate kind of motion*, having *only one single determinate amount of velocity*, and passing *only in one single determinate direction.*"—*Sensations of Tone*, pp. 40, 222.

How, then, in the name of reason and science, can the same air-particles receive and transport eleven different superimposed systems of undulations, each system causing these air-particles to move at a different number of swings per second, at a different velocity, and through a different distance, at one and the same instant? Really, opposing the wave-theory as I am now doing, I have no language at my command in which to so effectually declare the utter impracticability of the hypothesis as is made use of in the above sweeping generalization by Professor Helmholtz.

Professor Tyndall is equally explicit on this subject, admitting tacitly and unmistakably in a single sentence that sound does not and can not pass through the atmosphere by means of air-waves. I ask the reader's special attention to the language of this eminent authority:—

"I have already had occasion to state to you that when *several sounds traverse the same air, each particular sound passes through the air as if it alone were present.*"—*Lectures on Sound*, p. 281.

A more point-blank contradiction of his teaching in numerous other passages could not be put into language, as will be prominently pointed out in the next chapter. It is enough to say here that this statement shows conclusively, though unintended, that eleven sounds passing through the same air at the same time, "*each particular sound . . . as if it alone were present*," can not be accomplished by eleven systems of air-waves, since it is well known that such air-waves, the same as that many systems of water-waves, must conflict and naturally interfere with each other, mutually destroying or neutralizing each other whenever the crests of one system happen to fall into the troughs of another, as eleven different systems would be necessarily and continually doing, as Professor Tyndall well knows, and teaches in a score of places. Hence, the above quotation alone overthrows the hypothesis of these eleven different over-tones being constituted of eleven systems of superimposed air-waves, if there was not another consideration to be urged against it.

But this impossible occurrence of eleven conflicting systems of vibrational movements in a single string, and of eleven antagonistic systems of air-waves sent off from the same string at one instant, each system of a different amplitude and having a distinct and independent number of oscillations of the air-particles per second, does not constitute the whole nor the worst of this impracticable theory of over-tones invented by Professor Helmholtz, and copied by Professors Tyndall and Mayer. As I have already intimated, these writers do not rest satisfied till they have carried these eleven antagonistic rates of vibratory motion and widths of swing to the tympanic membrane, since they distinctly tell us that these oscillations are exactly reproduced from the eleven systems of air-waves on this *drum-skin of the ear*, which takes up and literally acts out all these conflicting and contradictory motions at one and the same time,—which necessarily involves the mechanical impossibility of a bit of membrane, about a third of an inch in diameter, stretched across the auricular passage, keeping up eleven distinct systems of superimposed vibrational movements, each system of a different rate per second and each having a different and independent amplitude or distance of motion!

To show that these superimposed vibrations of the tympanic membrane are a mistake and totally unnecessary, we have only to refer to the membrane of the phonograph, and observe that each of its coerced vibrations is separate and sharply defined, making a distinct indentation in the foil, without any of this meaningless so-called superposition. Hence, in the reproduction of phonographic sounds, there cannot be produced in the ear what is not possessed by this simple line of indentations, though we hear, as every one knows, the most complex of all sonorous pulses —*articulate speech!* Where, then, is this talked-of superposition? (See description of Phonograph at the end of Chapter VI.)

In view of the paramount importance of the subject, I shall be obliged, therefore, prior to further investigating the cause of over-tones, resultant tones, &c., to digress sufficiently to again present and meet this vital question of tympanic vibration in its new and various phases, as presented by Professor Helmholtz in his able and exhaustive work on the office filled by the different parts of the ear; and shall undertake to show that physicists are wholly mistaken in this fundamental principle of the wave-theory, and hence are mistaken

in the whole theory, since it is, in fact, upon this the entire superstructure rests. As this learned investigator deems the vibratory motion of the different parts of the ear in response to tone as the only means of hearing so essential to the current theory of sound that he devotes *forty* pages of his book to that special question, the reader will surely pardon half a dozen pages in reply.

In this general denial that sound is heard or intended to be heard by means of the vibratory motion of the tympanic membrane in response to whatever pitch of tone, I wish here to guard against what might appear to be a conflict with observed facts. I do not claim that this "drum-skin of the ear," rigid and circumscribed in area as it is, could not be jarred into slight tremor, apparently, by a very loud sound in close proximity, such as that of a powerful steam-whistle,—though really not by the sound at all, when we come to look at the matter critically, but by the tremor of the air *thrown into agitation by the same vibratory motion which generates the sound.* Such a tremor of the air near the whistle might even jar the fingers, or lips, or nose, as well as the whole ear. But it is a superficial view to suppose it to be the sound which effects this result, because the sound occurs simultaneously and is generated really by the same vibratory motion which incidentally shakes the air for a limited distance around. This distinction I have already made in several places in the preceding argument. As an example, the reader no doubt recollects the exposure of Professor Tyndall's memorable fiasco on magazine explosions and the effects of their "sound-waves" in breaking windows! (See page 103 and onward.)

Sound, proper, can only shake such bodies as are themselves capable of making a musical tone, and whose tension at the time allows them to oscillate normally, if started, with the same or nearly the same vibrational number; or, in other words, with the same or nearly the same number of swings per second that the sounding body makes which produces the exciting tone. The reader, I trust, can understand this.

I therefore claim that if the tympanic membrane, the ear, the nose, the lips, or the fingers, should jar or tremble as the apparent result of a loud sound, it is but the incidental effect of the vibration which generates the tone, the same as the air-waves themselves sent off by this sounding body for a limited distance around are but the incidental effect of such agitation, and not a part of sound-propagation, as already shown in several places. So far from such incidental shaking of the tympanic membrane, if it really occurs, being the means by which we hear sound, as all writers on the subject take for granted, it would rather be a hindrance to our analyzing or appreciating the tone properly, if so powerful as to actually jar this organ, just as an intensely bright object presented to the eye would so agitate and distract the retina as to prevent the accurate examination of its outline.

In opposition to this view, it is claimed by Professor Helmholtz that the tympanic membrane has been distinctly felt to vibrate to sonorous pulses, and that beats from two organ-pipes slightly out of unison have been reproduced by attaching a delicate style to the auditory bone (the *columella*) of the common duck, the style being observed sensibly to vibrate as the beats struck the drum-skin of the duck's ear! Here, again, I am compelled to charge these writers with the most inexcusable superficiality in mistaking the reactive effect of the tone, through the nerves of

sensation, for the direct mechanical effect of the sound upon this columella of the duck. To show the shallowness of this reasoning, let the duck be killed, without marring or deranging in the slightest degree the auditory apparatus, leaving the style connected as before with the columella, and then bring to bear the organ-pipes, with their "beats," and if the drum-skin, the auditory bone, and the style respond as when the duck was alive, I'll give up the argument! The explanation of all such effects, as just hinted, lies in the simple and natural reactive result of sound which first produces the sensation on the brain through the sensitive tympanic membrane and auditory nerve, and then reacts in throbs corresponding to the beats of the organ-pipes on the auditory bone, and no doubt to some extent on all other parts of the duck's body!

These great physicists ought to know that they can construct artificially a tympanic membrane, even more delicate and of much finer material than that constituting the drum-skin of the duck's ear. Yet they never think of testing such a membrane, and of that size and rigidity, connected in the same manner with an artificial columella, using their beating organ-pipes and sensitive style; but reason like children, that because they see such effects produced in a *live duck*, having a reactive nervous system, it must necessarily be the gross mechanical effect of objective air-waves dashed against the drum-skin, instead of the subjective reaction of sense-shocks communicated from the brain through the nerves back upon these auditory organs!

This case of the duck and the vibrating style is similar to that recorded of the *mysis* or the *opossum-shrimp*, whose so-called auditory hairs were experimented on by V. Hensen, as related by Helmholtz in his *Sensations of Tone*, p. 225. Hensen found, on sounding a keyed horn, that certain hairs of this crustacean would quiver in response to tones of a determinate pitch, while other hairs would vibrate to other tones. Hence, the profound (!) scientific inference that these hairs, without the least regard to size or length, were *tuned in unison* to certain pitches of tone, and vibrated sympathetically as such notes were struck on the horn!

One would have thought that such careful investigators would have been struck with the acoustical anomaly of hairs vibrating to certain tones without corresponding difference in size, length, or tension, and would have been led to inquire why this result was never witnessed in the sympathetic vibration of strings, rods, or any other kinds of musical device. A tyro in the investigation of acoustical phenomena would have made this his first inquiry, and have stopped right there till the mystery was solved.

But neither Hensen nor Helmholtz appeared to be capable of noticing this bottom fact, or of looking below the surface idea of the mere motion of the hairs as certain pitches of tone occurred, and thus grasping the beautiful thought that these tones, after reaching the ganglionic center of this animal, and being there translated into sounds of different pitch, reacted through its nervous system upon these auditory hairs, whose roots connected with these nerves,—certain nerves conducting tones of one pitch, while other nerves leading to other auditory hairs, without any regard to their length or size, conducting tones of a different pitch! The possibility of such a thing as reactive effect through the sense-nerves being produced, and thereby causing certain parts or organs to quiver, never entered the minds of these learned investigators. They

superficially observed certain auditory hairs of this shrimp to vibrate as certain sounds were produced on the horn, and at once jumped to the conclusion, like children, that these hairs must be tuned in unison with that particular tone, and therefore vibrated as the effect of that particular system of sonorous waves dashing against it.

But if Helmholtz and Hensen wish to satisfy themselves of their mistake, and to become convinced that these results can only be explained, as here suggested, by the reactive effects of these tones through the nervous system of the shrimp, let them first kill this animal, as suggested in the case of the duck, and they may then blow their horn till the crack of doom, and they will find, to their individual improvement, that, so far from these auditory hairs being tuned in unison, they will utterly fail to respond, demonstrating that their tremor was the effect of subjective reaction, and that they did not move as the objective result of hypothetic sound-waves.

In like manner, if any part of our own ear is felt to vibrate by sounds of a certain pitch, we may be sure that it is subjective, as the reactive effect of the tone through the sense-nerves leading from the brain to the affected part, and not the objective result of external air-waves which have no existence in the propagation of sound except in the superficial imagination of physicists.

Analogous to this view of reaction in sound, it is well known that powerfully pungent odor, when it has produced upon the brain the sensation of smell, acting through the sensitive membrane of the nose and the olfactory nerve, may so react through the nervous system as to not only cause a shiver in certain parts and organs and force water out of the eyes, but may easily produce a reactive shock which will cause the whole physical organism to shudder! Yet what physiologist or physicist would be so superficially innocent of all logic and reason as to conclude that it was the mechanical and objective force of the imponderable granules of odor striking against the membrane of the nose which jarred the whole body and condensed the fluids of the system into tears? How simply and beautifully could the vibratory sensation felt in the tympanic membrane be accounted for if physicists would reason about sound and its direct and reactive effects in the same manner as they would be compelled to reason about the action of the somewhat analogous corpuscles of odor! As well might they descant learnedly about the nasal membrane and the organs of olfaction being thrown into vibratory motion by fragrant pulses or odoriferous waves issuing from a lump of ammonia, ignoring the substantial corpuscles of this perfume, as to continually harp upon the same kind of philosophical nonsense about sound and the effects of the superposition of supposititious air-waves upon the drum-skin of the ear!

It has already been shown, a few pages back, by the most demonstrative mechanical and mathematical argument within human imagination, that the tympanic membrane can not vibrate in response to sound, since if it did so oscillate or was so intended to oscillate as the natural mode of hearing tone, it necessarily involves the shaking of *two thousand million tons* of such ponderable matter by the stridulation of an insect not capable of stirring an ounce by exerting all its strength. No physicist can reply to that argument against tympanic vibration, and I will venture to say that no one will ever attempt it, notwithstanding it saps the very foundation of the wave-theory, as the most superficial reader must see.

But even if it were conceded that this membrane can actually vibrate sympathetically as the mode of hearing sound, or as the means by which sonorous impressions are conveyed to the auditory nerve, still, as I have already shown, this would absolutely limit us to the hearing of one single pitch of tone *distinctly*, while we might hear *faintly* the slight variation from this vibrational number,—not to exceed a semitone either way from absolute *unison*. I recently promised to revert to this important matter, so vitally important to the wave-theory if true, but if false so fatally destructive to the reasoning of physicists on the structure of the ear, and the true mode of hearing tone; for, if tympanic vibration breaks down, there is not an unbiassed physicist living who would not be compelled to renounce the wave-theory of sound, since of what use would be air-waves in the propagation of sound if the tympanic membrane can not respond to them?

As already intimated, and as is well known even to the unscientific, a string, tuning-fork, reed, pipe, or membrane, however tuned, will not be thrown into appreciable vibratory motion in sympathetic response to the tone of another instrument unless it is tuned in unison or very nearly in unison with such exciting tone; or, in other words, unless its own vibrational tension and number correspond to the number of periodic pulses generated by such actuating instrument. Hence, if the tympanic membrane were intended to vibrate sympathetically at all as the mode of conveying sound to the auditory nerve, as physicists are necessarily obliged to claim, it could not sensibly stir, as observation proves, unless its own vibrational number, or normal tendency to oscillate when put into motion, corresponded to the vibrational periodicity of the exciting tone. A sounding instrument, such as fork or string, tuned to any other pitch save that of unison with the vibrational number of this membrane, or very near it, could not, of course, stir the drum-skin of the ear; and hence, if there is any truth in the wave-theory, such a tone would not be heard at all, since this vibratory motion of the drum-skin is the only mode of hearing sound! Can any inductive mode of reasoning on any question of science be more conclusively certain than this?

It is true that Professor Helmholtz partly foresees this difficulty, and to this extent tries to guard against it; but he evidently does not fully realize its fatal consequences to the wave-hypothesis, as I will clearly show. The infinite impossibility of this diminutive membrane, but a third of an inch in diameter, vibrating in sympathetic synchronism with tones of all possible vibrational numbers or degrees of pitch seemed to flash momentarily across his thoughts, like the vision of some miracle of which, though we might wish an explanation, we must content ourselves to remain in the dark. He goes so far, however, in trying to partially provide for it, as to tell the reader that an instrument like a membrane which comes quickly to rest after being thrown into vibration does not require such accurate unison in the exciting tone as would a tuning-fork, which, when once excited, vibrates a long time! This is true enough, but still, how little does it help this terrible difficulty! For, while the fork, owing to this enduring oscillation when started, requires the most exact unison to sympathetically excite it, the membrane requires very nearly unison, or not to exceed the variation of a semitone either way, as he is himself forced to admit in the most explicit language, when speaking of the "parts of the ear," as follows:—

"The *intensity* of *sympathetic vibration* with a *semitone difference of pitch* is only *one tenth of what it is for a complete unison.* . . . Hence, when we hereafter speak of individual *parts of the ear vibrating sympathetically with a determinate tone*, we mean that they are set into *strongest motion by that tone* [unison], but are also set into vibration *less strongly* by tones of *nearly the same pitch*, ☞ *and that this sympathetic vibration is still sensible for the interval of a semitone.*"—*Sensations of Tone*, p. 216.

Frankly and unmistakably, then, let it be understood, this highest living authority on sound admits that "parts of the ear" can not *sensibly vibrate* by sympathy more than a "semitone" out of unison with any "determinate tone"! How, then, in the name of acoustics, is the "drum-skin of the ear" to sympathetically vibrate to any "determinate tone" when it is out of unison with the vibrational number of this membrane more than the "interval of a semitone"? He clearly admits such sympathetic vibration impossible, unless within this circumscribed limit; and hence, if the wave-theory be true, that the tympanic membrane is intended to sympathetically vibrate at all in response to sound as the mode of transmitting tone to the auditory nerve, as all authorities tell us, then let it be proclaimed to the scientific world that this leading sound expert and investigator has shown that it is impossible for the human ear to recognize any tone or hear any sound save that of one determinate pitch, with a faint but rapidly diminishing margin of a "semitone" either way from the proper vibrational number of the tympanic membrane!

Is it possible to believe that this universally accepted scientific theory, expounded by its ablest advocates, first teaches that the tympanic membrane, one of the principal parts of the ear, vibrates in response to all audible sounds of the musical scale, including every degree of pitch, bending "*once in and once out*" as each sound-wave strikes it as the only means of hearing tone, and then that the same theory in the hands of the same highest living authorities turns right round and teaches exactly the opposite, as just quoted, namely, that the "*individual parts of the ear*" which respond by "sympathetic vibration" can only vibrate to a sound when within "the interval of a semitone" of "*complete unison*"? The world is challenged to find any theory in the annals of scientific investigation, ancient or modern, not excepting the Ptolemaic system of astronomy, containing as many point-blank and self-stultifying contradictions as have been pointed out in this wave-theory of sound during the preceding argument. Yet the exposure of its multitudinous absurdities and self-contradictions has hardly commenced. I ask the intelligent reader, in view of the above, if it is possible for the wave-theory to remain unshattered as science while receiving such staggering blows?

But I have evidence from this same authority even more definite than this, overthrowing tympanic vibration as Nature's plan of transmitting tone to the auditory nerve. When discussing another phase of the sound-theory he naturally forgets the absolute necessity of this membrane of the ear vibrating sympathetically to tones of every degree of pitch throughout the musical scale, and deliberately teaches that a stretched membrane will respond only to a tone which happens to be in "*unison*" with it, thus confirming my argument that the drum-skin of the ear is necessarily confined to one pitch of tone if it vibrates at all.

Thus, when instructing the reader how to detect *combinational* or *resultant tones*, which, as already intimated, are low secondary sounds generated by the two tones of a chord, he shows that a stretched membrane tuned in unison with such resultant

tone will instantly be thrown into sympathetic vibration *whenever the two notes of the chord are sounded*, thus proving the presence of this resultant tone in the air, even though it may be so feeble as not to be distinctly audible, and thus demonstrating that these resultant tones are not the effect of the imagination, as some have supposed,—while he goes further, and assures us that this membrane, thus tuned in unison with such resultant tone, *will not stir when either of the two generating tones of the chord is sounded separately*, simply because neither of such primary tones is in "unison" with it! Speaking of these combinational tones, his words are:—

"Their objective existence in the mass of air *can be proved by vibrating membranes tuned to be in unison with the combinational tones. Such membranes are set in sympathetic vibration immediately upon both generating tones being sounded simultaneously*, but *remain at rest if only one or other of them is sounded.*"—*Sensations of Tone*, p. 235.

Here, then, he himself admits that stretched "*membranes*" will not vibrate sympathetically except in response to "*unison*" tones! How, then, is the tympanic membrane to vibrate to any except one single pitch of tone, and that tone the "unison" to its own vibrational number?

I could extend the annihilating self-contradictions of this eminent authority *ad libitum*, showing that whenever he is not treating directly on the tympanic membrane or some other part of the ear, and the absolute necessity of it vibrating in sympathy to all degrees of pitch, he invariably takes the common-sense view of the matter, and the view which even a schoolboy knows to be the correct one, namely, that no instrument can be thrown into sympathetic vibration by the tone of another unless the two are in unison or very near it. Take one other example, where he is speaking of a singer having the power of throwing a piano-string into sympathetic vibration by directing the voice against it. His words are:—

"The more *exactly the singer hits the pitch of the string, the more strongly it vibrates. A very little deviation from the exact pitch fails in exciting sympathetic vibration.*"—*Sensations of Tone*, p. 61.

How sensible this great physicist can be when he confines himself to scientific facts, and is guided by the unfailing laws of acoustics? But how absurdly childish he becomes the moment he branches off into the self-contradictory superficialities of the wave-theory! Can any one imagine a more abrupt transition from sound reason to insipid nonsense, than, after reading the above, to turn back to pages 175 and 176 and read what this same author and Professor Tyndall say about the tympanic membrane vibrating sympathetically to tones of every degree of pitch, bending "once in and once out" as each sound-wave strikes it, from the lowest note of the church-organ to the highest tone of the piccolo-flute?

The fact is, the tympanic membrane, if it vibrates at all in sympathetic response to tone, must act as all other membranes act, and that is, respond to only one determinate pitch—its own vibrational number; and Professor Helmholtz knows it whenever he steps outside of the wave-theory, and is thus momentarily freed from the spell of its blinding influence. But this absurd philosophy having taught him from his youth up that we can only hear sound by the vibratory motion of the tympanic membrane, he has not even in his ripe manhood the power to stamp down, crush out, and break away from an erroneous hypothesis which contradicts his very senses and upsets the foundation-laws of acoustics and mechanics, but goes on advocating what he must know, unless mentally blinded, to be infinitely impossible in the nature of things.

Now, as everybody knows that a stretched membrane can only respond to one determinate pitch of tone, or, at most, can not vary from it even faintly more than a semitone either way, and as we all know that we hear tones of every degree of pitch throughout the musical scale, and all the separate degrees with equal facility, it becomes clearly demonstrative, as must be evident to the commonest intelligence of the unscientific reader, that the hearing of sound is independent of any vibratory motion whatever of this membrane. Is not this as acoustically certain as that we hear sound at all? Hence, the wave-hypothesis, depending as it does on tympanic vibration for its existence, necessarily and absolutely breaks down.

I therefore repeat my deliberate conviction, which I believe the judgment of the scientific world, upon re-investigation, will indorse, that this assumption of tympanic vibration as the means by which the sensations of tone are transmitted to the auditory nerve, lying as it does at the foundation of the wave-theory, is an error of so grave and glaring a character that its exposure must lead to the immediate revolution of the current hypothesis of sound; and that if physicists, who have already committed themselves by writing elaborate works on the subject, shall feel indisposed to undo what they have accomplished with so much labor and effort, the work must be relegated to other investigators in time, equally competent, who will arise and take up the imperfect chain of argument introduced in this monograph, and carry it out to a systematized analysis of the whole question.

I only regret that the discussion has unavoidably forced me into such direct antagonism to Professor Helmholtz, and compelled me, though reluctantly, to expose his utterly inexcusable contradictions and mistakes in his efforts to harmonize what is intrinsically incongruous, for otherwise I might have looked upon his great analytical ability to aid the new hypothesis, and thus assist in revolutionizing the theory of sound as no living physicist, perhaps, would have been so capable of doing, had the matter been brought to his attention under less embittering circumstances.

But this vital doctrine of tympanic vibration has become too important a question, and the very life of the wave-theory of sound is too intimately involved in the truth or falsity of this single proposition, to allow the discussion of it to drop quite yet. I propose to show still further the inexplicable involvement of Professor Helmholtz in his almost insane efforts to harmonize so utterly false a theory as that of wave-motion with so fundamentally erroneous and self-contradictory a principle as tympanic vibration.

He announces an important law, which turns out to be as amusing as it is absurd. He admits, in the first place, as he is necessarily compelled to do, that the tympanic membrane, like all other membranes, has a normal "vibrational number" or periodic swing of its own, corresponding to its size, weight, and tension, of which the most ordinary student of science is well aware; and while acknowledging, as just quoted, that a membrane can only vibrate sympathetically to a tone which happens to be in "unison" to its own normal rate of oscillation, or, at farthest, within a semitone of unison, yet he seems wildly to insist, in his apparent confusion, that this membrane of the ear, unlike any other membrane, and without pretending to any special reason for it differing from other membranes in this regard, will vibrate in response to *every audible pitch of tone, whether in unison or not*, simply because the wave-theory requires it so to vibrate, and because it would be

utterly disastrous to the whole hypothesis if it did not so vibrate! Is there any other reason, real or imaginary, why this one membrane should differ thus from all others? If there is, this great investigator does not pretend to point it out, but appears to assume it on general principles. He lays down this remarkable general law:—

"An elastic body set into *sympathetic vibration by any tone* [whether in unison or not], *vibrates sympathetically in the pitch* or *with the vibrational number* of *the exciting tone;* but as soon as the exciting tone ceases, *it goes on sounding in the pitch or vibrational number of its own proper tone.*"—*Sensations of Tone*, p. 215.

There is no difficulty in understanding the drift of this law. It necessarily assumes that a membrane or other elastic body not only has a vibrational number of its own, but will vibrate sympathetically to exciting sounds not in unison with this "*vibrational number of its own proper tone*" so long as the "exciting tone" continues; but that the moment the actuating tone ceases the membrane drops that coerced rate of oscillation, and "goes on sounding in the pitch or vibrational number of its own proper tone"!

Now, this law must evidently apply to the drum-skin of the ear, for reasons which I will give. Professor Helmholtz himself distinctly teaches, as already quoted, that—

'A periodically oscillating sonorous body produces a *similar periodical motion*, first in the mass of the air and *then in the drum of our ear*, and the *period of these vibrations must be the same as that of the vibrations of the sounding body.*"—*Sensations of Tone*, p. 16.

Thus, the "drum of our ear" must oscillate with the same period "as that of the vibrations of the sounding body," whatever may be its pitch of tone or number of vibrations per second,—whether it is in unison with the "vibrational number" of the tympanic membrane, or a thousand vibrations a second out of unison! The drum-skin of the ear, as this writer must include, "*vibrates sympathetically in the pitch or with the vibrational number of the exciting tone; but as soon as the exciting tone ceases it goes on sounding in the pitch or vibrational number of its own proper tone*"! That is, if it "goes on sounding" at all; and, as a proof that the tympanic membrane is thus necessarily included, Professor Tyndall reenforces Professor Helmholtz by distinctly teaching as follows:—

"Every *wave* generated by such vibrations [without reference to pitch] *bends the tympanic membrane once in and once out.*"—*Lectures on Sound*, p. 69.

And to show that this membrane "goes on sounding," bending in and out, after the exciting tone ceases, this same lecturer says:—

"Imagine the first of a series of pulses which follow each other at regular intervals, *impinging upon the tympanic membrane.* It is shaken by the shock; and a body once shaken *can not come instantaneously to rest.*"—*Lectures on Sound*, p. 49.

Hence, as Professor Helmholtz says, "it goes on sounding in the pitch or vibrational number of its own proper tone," because it can not, of course, vibrate out of its normal or unison rate, if at all, any longer than coerced; and, as it can not come immediately to rest after the exciting tone ceases, it must come under this extraordinary law of Professor Helmholtz, and go on sounding in its own normal or "vibrational number."

We will now look at some of the extraordinary and amusing results of this law, as applied to the drum-skin of the ear. Let us suppose a certain tympanic membrane to be of such size, weight, and tension, as to make "its own proper tone" or "vibrational number" that of A, having 440 pendular swings per second; that is to say, if the drum-skin should be thrown into vibratory motion, and left to swing

normally, it would continue to vibrate at that isochronous rate till it would settle to rest.

According to the teaching of these physicists,—which we are, of course, expected to believe as science,—if an organ-pipe, representing the highest note but one in a seven-octave pianoforte (G, with 3,400 vibrations in a second,) should be sounded, this tympanic membrane is of necessity coerced from its normal rate of 440 oscillations, and made to assume the vibrational number of this high G, and bend "once in and once out" for each of these 3,400 waves per second, so long as this "exciting tone" continues, though its own pitch or "vibrational number" is only about one eighth as much. But after a little this high G ceases to sound, and instead of the drum-skin of the ear doing likewise, we are assured by these highest living authorities that it "can not come instantaneously to rest," but goes on sounding in the pitch or vibrational number of its own proper tone," or at the old rate of 440 vibrations a second!

Contrary, then, to the observation and scientific experience of the whole world, it is first coerced into an abnormal rate of swing nearly 3,000 oscillations out of tune, and that, too, remember, by "*sympathetic* vibration"; and then, contrary to all known mechanical or acoustical laws, it drops that motion and takes up a new rate of 440 vibrations a second without any known or exciting cause whatever to superinduce it, since we are told that "*as soon as the exciting tone ceases it goes on sounding in the pitch or the vibrational number of its own proper tone*"!

I deny both these positions as preposterously absurd, and contrary to both science and reason. No membrane, however tuned or tensioned, can be excited sympathetically by any tone, as Professor Helmholtz has already admitted, not in unison or very nearly in unison with its own "vibrational number"; and if so excited into an abnormal rate by a discordant sound, it could not change to a new rate without a new exciting impulse.

But the more startling consequences growing out of the doctrine here inculcated have not yet been reached. If this law governing the sympathetic vibration of a stretched membrane or other elastic body —especially the drum-skin of the ear—is correct, as here laid down by these high authorities, we have only to assume, as already intimated, any particular pitch of sound as the one corresponding to the normal "vibrational number" of the tympanic membrane, in order to at once see the beautiful working of the principle enunciated; since it is evident, as admitted by Professor Helmholtz, *that the drum-skin, as well as every other membrane, must have some definite pitch as the "vibrational number of its own proper tone."*

We have already supposed the pitch of our own tympanic membrane, for example, to be A, or the same pitch as that of the second string of the violin, having 440 vibrations to the second. Now, it is manifest, as just seen, and as I wish again to impress upon the reader, that if D should be sounded, having 594 vibrations to the second, this drum-skin will be instantly forced out of "its own proper tone" and compelled to vibrate sympathetically with D so long as it sounds, according to this remarkable law and the necessities of the wave-theory; but the moment the sound of D ceases, the "drum-skin" drops this abnormal rate of 594 vibrations to the second, and relapses back into "its own proper tone," and "goes on sounding"! Of course, according to this admirable law of Professor Helmholtz, confirmed by Professor Tyndall, the "elastic body *set into*

sympathetic vibration" by the sound of D does not cease sounding or "come instantaneously to rest" when D ceases, though it ceases sounding in the pitch of D, or with 594 vibrations to the second, but "goes on sounding" in A, with 440 vibrations, for "as soon as the exciting tone ceases it goes on sounding in the pitch or vibrational number of its own proper tone"!

Thus, inevitably, if these writers are received as authority,—and they confessedly stand the highest on this subject,—it follows that on the cessation of every sound we hear, either above or below A, the ear instantly reverts to "its own proper tone," and "goes on sounding" in A! Hence, A must be sounding in my ear all the time as a perpetual *monotone* while an orchestra is playing, filling up every interval which occurs in any piece of music I hear. No matter what may be the *pitch* or the vibrational number of the exciting tones, if there is not a single A sounded by the entire orchestra, the tympanic membrane must instantly *jump* to the tones they produce or *fall* to them by "sympathetic (!) vibration," and continue to oscillate at that abnormal rate per second till such "exciting tone ceases," when, as before observed, it *falls* back or *leaps* back, as the case may be, to "the pitch or vibrational number of its own proper tone," and "goes on sounding"!

Thus, while the drum-skin "can not come instantaneously to rest," but "goes on sounding" A, at 440 vibrations a second or 'its own proper tone," these accurate scientists and greatest living authorities on sound tell us if some one in the orchestra should strike the high D of the piccolo-flute, with 4,752 vibrations in a second, the drum-skin of the ear temporarily ceases sounding A, on which it is vibrating when not coerced, and leaps a distance of 4,312 oscillations a second out of unison or away from *sympathy*, and continues to keep up this rapid, abnormal, coerced movement, by "sympathetic vibration," so long as the piccolo-flute sounds that note! Or, if the low E of the double bass should happen to be struck, with 40 vibrations to the second, the tympanic membrane (which is now supposed to be filling up the interval, after dropping from the high D of the piccolo-flute, by sounding A, "its own proper tone,") is instantly forced down to the "vibrational number" of this new "exciting tone," and is thus compelled to swing at this slow rate of 40 oscillations a second by "*sympathetic* vibration," or just 400 swings a second out of tune or away from *sympathy!*

The result is, in listening to an orchestra of fifty pieces, we not only hear A all the time, filling up all the intervals between the countless myriads of notes of various degrees of pitch, but we hear fifty A's at one time, making each instrument appear to sound in our ear practically like a demoralized hurdy-gurdy, and converting the orchestra into an enormous band of Scotch bagpipes, with their everlasting droning and monotonous A continually ringing its changes upon our tympanic drum-skin!

But the foregoing is not all there is in this lucid principle which controls the "sympathetic vibration" of this membrane of the ear, as announced by these eminent physicists. It is well known that a musical instrument, when re-enforced by the sympathetic resonance of another sounding body which vibrates in unison, is *louder* than it would be if not so re-enforced,—while the unison instrument, which sounds alone by sympathetic vibration, must necessarily be *vastly louder*, as every one knows, than it would be if coerced into an abnormal vibration by a discordant tone,—that

is, if such abnormal oscillation were possible, which it manifestly is not. Professor Helmholtz, however, as shown in the last citation, claims it to be possible, as he is, of course, compelled to do to make it possible for the "drum-skin of the ear" to vibrate sympathetically to tones of every degree of pitch, though he does so in defiance of the experience and observation of the whole scientific world. But suppose we admit it to be true, for the present, that this drum-skin of the ear is sufficiently accommodating to the necessities of the wave-theory to act unlike all other membranes, and to thus contradict all observation; yet it is nevertheless undeniable that when the note A should happen to be sounded the tone would be enormously louder than when any other note not in accord was heard, because the drum-skin, being thus in sympathetic unison, would surely oscillate with many times greater amplitude and force when sounding in "the pitch or vibrational number of its own proper tone"; because this tone, according to Helmholtz, is so easy and natural to make that the drum-skin "goes on sounding" it without being excited into action by any tone whatever! It simply *jumps* or *falls* into it without the least effort! But this does not require an argument. It is self-evident; and Professor Helmholtz would instantly admit that the tympanic membrane would vibrate with vastly greater amplitude in sympathetic response to a *unison* note than to a *discord*.

Then it follows, with my "drum-skin" tuned as I have supposed, that in listening to an orchestra, the one single note A, whenever struck by any instrument, would always appear immensely louder to me than any other note, not only because it would produce greater vibratory motion in my ear, but because it would be sure to meet with re-enforcement by this continual relapsing of the membrane at the end of every other note, as "*it goes on sounding in the pitch or vibrational number of its own proper tone.*" Hence, in my case, with my drum-skin tuned as supposed, A would always be the predominant tone, and enormously louder than any other sound I could hear; that is, if there is any truth in this hypothesis of tympanic vibration, which I am controverting.

But even this is not the funniest feature of the problem. As the "vibrational number" of any stretched membrane depends on its *size*, *weight*, and *tension*, and as it is perfectly evident that no two "drum-skins" would combine these elements to exactly the same degree in different individuals, it follows that with one person A would be the predominant or loud note, with another B or B♭, with another C or C♯, with another D, and so on through the chromatic scale, or possibly through several octaves,—the smaller the person and the younger the child the higher the pitch of the note would become which would sound the loudest, and *vice versa!*

Thus, while A would be to me a very loud sound, being in sympathetic accord with the "vibrational number" of my tympanic membrane, B, C, D, E, F, &c., would be comparatively but feeble tones, whatever the *vis viva* in their production; whereas Professor Helmholtz, being a larger man, would probably have a "drum-skin" tuned to G, which, in turn, would make it the loud tone to him, while he should scarcely be able to hear A, or any other note of the scale, according to this advanced scientific hypothesis, inc such rates of vibration in his ear w uld have to be coerced by a discordant tone! In this way no two persons would be physically able to estimate the same tone as having the same degree of intensity, owing

to the intrinsic and constitutional diversity in the "vibrational numbers" of their respective "drum-skins,"—depending, of course, on their size, weight, and tension! A theory based on such a sapient hypothesis as this, and supported by such trustworthy authorities, surely ought to command the respect of the great intellects of the world!

But this theory of tympanic vibration is self-destructive in more ways than one, as I will now undertake to show. Physicists assume sound and light to be every way analogous, and both to be equally the result of wave-motion,—the former acting on the auditory nerve by means of *air*-waves and their impression on the tympanic membrane, while the latter acts on the optic nerve by means of *ether*-waves and their impression on the *retina*. No man will dispute this statement who has any knowledge of the undulatory theory of light, and the arguments by which that hypothesis has been deduced from the supposed atmospheric waves of sound.

Hence, if it can be proved that *ethereal* undulations do not and can not convey the impressions of light to the optic nerve, and through it to the brain, by the vibratory motion of the *retina*, it must establish, by necessary analogy, that the impressions of sound are not produced on the auditory nerve, as physicists claim, by the oscillations of the tympanic membrane. Is not this logically and necessarily evident?

That the *retina*, corresponding to the *drum-skin* of the ear, can not transmit the impressions of light to the optic nerve by oscillating in synchronism to the waves of *ether*, will strike every intelligent reader as self-evident the moment we consider how many times this sensitive organ would be obliged to actually and mechanically *swing to and fro* every second to equal the periodicity of these supposed *waves of ether*. If the reader is not posted on this special question, it would be impossible for him to make even an approximate guess.

Let us consider this matter for a moment. The highest sound in music is generated by only four or five thousand vibrations in a second, which physicists have mistakenly supposed to be transferred by a corresponding number of air-waves to the tympanic membrane, producing a corresponding number of oscillations of that organ. But thousands of vibrations a second are absolutely as nothing when it comes to the inconceivable number of swings the *retina* must make to and fro as the waves of *ether* strike it! Millions of such oscillations a second are nothing! Hundreds of millions are nothing! Thousands of millions are nothing! Hundreds of thousands of millions of such swings, in and out, of this delicate sensitive organ every second are but as the drop to the bucket contrasted with the actual number of times the *retina* has to oscillate, if it acts in accordance with the teaching of the wave-theory of sound, and vibrates as this drum-skin is forced to do. This is no exaggeration, if there is any analogy between the modes of propagation of sound and light, and if wave-motion in both cases is, as universally taught, the correct solution of their phenomena.

Professor Tyndall distinctly teaches that no less than *six hundred and ninety-nine million million waves of ether have to strike the retina every second while we are looking at a violet light!* These are his words:—

"All these *waves* enter the eye *in a second*. In the same *interval* 699,000,000,000,000 *waves of violet light enter the eye. At this prodigious rate is the retina hit by the waves of light.*"—TYNDALL *on Light*, p. 66.

Thus the *retina*, or this analogue of the tympanic membrane, if there is any truth in the theory of wave-motion, must physically and mechanically bend "once in and

once out" as each wave of light hits it, or, as here authoritatively given, must actually oscillate to and fro 699,000,000,000,000 times every second without producing the least injury to this most sensitive and delicate organ!

Is it possible for an intelligent man to believe that a physical organ of any kind could exist for a single second unimpaired, even if constituted of material a thousand times more durable than the finest steel, subjected to this process of being thus bent "once in and once out" as many times a second as required by this insane hypothesis? If not, then retinal oscillation is proved to be an absolute chimera, and with it tympanic vibration also breaks down, since modern science assures us that the two operations are entirely analogous, and equally depend upon wave-motion for their sensations.

If, to avoid this manifestly destructive effect on the *retina*, by thus bending in and out 699,000,000,000,000 times a second, it should be denied that any physicist claims such a preposterous result, or supposes it possible that the *retina*, being a physical, ponderable body, can be stirred at all as the effect of contact with an incorporeal substance like *ether*,—then I answer, if *light* can make its appropriate impression on the *retina*, and if this organ can transmit all the complex sensations of tints and shades of color to the optic nerve, and through it to the brain without the aid of retinal oscillation by the dashing of *ethereal* waves, why, in the name of science and reason, can not its congener—the drum-skin of the ear—receive and then transmit its characteristic impression to the auditory nerve in the same way, and without any oscillatory motion whatever?

Thus, in every way the question is viewed, tympanic vibration is rendered as useless as it is impracticable. It does not require a philosopher to see at a glance that if both *light* and *odor* can produce their appropriate and peculiar impressions on their special nerves of sense without bending in and out the *membranes* with which they first come into contact, that the oscillation of this sensitive membrane of the ear would not only be analogically unnecessary, but an abrupt departure from the order, uniformity, and harmony of Nature's plans. It would seem that no other argument would be required to overthrow this impracticable assumption of tympanic vibration save this single class of analogical facts just referred to, especially in view of the undulatory theory of light, which has been alone deduced from the supposed action of sound.

Really, this question of tympanic vibration as the effect of sound, on which the wave-theory absolutely rests, needs only to be presented in its proper light to a mind capable of reasoning philosophically on any question of science, to show its entire uselessness as well as impracticability. The bare fact that such pretended laws and principles as those recently examined, by which a membrane may be forced to vibrate *sympathetically to tones of every conceivable pitch*, have to be employed in order to give a show of plausibility to this vital assumption of tympanic oscillation; and the simple consideration that renowned physicists, like Professors Tyndall and Helmholtz, are compelled to resort to such a preposterous fallacy as that any musical instrument will vibrate "*sympathetically*" to a pitch of tone 4,000 oscillations out of unison, and that as soon as such exciting tone ceases will relapse to its normal swing, and go on "*sounding in the pitch or vibrational number of its own proper tone*," as the tympanic membrane must necessarily do, ought to be enough to condemn the hypothesis in the estimation

of every logical mind, even if it had not been demonstrated, as recently done, that such vibration mechanically involves the displacement of *two thousand million tons* of ponderable matter *four hundred and forty times a second* by the physical strength of an insect!

But I am even yet not through with this unspeakable folly of tympanic vibration. Its impracticability is so unavoidably self-evident that it is impossible for Professors Tyndall and Helmholtz to touch this question without developing the most startling and glaring inconsistencies. For example, in explaining "Corti's arches,"—a mass of microscopical processes in the inner ear,—they account for the use of these numerous rods or fibers as they bristle around the appendages of the auditory nerve, by assuming that they serve the practical purpose of conveying sounds of *different pitch* to the brain by each of the different arches vibrating *sympathetically* or in "unison" with the *corresponding pitch of tone* as it strikes the drum-skin of the ear! Thus, each individual arch or rod of Corti, having a proper vibrational number of its own, can only respond when a "unison" sound, or one nearly of a corresponding vibrational number strikes the tympanic membrane!

Notwithstanding its utterly suicidal and subversive character, involving as it does the flattest possible contradiction of the idea that the "drum-skin" of the ear can vibrate *sympathetically* and with equal facility to every audible pitch of tone, yet these greatest of modern physicists and the leading sound experts and investigators of the world go on innocently fabricating their theory of Corti's arches and their absolute acoustical necessity in the mechanism of the ear for the transportation of *each separate pitch of tone* to the brain by the *sympathetic* vibration of a correspondingly tuned Corti's arch,—forgetting, as usual, for the time being, that this single little drum-skin of the ear, a third of an inch in diameter, can individually and alone take on as many different vibrational numbers and respond sympathetically to as many separate degrees of pitch as the whole of Corti's 3,000 arches put together, where there are, as we are told, about *fifty* rods tuned in unison for each tone of the audible register!

The whole matter is thus so pitiably self-stultifying and subversive of the fundamental principles of the wave-theory, as based on tympanic vibration, that I must treat the reader to a brief citation or two. Professor Helmholtz remarks:—

"When a simple tone is presented to the ear, those Corti's arches which are *nearly or exactly in unison with it will be strongly excited*, and the rest only *slightly or not at all.* Hence, every simple tone of *determinate pitch will be felt only by certain nerve-fibers, and simple tones of different pitch will excite different fibers.* When a compound musical tone or chord is presented to the ear, *all those elastic bodies will be excited which have a proper pitch corresponding to the various individual simple tones contained in the whole mass of tones;* and hence, by properly directing attention, all the individual sensations of the individual simple tones can be perceived."—"The end of every fiber of the auditory nerve is connected with *small elastic parts*, which we can not but assume to be *set in sympathetic vibration by the waves of sound.*"—*Sensations of Tone*, pp. 190, 222.

In addition to these statements, on page 218, in speaking of the same rods of Corti, he insists that they "*must be differently tuned, and their tones must form a regularly progressive series of degrees through the whole extent of the musical scale*,"—even, of course, down to the lowest notes of the pianoforte or organ!

Professor Tyndall is equally explicit in teaching that Corti's organ must be an instrument having its multitudinous strings tuned in "unisonant vibration" with all our audible musical sounds:—

"Finally, there is in the labyrinth a wonderful organ, discovered by the Marchese Corti, which is to all appearance a *musical instrument, with its chords so stretched as to accept the vibrations of different periods and transmit them to the nerve filaments which traverse the organ.* . . . Each musical tremor which falls upon this organ selects from its *tensioned fibers* the one appropriate to *its own pitch*, and throws that fiber into *unisonant vibration*."—*Lectures on Sound*, p. 224.

These quotations only need to be casually examined for the reader to recognize the complete absurdity of this entire assumption, so essential to the wave-theory, namely, that the tympanic membrane, singly and alone, tuned necessarily to one single pitch, if tuned at all, can take on a vibratory motion corresponding to every sound we hear, whatever may be its pitch.

We must understand that Corti's arches are located in the labyrinth between this tympanic membrane and the brain, and that every sound we hear has to first pass through the drum-skin, according to this theory, by the proper vibratory motion, before it can play upon this harp of three thousand strings! According to Professors Helmholtz, Tyndall, Mayer, and, in fact, all writers on sound, this one little membrane can not only vibrate by the synchronous dashing of air-waves in perfect periodicity to every pitch of tone we hear, assuming each separate vibrational number, but it can even oscillate to fifty or a hundred or even a "thousand" different degrees of pitch at once! But as soon as the sound passes through this membrane, which alone answers the purpose of oscillating to every shade of pitch we hear, it absolutely requires a separate Corti's arch of the exact "unison" length and tension for each separate pitch, in order that high and low sounds may be equally conducted to the brain! Why, in the name of acoustics and common sense, can not a single Corti's arch, of a single length and of one degree of rigidity, vibrate to all possible pitches of tone, when a single diminutive drum-skin is susceptible of taking on not only a suitable rate of vibratory motion for every audible tone throughout the musical scale, but can adapt itself to a "thousand" different and antagonistic vibrational rates at one and the same time? The pitiable involvement of the wave-theory becomes more and more conspicuous and hopeless at every new advance made in the examination of its details.

Another practical absurdity in the assumed sympathetic vibration of Corti's rods, "*differently tuned*" to respond to tones of all degrees of pitch, or "*through the whole extent of the musical scale*," as just quoted, must strike the critical reader at a glance. The "differently tuned" strings of a pianoforte, in order to produce its seven octaves, are not only compelled to vary in length from $5\frac{1}{2}$ feet to $1\frac{5}{8}$ inches, the difference being as 1 to 40; but the size and weight of these strings, from the lowest to the highest, must diminish in about the same proportion. Thus, there is a difference between the *weight* of the highest and lowest strings of the pianoforte, in order to "*form a regularly progressive series of degrees through the whole extent of the musical scale*," as 1 to about 1600!

How is it, now, with these Corti's rods, which, as Professor Helmholtz claims, accomplish the same acoustical result, and which Professor Tyndall describes as a "*musical instrument, with its chords so stretched as to accept the vibrations of different periods*"? The fact is well ascertained by Hensen's careful measurement, which was right before the eyes of both Professors Helmholtz and Tyndall when they made these statements, that the difference of length between the longest and shortest of these rods is only about *one half*, or as

1 to 2, while no perceptible difference in size is recorded Notwithstanding this essential and patent acoustical fact, these model investigators, either ignorant of its bearing on the main question or regardless of the scientific opinions of mankind, ignore it as if it had no existence, and go on bunglingly to teach that these microscopical rods, with only this maximum difference in length as 1 to 2, and no difference in thickness, are actually tuned as a "musical instrument" of 3,000 strings, in absolute "*unison*" with the chords of a seven-octave pianoforte, having an unavoidable difference in length, in order to generate the tones, as 1 to 40, and a necessary difference in weight as 1 to 1600! Yet such teachers and such instruction are pointed to as the highest "scientific" authority on sound!

I must ask the reader's indulgence while presenting just one other and the closing argument against this vital assumption of the wave-theory that the tympanic membrane or Corti's rods can vibrate, by any possibility, in "unison" with musical sounds,—an argument, by the way, which, like the preceding, admits of no kind of reply.

The truth is, no argument would be really necessary to show the practical impossibility of any such an operation as tympanic vibration, or the "unisonant" response of Corti's rods, to a mind possessing the least original scientific capacity. I say this advisedly and deliberately, but kindly. It is only for these so-called *scientific investigators*, who have learned to circle in this beaten theoretic path, that any serious argument is required,—who, however competent and profound on other questions of science, seem so completely bewildered and blinded by the influence of the wave-theory of sound, that they exhibit the puerility of mere children the moment they come to treat of the effects of wave-motion upon the ear, and the office of its individual parts.

This charge, I admit, appears supremely ridiculous on its face, made against such world-renowned scientists as those I am reviewing; but, after the most careful deliberation, I defy any man of ordinary intelligence to doubt the exact and literal truth of the impeachment, after paying the slightest attention to the arguments here being presented. The reader need go no further for the evidence on which to base his decision as to its correctness than the single consideration which I will now submit.

As surprising as it may seem, these learned authorities, who have devoted much of their lives to the investigation of sounding strings, reeds, forks, rods, membranes, &c., and who have experimented hundreds and perhaps thousands of times on the proper length, weight, and rigidity of strings, and size and tension of membranes to produce tones of certain determinate degrees of pitch, have never once taken the trouble to think of the practical impossibility of rods or strings under a certain definite length, weight, and rigidity, producing such results, or responding to them, by "unisonant vibration"! With all their experience and familiarity with such phenomena, it never occurs to them, when they come to philosophize about the individual parts of the ear, and when trying to adapt them theoretically to the chimerical requirements of the wave-theory, that it is acoustically essential for a string to be at least of a certain determinate length in order to vibrate in "unison" to the low notes of the pianoforte, for example, but really suppose and seriously publish to the world that a Corti's *rod*, only the one 300th of an inch long (less in length than the diameter of a common hair), is capable of

vibrating in "unison" with, and hence of actually producing the tone of, the low A of the pianoforte, having but twenty-seven vibrations to the second,—which, under the best mechanical skill, requires a string with a length of about five feet, and a weight at least of several ounces!

Instead of allowing this essential feature of *length*, *weight*, and *rigidity*, a place in their thoughts, as a basis for determining the "vibrational number" of a given string, or other sounding body,—the very first thing a schoolboy would take into account, if his attention were called to the subject, —they quietly and innocently ignore this whole question, as if it had nothing to do with the laws of acoustics, and go on reasoning about a loosely stretched membrane, a *third of an inch in diameter*, having the same vibrational number as that of the head of a bass drum, *with a diameter of three feet!* Is not the charge I have just made well founded? Let us illustrate the matter in a way which can not fail to produce conviction.

Imagine Professor Helmholtz stepping into the pianoforte manufactory of Mr. Steinway, in this city, where he finds the proprietor busily engaged on an improved working model of a grand piano, *about an inch long!* I can fancy the following conversation as occurring between this greatest of living acousticians and sound experts, and this king of pianoforte-makers.

HELMHOLTZ.—"Good morning, Mr. Steinway. What in the world are you making there, in which you seem to be so deeply absorbed?"

STEINWAY.—"A grand piano, sir;—an improvement that is going to revolutionize the business, based on late acoustical discoveries which do away with the necessity of such enormous size and expense in construction. I am building, sir, a vest-pocket piano,—one that a musician can carry with him, wherever he goes, as easily as he can carry his watch. 'There are millions in it!'"

HELMHOLTZ.—"What length, Mr. Steinway, do you propose to have the strings?"

STEINWAY.—"The longest strings, or those producing the lowest notes of the bass, according to my improved scale, which I have just completed, will be exactly *one inch* in length, while, for the highest notes, seven octaves above, the strings will be just *half that length.*"

HELMHOLTZ.—"Mr. Steinway, you are a practical joker. But come, now, be serious. We Germans do not deal in jokes when we come to mechanical improvements, involving, as yours does, the established laws of acoustics,—especially when our knowledge of them harmonizes with the universal experience of acousticians and musical instrument makers. You surely can not be in earnest about practically producing the tones of the pianoforte on such a diminutive affair as the one you are constructing!"

STEINWAY.—"I am in earnest, sir; and you will find, before you are through with me, that it is anything but a '*joke.*' I am prepared to prove that the laws of acoustics have always been misunderstood until very lately, and that musical instrument makers have all been laboring under a foolish and expensive mistake in regard to the length of strings essential to generate the low tones of a pianoforte, since it is now demonstrated by recent scientific discoveries that strings *an inch long* are even more than sufficient for the lowest bass notes of the musical scale. You smile, sir, and seem astonished; but you will find that this valuable improvement, based on scientific principles, is anything but a 'joke.'"

HELMHOLTZ.—"Why, my dear sir, you are crazy! Your constant study over this

instrument for so many years must have turned your head, and converted you into a *monomaniac* on the question of improving the pianoforte! Take my advice, and burn your model at once; and banish the hallucination from your thoughts. It will ruin your reputation and your business, as it is all nonsense, and a clear evidence of insanity in your case, to suppose that you could generate as low a note as A, with twenty-seven vibrations in a second, on such diminutive strings as those on your model, only an *inch long* and no *thicker than fine silk threads;* and then it is worse than folly that you should suppose it possible to raise the scale through *seven full octaves* by a reduction of only *one half in their length*, when the laws of acoustics, according to all experience, require the bass strings of a pianoforte, in order to generate the appropriate tone, to be *over five feet long*, and the length of the highest strings, for seven octaves above, to be but the *one fortieth* as much! Yet you madly essay to accomplish the same result, with a difference of only *one half!* I am surprised that you could ever have permitted such a baseless fallacy to take possession of your thoughts! Why, Mr. Steinway, the idea of attempting to make a string only *an inch in length* assume the normal swing or vibrational number of one *five feet long*, surpasses in folly the whimsicality of the clockmaker who would attempt to force a *pendulum* to beat *seconds* with a rod no longer than one of your strings. Think of it! A child, half a dozen years old, ought to know better than this!"

STEINWAY.—"Professor Helmholtz, I will give you the reasons which have led me into this important improvement. I have been reading lately a couple of popular works on acoustics and sonorous phenomena in general,—one called the *Sensations of Tone* and another called *Lectures on Sound.* In these able productions I have learned, for the first time, to my surprise, that Corti's microscopical rods, situated in the labyrinth of the ear, constitute a 'musical instrument'—a 'lute of 3,000 strings'—which is actually tuned in 'unison' to all the different strings of the pianoforte, from the lowest bass notes up to the high A of the upper octave. And I also found, in these popular and authoritative scientific works, that there was only a difference of *one half* between the length of the longest and shortest of these Corti's rods, which has led me to improve my scale accordingly. But, most important of all, I found that the longest of these rods was only about the one 300th of an inch in length, and that this rod really oscillated in 'unisonant vibration' to the lowest note of the piano. Why, then, should you call me crazy, and seem so astonished because I take advantage of this important scientific discovery, especially *when the strings on my model are exactly three hundred times longer than are the strings of this wonderful 'musical instrument' in the human ear, which responds sympathetically by 'unisonant vibration' to every note of a grand piano?* You evidently are not posted in modern science; for, if you had read these standard works on sound, you would have applauded my advanced ideas as away ahead of all competitors in the art of pianoforte-making, instead of charging me with being a 'monomaniac'!

"I admit, at once, that the pendulum is governed by the same isochronous law; and hence I assume that clockmakers, as well as pianoforte-makers, have always labored under a radical misapprehension, for *science* can not be wrong, of course; and therefore, according to these recent acoustical discoveries, it is perfectly manifest that no special length of rod is needed to produce sixty or any other number of

oscillations of the pendulum-ball in a minute! I intend, as soon as I have demonstrated the correctness of my piano-scale, to go and see the clockmakers of this city, and bring about a revolution in their crude ideas of the pendulum and the length of rod necessary for determinate rates of oscillatory motion.

"I fear, my dear sir, that it is the authors of those books on sound who are insane, *or at least just three hundred times nearer being monomaniacs than your humble servant.* Whenever those books of which I have spoken (which teach that strings and rods three hundred times shorter than those of my instrument can be tuned to vibrate in 'unison' to every note of a grand piano) shall be made a public bonfire of, as an oblation to the cause of true scientific progress, you can then ask me to burn my model,—not before. Good-day."

Really, with such a practical rejoinder as this, one can imagine Professor Helmholtz making a bee-line for Berlin to destroy his stereotype plates and revise his *Sensations of Tone*,—while he no doubt would stop off on the way in London, and suggest to Professor Tyndall the propriety of adopting a similar course.

It would seem that the infinite impossibility of one of Corti's rods actually vibrating in "unison" with the E-string of the double bass, for example, or with any other note in the audible register, would be so self-evident that its suggestion and advocacy in any work on science would be scouted and laughed at, and its author branded by universal acclamation either as a scientific lunatic or an ignorant pretender. Yet, instead of this, the very works which teach such inexpressible nonsense as this "unisonant vibration" of Corti's rods to every tone of the musical scale, are received as standard authorities in our greatest institutions of learning.

If these microscopical rods of Corti can really vibrate at all in "unisonant" response to tones of any kind, it is perfectly evident that *such tones must also be microscopical;* that is to say, the tone which would be adapted to the excitation of such a rod would require to be as much *finer* and *higher* than ordinary musical sounds as these strings of Corti's organ are more diminutive than those of ordinary musical instruments! Is not this acoustically rational and consistent? Then, as these rods of Corti are but the one 4,000th as long as the strings of the violin, for example, it follows that Corti's "lute of 3,000 strings," as Professor Tyndall calls it, ought only to respond by "unisonant vibration" to a tone 4,000 intervals higher than those generated on the unfingered chords of the violin! This must be obvious to every thinker.

A church-organ builder who should become so demented or infatuated with modern science as to attempt to substitute for his longest pipe a section of a timothy straw an inch in length, expecting thereby to produce the same result, though he would be pronounced a monomaniac by Professor Helmholtz, as was the case with the piano-maker just supposed, is really three hundred times *less insane* than the scientific writer who insists that a Corti's rod the one 300th of an inch long is capable of vibrating in "unison" to the same pitch of tone. Yet these learned authorities can not see it.

But, finally, to cut the argument short on these Corti's rods, and thus brush the whole hypothesis of the "unisonant vibration" of this "lute of 3,600 strings" out of existence at a single sweep, it is only necessary to refer to the recent discovery of C. Hasse, by which he has shown that these microscopical processes, so essential to the wave-theory of sound, have no existence

at all *in the ears of birds!* Yet it is a notorious fact that the mocking-bird can distinguish and analyze tone, noting and imitating the finest shades of difference in *pitch*, equal to a prima-donna! Thus, we have at last a fitting culmination to one of the most stupid and inexcusable scientific fallacies of this or any other age.

If Professors Helmholtz and Tyndall *have* been blindly led into this fatal assumption of tympanic oscillation and the "unisonant vibration" of Corti's rods in response to the lowest strings of the pianoforte, they are neither of them so stupid as not to realize, as soon as they read this exposure, the doom which has overtaken their elaborately developed hypothesis. To suppose that such renowned investigators of sonorous phenomena do not know and can not see, when they come to reflect, that such "unisonant vibration" and tympanic oscillation are out of the question, and acoustically impossible and absurd, would be to proclaim them ignorant of the elementary principles of science. Yet that *they did not know it when they wrote their works on sound*, but actually believed a locust capable of shaking millions of tons of physical drum-skins by the motion of its legs, and that the infinitesimal rods of Corti were actually tuned so as to vibrate in "unison" with the lowest notes of the piano and church-organ, is conclusively shown by the numerous quotations from their works already made. What explanation they can make, if any, remains to be seen. I venture the prediction that no reply to these ruinous arguments will ever be made or even attempted.

Really, in view of such mechanical and acoustical fallacies, publicly taught in books and lectures, and which everywhere superabound in the writings of these physicists, gravely spread out before the world as *philosophy* and *science*, and which a schoolboy might easily have known to be without a possible foundation in fact, one is almost inclined to doubt *in toto* the advantages of a scientific education, and to fall back, as the only safe thing, on the common schools of our ancestors. What is the use, one is tempted to ask, of our so-called "scientific courses," in colleges and universities, which lead to such preposterous results?

We need no better illustration than the one before us, since we can scarcely imagine it possible, in this seventh decade of the nineteenth century, that any physicist or mathematician could be found who would venture to teach that the tympanic membrane actually bends "once in and once out" for each sound-wave and for every audible pitch of tone we hear, without regard to "vibrational number"; or that Corti's rods, less in length than the diameter of a hair, can be actually tuned in "unison" with the strings of the violoncello!

Still, the fact that such unspeakable absurdities in science are really taught by sound experts and investigators, like those from whom I am quoting, must be attributed alone, as I have already explained, not to their want of intellectual ability or scientific culture and discrimination, but to the paralyzing and blinding influence of the prevailing theory of sound. But even this fact, that a few such specialists should be thus misled and duped by a universally accepted theory, to which they have devoted much of their lives, is not nearly so surprising as that the same fallacies should be adopted and believed by scientific thinkers throughout the land, and of all classes, without one man being found to lift his pen or his voice against such an imposition upon the education of the world.

I have felt, at times, while plodding through these learned disquisitions on the tympanic membrane bending "once in and once out" by the contact of air-waves which have no existence, and of Corti's rods, which have no necessity for moving at all, being *tuned* to "unisonant vibration" with the strings of the double bass, that if the earnest and sincere manner in which the positions were maintained did not preclude derision by evincing such intense candor on the part of these writers, the hypothesis ought justly to meet with the jeers and laughter of the whole scientific world. As it is, the hypothesis from beginning to end appears to the writer like a serious scientific joke, too absurd to believe and yet too grave to laugh at.

But I have pursued this feature of the subject farther than I had intended; and sufficiently, I trust, to convince the reader that the vibratory motion of the tympanic membrane, as well as of Corti's rods, is purely visionary, without the least foundation in fact or necessity in science, being impossible in the nature of things, and self-contradictory, as we have seen, even in the hands of the most careful and critical advocates of the wave-theory of sound.

I repeat, and emphasize it, and wish to impress it on the mind of the reader, that if the *retina* can receive the supposed waves of *ether* in countless millions per second, and transfer their impression to the optic nerve without any oscillatory motion whatever of that sensitive organ, and if the *membrane of the nose* can receive by direct contact the admitted corpuscles of odor and convey their impression to the olfactory nerve, along which it is conducted to the brain, and there analyzed and translated into its characteristic sensation of smell, without the intervention of any kind of wave-motion of *air* or *ether*, and without any vibratory action either of the nose or its membrane, then what absolute folly and waste of valuable time on the part of Professors Tyndall and Helmholtz is all this labored and contradictory effort through hundreds of pages of their books to prove that we only hear sound by means of the oscillation of the tympanic membrane or the "unisonant vibration" of Corti's arches!

What conclusion, then, are we to come to as regards the true cause of these overtones, resultant tones, &c., from which I have unavoidably been forced to digress in order to examine thoroughly this question of tympanic vibration? They can not result from the "vibrational form" assumed by a string while oscillating as a whole, and thus producing its fundamental tone, as it would require the string to divide itself up into as many as eighteen different sections in addition to the primary, some of them not much over an inch long, and each section to take on a separate and independent rate of vibratory motion corresponding to the pitch of its special overtone. This, without an argument, must strike the mind as an utter impracticability.

The assumption of Professor Helmholtz that the "vibrational form" of a violin-string under the action of the bow is the real cause of the peculiar quality of such tone, and consequently the cause of the ten over-tones thus generated which constitute such quality, and which can be heard in connection with its primary tone, is entitled to but very little weight in the estimation of the reader. It will be recollected that while originally preparing his hypothesis of "vibrational form," and describing the peculiar manner in which the string oscillates and its velocity in relation to that of the bow, he perpetrated one of the most ridiculous and inexcusable

scientific blunders on record, making the normal velocity of the oscillating string *ten times greater than that of the bow in the player's hand!* I refer the reader back to that memorable *trip-hammer* fiasco exposed on pages 95–98, in which it was shown that his whole hypothesis of vibrational form was based on an assumed state of facts which turned out to be exactly in every respect the opposite of what he supposed. If, therefore, this eminent investigator, in laying the foundation for his hypothesis of "vibrational form" as the true solution of the cause of over-tones, is wildly at sea on its fundamental element, a matter which a child a dozen years old should have understood, ignoring and misconceiving the primary and governing laws of physics as he did, is it not more than probable that he has also misapprehended the other essential features of these phenomena? At all events, though I make it a rule to attribute all these errors to the blinding influence of the wave-theory, it may be considered every way safe, nevertheless, not to rely too implicitly on the absolute accuracy of observations which have shot so wide of the mark as in the case referred to, and which have been also found wanting in so many essential instances as pointed out all through the preceding argument.

But even supposing that the violin-string could take on *eleven* separate vibrational rates of motion, acting like the trip-hammer in the mill, rising with the bow slowly and then returning *ten times* as rapidly, I have already shown that the eleven separate systems of air-waves necessary for the propagation of these over-tones, according to the wave-theory, do not and can not exist, whether superimposed or not; and if they did exist, they could not produce eleven systems of oscillation in the tympanic membrane, since that organ does not vibrate at all in response to sound, and is not so intended to vibrate, as demonstrated in half a dozen ways. And, finally, I have shown from Corti's arches the unspeakable folly of this whole vibratory hypothesis as relates to the ear and its individual parts as the means of conveying sound to the auditory nerve, and through it to the brain.

In view of all these considerations the reader must admit the probable correctness of the conclusion that these over-tones are neither generated by the eleven-fold vibrational form of the string, propagated by the eleven-fold superimposed systems of air-waves, nor transmitted to the brain through the eleven-fold vibrational movement of the tympanic membrane.

The wave-theory, then, being shown to be wholly inadequate to explain the cause of these phenomena, or to account in the slightest degree for their manner of propagation or transmission to the brain through the sensitive mechanism of the ear, let us now see if the corpuscular hypothesis may not furnish a rational clue to the solution of over-tones. If it shall turn out, after a careful examination of the question, that the assumption of substantial sonorous pulses really meets and solves this complex and difficult problem as beautifully and consistently as it has met and explained other phenomena encountered since the commencement of this investigation, without rippling the surface of the solution with a single contradictory or impossible detail, it would then seem little short of downright madness, not to say pig-headedness, on the part of physicists to reject the possibility of corpuscular emissions, and cast them aside as unworthy of scientific consideration.

On the assumption that sound, like odor, is really a substance of unknown but won-

derful attenuation, emanating from the sounding body in absolute corpuscles, there would be nothing at all unreasonable or marvelous in the fact that primary sonorous particles, generated by the vibratory motion of the string, should, on radiating through the air, scintillate or give birth to secondary systems of corpuscles, which might pass off in pulses not only of the periodicity of the primary radiations, but which might include many different vibratory rates corresponding to and thus producing the feeble over-tones of different degrees of pitch described by Professor Helmholtz as heard accompanying the fundamental sounds of instruments.

This explanation of over-tones, resultant tones, &c., as their probable solution, and the most rational way of accounting for the quality of tone, was distinctly foreshadowed while discussing the decrease in the intensity of sound as the square of the distance from its source. (See pages 156, 161.)

By turning back to this reference it will be seen that the primary corpuscles of sound may not only become radiating centers for other systems of smaller sonorous particles, but that these in turn may likewise become radiating fountains of still smaller offshooting systems, and so on,—each new system of radiations, or at least a portion of each system, passing through the air with such relative periodicity as will correspond exactly to the vibrational numbers of the over-tones heard, the same as if they had been generated as harmonics by the vibratory motion of corresponding ventral sections of the string.

In this way the over-tones resulting from successive subradiations would necessarily become fainter and fainter about to the same degree as observed; and instead of being limited in number to the producible and audible harmonics of a string, or even *eighteen*, as noted by Professor Helmholtz, we might reasonably suppose that the constantly diminishing systems of radiating corpuscles might be extended far beyond the power of human observation, the ear in the mean time being only capable of recognizing, by the best scientific helps, the number already indicated. The probability of such an almost unlimited extension of these higher and fainter over-tones only adds to the absolute impossibility of accounting for their generation by the unlimited multiplicity of segmental divisions of the string, or of their propagation by an equally complex superposition of atmospheric undulations.

Although this hypothesis of secondary radiations of sonorous corpuscles, as the actual cause of over-tones, can not be directly demonstrated, it is equally true that it can not be disproved, as has been done in the case of air-waves; while I have no hesitation in believing that the view thus presented can be so re-enforced by analogous phenomena in Nature all around us, as to render it not only highly probable as the true solution, but almost rationally certain. At all events, I propose now to show that it not only has this reasonable and consistent ground for acceptance as the true explanation of these phenomena, but that it is completely justified and warranted by the voluntary admissions of the very authorities I am reviewing, and in such language that there can be no valid objection urged against its probability, especially by advocates of the current theory of sound.

But supposing, before we advance further, that the current hypothesis is correct as to the first branch of the general assumption that these over-tones are really generated by the segmentation of a string

into that many ventral and vibrating sections; and admitting it possible that these subdivisions can all vibrate at one time in connection with the fundamental oscillation of the string, and with as many different rates of periodicity as claimed by the theory:—such a state of facts would be entirely consistent with the corpuscular origin of these eighteen distinct over-tones, since each independent section of the string, having a vibrational number of its own, would generate and radiate a system of substantial sonorous pulses which would pass through the air with a periodicity corresponding to the normal oscillation of its ventral segment, as well as agreeing with the observed pitch of its proper harmonic over-tone. If, therefore, it were possible for a single string, as Professor Helmholtz claims, to subdivide itself up into *eighteen* ventral segments, besides its fundamental swing, and thus generate these eighteen tones by as many corresponding rates of oscillation, I would not have to go a single step further for my explanation of over-tones, based on corpuscular emissions; since these vibrational rates in the string would generate the very substantial pulses with the exact periodicity required by my hypothesis, without any of the absurd "superposition" required by the wave-theory.

With this view, therefore, of the origin of these *eighteen* over-tones, I am only obliged, so far as my hypothesis is concerned, to postulate *one* impossibility—the separate and independent oscillations of *eighteen* ventral segments of the string at one time; while Professor Helmholtz is compelled to assume *three*, by extending these eighteen rates of periodicity to eighteen superimposed systems of air-waves, and then, finally, to eighteen independent rates of tympanic vibration at one and the same time!

The corpuscular hypothesis, therefore, even accepting the *first impossibility* as a basis, steers entirely clear of the *other two*, either of which is infinitely more inconceivable than the first, since we do know, by actual observation, that a string can vibrate in separate ventral segments, to a limited number, at one time; while the superposition of air-waves or of tympanic oscillations, even to the number of *two*, has not only never been observed, but has been proved, in a score of different ways, to be impossible according to every known mechanical law or principle of science. Thus, admitting the truth of the first and lesser impossibility, the corpuscular view of the origin of over-tones becomes at once clear and simple, and confessedly *three times* as consistent and reasonable as the current explanation,—involving, as it does, all three of these impossibilities. Can any logical course of reasoning be more plainly self-evident than this?

But suppose, as I insist, that the self-division of a string into eighteen independent vibrating sections at one time is actually and mechanically impossible; and assuming, then, that the fundamental oscillation of the string does really generate substantial sonorous pulses, as my hypothesis requires, is there anything unreasonable or impracticable in the view here taken that the primary sound-corpuscles thus generated should, by subdivision, radiate a secondary system of pulses, these a third, these a fourth, and so on, as already explained, thus giving rise to the various degrees of over-tones observed? I hold not only that such a result would be entirely possible and reasonable, but I will immediately show that it is clearly justified by the teaching of the very authorities I am now reviewing.

To treat the matter specifically, I maintain that there surely can be no greater difficulty in conceiving the idea that pri-

mary sonorous corpuscles, passing off from a sounding body, should *give birth to secondary pulses* of smaller corpuscles possessing a faster or slower rate of emission, thus generating these faint secondary tones either higher or lower, than there is in supposing, as Professor Tyndall distinctly teaches, that the *primary air-waves* sent off from a sounding body, after they have left it and started on their journey, may "*give birth to secondary waves*" which will propagate themselves through the air with an entirely new rate of periodicity, and thus generate these over-tones, resultant tones, &c., having distinctly different degrees of pitch! As strange as it may seem to the reader, this is not only taught in unmistakable language, but it is reiterated in several forms, by this author, as I will now proceed to show. Note the following words:—

"*Vibrations* which produce a *large amount of disturbance give birth to secondary waves which appeal to the ear as resultant tones.*"—*Lectures on Sound*, p. 281.

Thus, a primary air-wave has the power of subdividing itself, and giving birth to other waves of a distinctly different periodic rate! Is not this clear? It might be charged, however, that I misunderstand Professor Tyndall. That he does not say that *air-waves* after being generated "give birth to *secondary waves*," but that "*vibrations . . . give birth*," &c. I assert that I do not misconceive his meaning. These "vibrations" refer to the "oscillations to and fro" of the air-particles constituting such primary sound-waves, and not to the vibratory motion of the sounding body itself, which any one can see by reading the context. As a proof that this is his meaning, the reader is referred to the following, where the same author is explaining the action of the double *siren*:—

"The sound of the *siren* is a highly composite one. By the suddenness and violence of its shocks, not only does it produce *waves* corresponding to the number of its orifices, but the *aerial disturbance breaks up into secondary waves which associate themselves with the primary waves of the instrument.*"—*Lectures on Sound*, p. 291.

This language can not be misunderstood. It is the "primary waves of the instrument," or, in other words, the "aerial disturbance" which "*breaks up into secondary waves*," or which *gives birth to them*. Hence, plainly, if a primary wave can "give birth to secondary waves," which can start off into new vibrational rates, thus generating "resultant tones" of entirely different degrees of pitch, I have an equal right to assume that primary sonorous corpuscles may "break up into" or "give birth to secondary" sonorous corpuscles which will pass off at diverse rates of periodicity, and thus "appeal to the ear as resultant tones" as well as over-tones! If secondary air-waves can be born of primary air-waves, after leaving the instrument, and can then change their *vibrational rates* so as to "appeal to the ear as *resultant tones*," two, three, and four octaves lower than such primaries, then surely sonorous corpuscles constituting the fundamental tone of a string, according to my hypothesis, may give birth to secondary systems of corpuscles constituting over-tones, on the same principle, after they have left the generating instrument, of but one half, one fourth, or one tenth such primary periodicity. Is not this inductive reasoning every way logical and consistent, if there is the least rational foundation for the position of Professor Tyndall?

But here comes in the amusing feature of this great writer's unique assumption that "primary waves" can "*give birth* to secondary waves, which appeal to the ear as *resultant tones*." It is well known to every scientific student that "resultant tones," as already explained, are two, three,

and even *four* times *lower* in pitch than the primaries which generate them; and hence their air-waves are correspondingly *longer*, since the wave-length of any tone is exactly proportional to its depth of pitch. Professor Tyndall thus presents us with the startling scientific exhibition of baby-waves at their "birth" *three* and *four* times longer than their *mothers!* But what is such a feat as this for a theory which has no hesitation in giving to a trifling insect more physical and mechanical power than is possessed by all the locomotives in the world combined, making it capable of bending "once in and once out," at the rate of 440 oscillations a second, *two thousand million tons of tympanic membranes by the motion of its legs?* Why, then, should it excite a smile when we are informed that *maternal* air-waves, according to this same theory, can really "*give birth* to secondary waves, which appeal to the ear as *resultant tones*," four times longer than these primary parents? Really, we are only just beginning to get an adequate idea of the prodigious capacity of this enormously underrated theory which has stood unshaken for so many centuries!

The new hypothesis, though postulating a somewhat analogous result, does not involve the nativity of any such absurd aerial or corpuscular monstrosities as just described. It only supposes that the primary sound-corpuscles, as they pass off from a sonorific body, scintillate, or "give birth" to smaller secondary particles of their own sonorous substance, and thus become the parents of lesser pulses, which, radiating in new currents, necessarily produce feebler tones, either higher or lower as the case may be, according to the periodicity of these successive scintillations, or according to the vibrational rate at which they follow each other through the air.

Surely Professor Tyndall, who has no difficulty in believing that primary air-waves may, by subdivision or breaking up, "give birth to secondary waves," thus generating tones of a different pitch, ought not to object to my hypothesis of primary substantial pulses giving birth to secondary pulses of a fainter and fainter type, which will "appeal to the ear" as harmonic over-tones in connection with the fundamental sound of the string.

Every phase of the sound question seems to favor this corpuscular idea as the probably correct solution of such exceedingly faint over-tones, rather than the self-contradictory and preposterous abnormality of primary air-waves subdividing themselves, or breaking up into other waves four times as large as the originals, each of which has a fourfold length of "condensation and rarefaction." The very fact that the so-called harmonics of the violin, made in the usual manner with the bow while gently touching the proper node of the string, are always shrill, and heard among the loudest and most distinct tones of the orchestra, being produced, as they are, by the proper vibrations of the corresponding ventral sections of the string, while the same notes generated as over-tones are so extremely feeble that they are only audible to the finest ear, even by the aid of a resonator when no other fundamental tones are being sounded, would seem clearly to indicate that the latter are not generated at all by the same vibratory motion of the corresponding ventral sections of the string which produces ordinary orchestral harmonics.

Here, then, as now presented, is my main argument, against which, I aver, Professors Tyndall and Helmholtz can make no reply. They are themselves wholly estopped by their own reasoning, since they are compelled to assume at least one class of secondary tones ("resultant") which do not

originate in any possible sectional vibration of the string, since they are lower than its fundamental note, and hence can not be accounted for on the principle of "vibrational form"! All the talk of these learned physicists, therefore, about air-waves "exceeding the limits of superposition," and then breaking up into secondary waves which give birth to resultant tones, only goes to help the corpuscular hypothesis of sound, as here maintained. I ask no other admission from these high authorities than the fact that "*resultant tones*" can and do originate in the air after the two generating tones of the chord have left the instrument, to prove that *over-tones* may and necessarily should originate in the same manner, whatever that manner may be, and without the aid of the string's segmental vibration, even if any such vibration were possible.

If primary *air-waves*, I repeat, must necessarily "give birth to secondary waves, which appeal to the ear as *resultant tones*," being the only possible way to produce them, *since the string can possess no vibrational rate slower than its fundamental swing*, then surely there is no acoustical nor mechanical reason, which any physicist can give, why the same primary air-waves may not also break up into or "give birth to secondary waves, which appeal to the ear" as harmonic over-tones! If primary air-waves sent off from a string can, as Professor Tyndall teaches, give birth to baby-waves three and four times longer than themselves, it would manifestly be easier, on the wave-theory, and less strain on the primary maternal waves if they should "give birth to [small] secondary waves, which appeal to the ear" as upper partial tones, only one half to one twelfth as long as their aerial mothers!

If, in plain logic, "resultant tones" do not require "vibrational form" or any equivalent segmental vibration of the string to generate them, but can leap forth out of other waves while passing through the air, what, in the name of acoustics, is the use of "vibrational form" or the oscillation of any ventral sections of a string to give birth to over-tones! It is either all nonsensical superfluity, or else this revelation of Professor Tyndall about primary waves giving birth to enormously long secondary waves, constituting "resultant tones," is scientific latitudinarianism in the superlative degree.

Is it reasonable, therefore, or consistent, to suppose that there could be two distinct and directly opposite plans of generating these secondary sounds,—a part of them being produced by the segmental vibration of the string while the fundamental tone is sounding, and another part without any such sectional vibration of the string at all, but generated on an entirely different principle, after the fundamental tone had left the string and started through the air? Such a supposition is manifestly inadmissible.

But now, after having shown by the order, harmony, and consistency of things, the reasonableness of my position—that all secondary sounds, including *upper partial* as well as *resultant tones*, should have but one mode of origination, and that mode the one substantially admitted by Professor Tyndall—*given birth to in the air after the instrument has done its work*—I here undertake to prove by the same authority that *over-tones*, or *secondary harmonics*, which accompany fundamental tones, also do not originate in the "vibrational form" of the instrument or by the independent oscillation of its sectional subdivisions at all, *but are generated like resultant tones in the air after the tone leaves the sounding body, by the primary waves, as he claims, subdividing or breaking up into*

harmonics as well as into lower resultant tones. I will first show this by continuing the quotation made a moment since, in which Professor Tyndall teaches that the primary waves issuing from the *double siren* break up into secondary waves, which also include these upper partial or harmonic over-tones. The reader will mark the language well, as it drives and clinches the last nail for this over-tone problem:—

"The sound of this siren is a highly composite one. By the suddenness and violence of its shocks not only does it produce waves corresponding to the number of its orifices [its *fundamental tone*], but the *aerial disturbance breaks up into secondary waves which associate themselves with the primary waves of the instrument exactly as the harmonics of a string* or of an open organ-pipe *mix with their fundamental tone.* When the siren sounds, therefore, *it emits, besides the fundamental tone, its octave, its twelfth, its double octave* [its upper partial or over-tones], and so on."—*Lectures on Sound*, p. 291.

Corroborative of this, another passage is equally to the point, in which Professor Tyndall is speaking of air-waves becoming *overgrown*, so to speak, to such extent as to exceed the limits of "superposition," and thus break up into over-tones "*which correspond to the harmonic tones of the vibrating body.*" Here are his words:—

"A *single sounding body* which *disturbs the air beyond the limits of the law of the superposition of vibrations*, also produces *secondary waves* which *correspond to the harmonic tones of the vibrating body.*"—*Lectures on Sound*, p. 282.

Or, as before quoted, "the *aerial disturbance breaks up into secondary waves which associate themselves with the primary waves of the instrument,*" and thus "*give birth to secondary waves*" which "*correspond to the harmonic tones of the vibrating body*"! Can anything in science be plainer than this?

It is thus clearly conceded by this authoritative writer that these over-tones caused by the breaking up of the "aerial disturbance" into secondary waves are not produced by the harmonic vibration of the ventral segments of the string at all, since they only "*correspond to* the harmonic tones of the vibrating body," whereas they would be the actual harmonics themselves if made in that way! I therefore ask no other concession from our learned authorities than the foregoing, that these harmonic over-tones, as well as differential tones, are the result of the subdivision of the "aerial disturbance" after it has left the string, and thus can not come directly from the "vibrational form" of the sounding body, as laid down by Professor Helmholtz at the very foundation of his theory of over-tones.

Hence, we arrive at the logical conclusion *that all secondary tones, whether upper partial or resultant, originate in the air, after the sounding body has done its work, by the subdivision and radiation of that which constitutes sound itself!*

It only then remains to determine what actually constitutes sound. Is it simply wave-motion or substantial corpuscles? Professors Tyndall and Helmholtz assume, as their theory requires, that air-waves sent off from the vibrating instrument are all there is involved in its phenomena; and that, by breaking up and subdividing, all these secondary tones are produced. I assert that this assumption has been utterly and disastrously overthrown in numerous ways during the progress of this argument, by showing the impossibility of wave-motion being the cause of sound. Hence, I feel sure the reader must agree with the conclusion that these secondary sounds can not originate by the breaking up of one system of air-waves which have no existence in Nature, and thus give birth to another system equally having no existence, while having, as assumed, an entirely different rate of vibration, and several diverse degrees of amplitude and of

wave-length. Hence, the final and only possible conclusion is, that, if substantial sonorous pulses be admissible at all (and the preceding considerations must determine that), the subdivision of their corpuscles into lesser and lesser secondary radiations, having the proper periodicity, must be the only rational solution of all such secondary sounds.

If Professor Tyndall should object to these successive radiations of already infinitesimal sonorous corpuscles as being too "thin" to admit of such subdivision, and as being beyond our comprehension or even conception, I refer him to his own words concerning the corpuscles of *ether*, an hypothetic and all-pervading substance which is so attenuated that 699,000,000,000,000 of its waves a second may dash against the *retina*, as recently quoted, without injury to that sensitive organ! He also says:—

"The intellect knows no difference between *great* and *small:* it is just as easy, as an intellectual act, to conceive of a vibrating *atom* as to conceive of a vibrating *cannon-ball;* and there is no more difficulty in conceiving of this *ether*, as it is called, which *fills space*, than in imagining *all space to be filled with jelly*."—"Within our atmosphere *exists a second and a finer atmosphere* [ether] in which the *atoms of oxygen and nitrogen hang like suspended grains*."—*Heat as a Mode of Motion*, pp. 264, 345.

This is manifestly getting substantial corpuscles down as "thin" as required for my hypothesis of sound, even with its sonorous particles scintillating secondary radiations of smaller and "finer" corpuscles, constituting, as I have assumed, these upper partial and lower resultant tones.

If Professor Tyndall can not understand how such secondary corpuscular radiations can dart off through the air at different rates of periodicity, corresponding to these various over-tones of different pitch, let him explain to the readers of his book how a primary system of air-waves can subdivide itself by *exceeding the limits of superposition*, and thus *give birth to secondary waves*, which propagate themselves through the air at various rates of periodicity, both faster and slower than the primary system, corresponding to all the upper partial as well as lower resultant tones, and I will agree to at once adopt his explanation for the secondary corpuscular radiations involved in my hypothesis. This is surely a fair proposition to the wave-theory.

Having thus endeavored to give my reasons, in general terms as well as in detail, for rejecting the explanation of the cause of over-tones offered by the wave-theory, and in favor of the more simple, consistent, and evolutionary hypothesis of corpuscular emissions as the true solution of the problem,—let us now look for a moment at the beautiful analogical phenomena existing all around us favoring the latter eclaircissement, while we note the unquestionable fact that not one single analogical consideration can be found in Nature (not even *water-waves*, as will be seen in the next chapter) favoring the assumption of physicists that these secondary tones owe their origin to the unparalleled phenomenon of one system of air-waves breaking up and giving birth to other systems, each of an independent periodicity or "vibrational number," and some of them several times larger than their primary parents.

If sound really consists of substantial sonorous pulses instead of the wave-motion of the *medium which conducts it* (which the ultimate overthrow of the current hypothesis must fully establish, as no doubt most physicists would readily admit, since there seems to be no middle ground to assume), there will then be no difficulty in conceiving the fact that the sonorous particles thus constituting a sound-pulse might con-

tain within their substantial elements the principles and radiating forces necessary to generate these secondary emanations. For, if original sound-corpuscles can pass off from a string by some unknown law of radiation and conduction at the rate of one thousand feet a second, there would seem to be no good reason why smaller scintillating particles might not also dart off from these primary corpuscles in various directions by the same law, and from these again others, and so on for each successive over-tone; and, as already observed, far beyond the powers of human observation.

There would appear to be no reason, judging from analogy, why a substantial sound-pulse should not radiate secondary sonorous corpuscles with such variety of periodicity as would constitute tones of different pitch, when the substantial corpuscles of odor passing off from a single flower can radiate atoms, or give birth to secondary fragrant pulses, which appeal to the olfactory nerve as different and distinct perfumes! A certain rose, for example, as my own sense of smell bears me witness, may not only be rich in the prime or fundamental fragrance of its genus *rosa*, but may also radiate at the same time the faint partial smells or odoriferous over-tones of both *tea* and *musk* as its upper harmonics. And as that wonderful musical genius, Blind Tom, will instantly name off correctly every note, when a discordant mass of a dozen digitals is struck on a pianoforte at one time, alone by the analytical powers of the auditory nerve, so a certain perfumer in New York is well known to the writer, whose olfactories are so sensitively acute and so educated by practice that he is able to disentangle in an instant an unknown mixture containing half a dozen or more essential oils, or other odorous substances, and name each ingredient, alone by the analytical powers of the nose! The beauty of this analogy existing between the *nose* and the *ear* and between the universally admitted particles of substantial *odor* and what I claim to be the equally substantial corpuscles of *sound*, can hardly fail to impress the mind of the reader with the remarkable similarity in this analytical operation of the two nerves.

It is a well-known fact, worthy of remark, that the analogy existing between the *eye* and the *ear* and between *light* and *sound* is constantly referred to by physicists when treating on the phenomena of hearing and of sonorous propagation; but I have yet to see the first hint or reference, directly or indirectly, in any of their writings, to the manifest and wonderful analogy existing between the *ear* and the *nose*, or between the action of *sound* and that of *odor!* Why this universal and apparently studied omission? There can be but one intelligible reason assigned for such seemingly wilful and concerted ignoring of the most beautiful and startling analogies in Nature, and the utter silence of physicists in regard to their numerous parallel phenomena, and that is this: that any reference to the substantial corpuscles of *odor* and the action of the *nasal membrane* or of the *olfactory nerve* in receiving and transmitting to the brain the sensation of *smell* as analogous to that of *sound* and the action of the *ear*, would instantly overthrow the wave-theory! Who could believe in sound as wave-motion after the admission of any such analogy? But since the comparatively recent origin of the undulatory theory of light, based on the wave-theory of sound, thus making *ether* the analogue of *air* and the *retina* the congener of the *tympanic membrane*, it becomes perfectly safe and scientifically legitimate, in the estimation of these careful and candid investigators, to constantly remind

their readers of the remarkable analogy between the *eye* and the *ear*, and the numerous points of resemblance between the action of *light* and that of *sound!*

Judging from all my reading on the subject, and I have read very carefully on this question, it is safe to infer that if *light* were now universally accepted as the emanation of substantial corpuscles, as it was before the time of Sir Isaac Newton, Professors Tyndall and Helmholtz, in advocating the popular atmospheric wave-theory, would be as careful to avoid any reference to the beautiful analogies existing between *light* and *sound* as they now are to give a wide berth to those existing between *sound* and *odor!*

It is anything but agreeable to be compelled to believe such a state of facts, and even more unpleasant to be forced to thus charge home upon the greatest modern investigators of science any such superficial onesidedness; but this monograph would be inexcusably imperfect, and the writer justly chargeable with direliction of duty to the young scientific students of our colleges and other institutions of learning, if this narrow-minded, not to say disingenuous, tendency of our greatest so-called impartial scientific investigators were not laid open to the world as it deserves, and as a warning to future scientists.

There is no question but that an analogy exists between the modes of operation of all the senses, from the lowest or most limited (that of *touch* or *palpation*) up to the highest or most unlimited (that of *sight*); yet not much as between the lowest and the highest, taken at a single step, though the gradation upward is beautiful, and the transition as each step is taken from sense to sense is perfect. In the sense of taction the sensation depends upon the actual contact of the body felt, and not of its radiated or diffused corpuscles, and therefore the distance is nothing.

Taste is greatly similar, yet it borders slightly on smell, since a pungent flavor touching the palate or any portion of the gustatory membrane, instantly diffuses itself throughout the entire mouth, from the lips to the laryngeal region.

Smell, next in the upward order, is higher than taste and approaches hearing, receiving the atoms of perfume at a distance from their source, as they radiate from the odorous body through the air, and with considerable velocity, though much less, and of vastly less range than that of sonorous pulses.

Though *hearing* can reach to a still greater distance than *smell*, yet the difference is almost as nothing contrasted with the immeasurable difference between the range of *sound* and that of *light*.

Although the range of vision and the inconceivable velocity of light almost infinitely surpass those of hearing and of sound respectively, yet there are many beautiful analogies between them, especially those of *reflection* and *convergence;* while there are many marked dissimilarities, such as the absence of shadow in sound, and its power of penetration and conduction through all substances, while light can pass through no opaque body whatever!

There is also a great difference in the analytical capacity of the two senses. The eye can not analyze a single ray of light, and resolve it into its primary colors of the spectrum till it has been separated by the prism; yet the ear is capable of grasping and disentangling the separate notes of a complex chord, as just illustrated in the case of Blind Tom, while the *nose* in a similar manner vastly surpasses the *eye* and almost equals the *ear*, as just shown, by its

capacity for separating and recognizing the individual constituents of a conglomerate mixture of different odorous substances.

So natural and unstrained is this manifold analogy existing between *sound* and *odor*, and between *hearing* and *smell*, that among the uneducated masses almost universally a *strong effluvium* of any kind is referred to as a "*loud*" smell! To speak of an intense light as being "*loud*" would be so evidently strained and far-fetched that the intuitive employment of slang among the vulgar has never yet led to its use, though a flash dress of very brilliant colors has sometimes been spoken of as "*loud.*" Yet physicists, noted for almost judicial candor and fairness in their investigations of science, as just seen, deliberately ignore these marked analogies between the two senses, which do not reenforce wave-motion, for no visible reason except that they would prove utterly ruinous to a pre-adopted theory. To deny this manifest analogy between sound and odor and between the auditory and olfactory nerves is impossible. To attempt to give any other explanation of the universal silence of physicists on the subject, when writing on sound, is equally out of the question.

The sense of *taste* also possesses an immense register, as well as remarkable analytical powers like those of *smell* and *hearing*,—in this respect also surpassing the *eye*, as it can detect and recognize different degrees of gustatory sensation equivalent in extent to many octaves of sound. In fact, the register of distinct and sensible degrees of *saporosity* which a palate is capable of analyzing and distinguishing, from the lowest notes of *bitter* to the highest tones of *sweet*, not only surpasses that of the eye, even after the ray is separated, but equals that of the nose and very nearly that of the ear.

It is simply surprising when we come to reflect upon the scores of different sensible gradations of the low pungent, bitter, and acrid flavors, alone, which the palate can separately recognize, and then the equal number of degrees of acidity; and, finally, the almost endless varieties embraced in the sweets and fruits of Nature, including the viands, condiments, desserts, and relishes developed by the culinary art.

These analytical powers of the sense of taste are so perfect that a number of different kinds of spice—such as clove, cinnamon, nutmeg, &c., or other highly flavored substances,—may be thoroughly pulverized and mixed, and a pinch of the compound be placed upon the tongue, yet the composite mass can be at once analyzed by the palate, and each individual ingredient definitely determined by a proper effort of attention, the same as the nose can untangle a combination of different odorous substances, or the auditory nerve analyze and separately recognize a composite sound, designating the constituent elements of the chord. Yet who supposes that the gustatory membrane and nerve receive their impressions of taste by the *vibratory motion of the palate* rather than by means of the actual contact of the corpuscles of flavor?

It is also a noticeable fact that flavor can produce a persistent or a kind of *resonant* effect upon the gustatory membrane, which will continue to *ring* even for some minutes after its substantial corpuscles have entirely left the mouth. It is on account of this persistent impression that the intensity of sweet, for example, may be augmented through contrast by previously tasting some sharp acid, such as lime-juice, and *vice versa;*—just as the action of a high or shrill tone on the tympanic membrane causes a low note immediately following to appear lower than it

really is, and *vice versa*. Professor Tyndall would, of course, undertake to account for such tympanic effect by insisting that the drum-skin of the ear "can not come instantaneously to rest" after being "once shaken," or thrown into vibratory motion, though he would hardly venture to claim that the palate continues on oscillating after receiving a *sour* impetus from the gastronomical undulations of tartaric acid!

I might easily extend this analogy to *combinational* or *over-tastes*, as the experience of any one with a little attention will confirm. Under civilized improvements in the culinary art we can scarcely taste an article of food which does not contain the upper partial flavors of spices, condiments, seasonings, or relishes of some kind, in addition to the normal flavor of the viand proper, which an effort of attention can easily recognize as the saporific harmonics in the scale of gastronomy,—while, without any additions by the *cuisine*, we all know that the delicate flesh of the snipe or woodcock, if left an hour too long in the sun before being prepared for the table, will so far "exceed the limits of superposition," acting under the law of some sort of gustatory "parallelogram of forces" as to "give birth to secondary waves" of flavor, the "algebraical sum" of which will appeal to the palate of the epicure as a *resultant* taste, producing anything but gastronomic harmony!

It matters very little to me, therefore, if physicists, in their confused and onesided attempts to harmonize the inconsistencies of the wave-theory while treating on *sound* and the mechanism of the *ear*, dare only call attention to the analogies of *light* and the structure of the *eye*, in order to reenforce that hypothesis. The advocate of the evolution of sound, from its low and superficial base of wave-motion to the higher and sublimer level of corpuscular emanations, is not forced into any such asymmetric science by blotting out a part of Nature's analogical chart. He has no need for keeping back a part of the price, or for suppressing a single page of the record of Nature, since he has no such circumscribed and limping hypothesis to maintain. He is not tied to the superficialities of incidental air-waves which sometimes result from sound-generation, but which have no more causal relation to the propagation of tone than the incidental lengthening of the shadow of a tree has to the setting of the sun, or to the revolution of the earth! He sees in this shallow attempt at the solution of sonorous phenomena the same puerility which the far-reaching and evolutionary grasp of Copernicus discovered in the superficial and weak conceptions of philosophers of his time, who persisted in maintaining the Ptolemaic view of the solar system, based on the mere surface appearances of solar and stellar movements. He recognizes, in carefully investigating the phenomena of sound, an intimate and connected correlation linking all the senses into one beautiful and homologous concatenation, from the lowest to the highest, and rationally concludes that if the first three—*touch*, *taste*, and *smell*,—depend for their sensations, as the whole world admits, upon the absolute contact of substantial corpuscles, that it is unwarranted and illogical in the highest degree, unless from overwhelming facts to the contrary, to assume that the remaining two senses —*hearing* and *sight*—should constitute a departure from this inauguration of Nature's plan, and thus abruptly sever its analogical chain.

Is it not every way in harmony with correct ideas of order and congruity of purpose in the working of Nature's processes, that corpuscular contact, which ad-

mittedly prevails in the operations of the first three senses, should continue unbroken through the other two, with the corpuscles of sound and light, inconceivably more tenuous, and radiated under the control of subtler and more refined laws, rather than to assume a change in this consistent and beautiful programme by postulating another and unnecessary arrangement utterly unlike that governing the first three, and without the least regard to unity of design or continuity of operation?

In thus assuming to discard the surface ideas of wave-motion and to explain the problem of over-tones, resultant tones, &c., by the hypothesis of secondary radiations of substantial pulses, we are taught to reject mere appearances as generally superficial and false; and this is re-enforced by the fact everywhere observed in Nature, that what appears as a single substance becomes, when analyzed, a duality, and oftentimes a multiplicity of distinct substances, so interblended as to utterly defy the powers of human observation till they are separated.

That primary sonorous corpuscles should contain within their substance the entitative elements and forces which constitute and radiate these faint and almost inaudible over-tones, is no more of a mystery than that a single drop of apparently homogeneous blood should not only be constituted of a multiplicity of separate globules, but that each globule should be a composite and heterogeneous mass, containing not only its primary elements of albumen and fibrine, but also its fainter ingredients of iron, salt, lime, sulphur, sugar, phosphorus, magnesia, and even water, whose separate corpuscles are also composite and constituted of independent atoms of oxygen and hydrogen! No more marvelous than that the golden nuggets cast forth from the secret laboratory of Nature should contain, besides the prime metal, the "harmonic over-tones" of silver and copper; or even the faint "partial notes" of nickel, bismuth, or other metalliferous substances. No more wonderful, carrying the mystery from the physiologic, metallurgic, and acoustical world, into the realms of psychology, than that the fundamental passion of *love* should contain within its elemental nature the substantial "over-tones" of *jealousy*, *hope*, and *fear*, blended many times with the apparently antagonistic but deeply rumbling "resultant" or "differential" notes of *anger*, *hate*, and *revenge!*

In this analogous manner, as just seen, a single sensation of taste may recognize the presence of half a dozen distinct flavors,—a single sniff of odor may convey to the analytical department of the brain adapted to this sensation a number of separately recognizable grades of perfume,—while a single fundamental sound can be analyzed by the auditory apparatus exactly in the same way, and may thus be found to contain several distinct over-tones of different degrees of pitch and intensity.

Thus each of the senses, including the substantial corpuscles actuating it, has its *range* as well as its *register*,—while every sensation is equally the result of absolute corpuscular contact with the appropriate sense-membrane. Without this there is no consistency nor analogical harmony in the plan of Nature. For example, as the auditory nerve recognizes the octaves of sound by their *pitch*, from the slowly pulsating bass to the rapidly throbbing soprano, so the optic nerve recognizes its single octave of light in its variety of *color*, from the deep notes of vermillion and crimson, through the middle register of green and yellow, up to the highest tints of blue and violet: and as the gustatory nerve recognizes its octaves of taste by

variety of *flavor*, from the low and shuddering notes of aloes and wormwood, through the mean register of acids, up to the purest and highest tones of nectarous sweets,—so the olfactory nerve recognizes and analyzes its numerous octaves of odor by their variety of *scent*, from the low exhalations of putrid substances and the repugnant effluvium of the sty, up through the numberless gradations of agreeable perfumes, finally culminating in its highest octave, containing the exquisite fragrance of the rose and the pink, the ineffable and delicate sweetness of the hyacinth and honeysuckle, and the matchless richness of the heliotrope and lily of the valley, which may be accented as among the purest harmonics of this wonderful odoriferous scale!

Analogies like these existing between the different senses, particularly between those of *taste*, *smell*, and *hearing*, and consequently between *flavor*, *odor*, and *sound*, with two of them the acknowledged results of corpuscular contact, could hardly be supposed to exist unless the other was equally the result of analogous substantial pulses! While physicists would never think of calling to their aid any kind of wave-motion, either of the *air* or *ether*, in accounting for the sensation of *taste* or *smell*, and would resort to no oscillatory movement whatever, either of the *palate* or of the *nasal membrane*, in order to explain the wonderful analytical powers of these organs in disentangling the most complicated mixtures of *flavors* and *odors*, is it reasonable, I again ask, that they should upset this consistent programme as soon as they come to *sound*, and thus violate the unity and continuity of Nature's plan by making the sensations of tone depend upon the manifestly impracticable wave-motion of the air, the impossible oscillation of the tympanic membrane, or the ridiculous "un.sonant vibration" of Corti's microscopical rods?

And lastly we have in perfume the startling analogue of *differential* or *resultant tones* by the mingling of a *chord* of two distinct odors, and thus generating a third effluvium essentially different from either.

It is well known to chemists that if a solution of ammonia is saturated with sulphureted hydrogen gas, each possessing its own peculiar and characteristic odor, a compound is obtained called sulphide of ammonium. In this compound an experienced observer can easily detect three distinct smells, namely, that of ammonia proper, that of sulphureted hydrogen proper, and besides these a *resultant* or "*differential*" smell entirely distinct from either, which clearly results from the combination. There is no "*vibrational form*" about this resultant smell which produces the peculiar "quality" of the odor, while physicists will hardly undertake its solution by the "superposition" of a number of systems of odoriferous undulations, aided by the "parallelogram of forces," thus making up the "algebraical sum" of all the different systems of smell considered individually, as does Professor Helmholtz in accounting for combinational tones!

In conclusion, I will only repeat in substance what I have before intimated, and now wish to impress upon the mind of the reader, that if the sensitive membrane of the nose is capable of receiving and transferring to the olfactory nerve the numberless varieties and shades of perfume of which Nature is so prolific, each one of which is separately conveyed to the brain and there translated into its proper individual sensation, without the aid of any vibratory motion whatever of this membrane, and without the dashing of superimposed waves of *air*, *ether*, or any other

kind of substance save that of the granules of odor itself, and with the whole scientific world admitting perfume to be a substantial emanation of corpuscles, though unrecognizable by any other of the senses,—is it not reasonable and every way consistent to assume, as I have done, that sound likewise is an emanation of substantial corpuscles, also unrecognizable save by a single sense; and is it not rationally probable that such sonorous particles act on the sensitive membrane of the ear, and through it on the auditory nerve, and finally on the brain, in substantially the same manner as do the corpuscles of odor, without the intervention of air-waves or any vibratory motion of the ear or its individual parts, especially in view of the various classes of facts and arguments brought to bear in this chapter against the current theory of sound?

I therefore, with the utmost confidence in its truth, submit the new hypothesis (with my reasons in part for rejecting the old one) to the unbiassed judgment of physicists, especially such as are not directly and personally committed to the wave-theory of sound, confidently expecting that a verdict will be rendered alone in the interests of science.

CHAPTER VI.

EVOLUTION OF SOUND.—Review, &c., Continued.

A New Class of Arguments Introduced.—The Impossibility of Wave-Motion in Solids, such as Rock, Iron, &c., demonstrated.—"Condensations and Rarefactions," the only Sound-Waves claimed by Physicists, an Absurdity when applied to Rock or Iron.—The Similarity of Water-Waves and Sound-Waves admitted by Physicists.—This Fact alone Fatal to the Wave-Theory.—Many Reasons given for it.—The Uniform Ratio of Amplitude to Wave-Length about 1 to 10 in all True Waves.—Absence of Amplitude in Iron Sound-Waves demonstrated, while Certain Waves are Proved to be 476 feet long.—Infinite Difficulties in the Way of the Theory.—The Absence of Amplitude confirms the Corpuscular View that Sound passes in Straight Lines.—Fatal Admissions by Professors Tyndall and Helmholtz.—A Condensed Account of an Interesting Investigation of the Wave-Theory with a Scientific Friend.—Numerous Objections Raised and Answered.—The Wind Proved to have no Effect on Sound.—The Evidence of the Signal-Service.—A Strong Argument against the Wave-Theory, and in Favor of Corpuscular Emanations.—Professor Tyndall's Illustrations of a Row of Boys and a Row of Glass Balls Exploded.—Physicists shown to be Dishonest without intending it.—Professor Tyndall's Illustration of the Tin Tube and the Lighted Candle Annihilated.—His Illustration of the Resonant Glass Jar and the Quarter Wave-Length Hypothesis Scathingly Reviewed.—Another Illustration, showing that sounding two Forks half a Wave-Length apart will produce Interference, Reviewed and Exposed.—No Foundation in Truth for the Assumption.—The Explanation of the Interference of the Double Siren, as given by Physicists, Explained Away.—No Interference about it.—A Serious and Fatal Misapprehension.—An Unmistakable Test Proposed to Professor Helmholtz by which to Determine the Whole Question.—The Wave-Theory Self-Contradictory and Self-Neutralizing.—Musical Beats Explained Scientifically.—Their Production by Interfering Air-Waves Shown to be Impossible.—The Konig Instrument for Dividing a Stream of Sound into Two Branches Explained.—Professor Tyndall's Statements Positively Denied.—His Contradictions, Inconsistencies, and Numerous Scientific Errors Pointed Out.—A Final Overwhelming Argument based on the Nature of Wave-Motion which Alone Breaks Down the Current Theory.—Note on the Supposed Sympathetic Vibration of the Antennæ of the Mosquito.—An Amusing Exposition of Professor Mayer's Hypothesis.—Addenda to Chapter VI.

In concluding this examination of the Undulatory Theory of Sound, it is my purpose to devote the present chapter to an entirely new class of arguments bearing directly against the hypothesis. Although it might be considered almost a work of supererogation to the reader who has attentively followed the argument through the preceding chapter, yet the overthrow of the theory may not be considered complete so long as physicists can point to a single consideration appearing to support the hypothesis which has not passed under review. I shall, therefore, not only undertake to introduce a number of new and overwhelming arguments against the current theory, but shall call the reader's attention especially to the enormous and glaring impossibilities to which physicists are compelled to resort in order to sustain the idea of wave-motion and make it appear feasible. If, therefore, in these animadversions, it shall become necessary to expose to an unenviable view the hollow scientific pretensions of some of our greatest authorities on sound, no personal construction must be placed upon language which is only intended to apply to the theory itself and to the arguments employed to sustain it.

With these preliminary remarks I come directly to the question in hand, and will in the first place look at what I conceive to be one of the most manifest and self-evident impracticabilities of the wave-hypothesis viewed from a common standpoint, and based upon the universally admitted facts and figures of the theory, about which there can be no dispute among writers on acoustical phenomena.

That sound passes through *wood*, *water*, *rock*, *iron*, and other solid and fluid substances, no one questions; and that it passes through these substances on the same principle and according to the same uniform laws of propagation as through *air* I shall assume as granted, or at least incontrovertible, from the very necessities of the case, since such a thing as two modes of sonorous propagation was never intimated by any writer on the subject, ancient or modern. To assume two modes of conduction through any two substances —one wave-motion and the other something else—would be to at once open the floodgates of logic, and make a separate and dissimilar mode of propagation possible or even necessary through every known substance, from hydrogen gas to platinum. There is therefore no view admissible or supposable except the one here assumed, namely, that sound travels through all bodies, of whatever density or rarity, gravity or levity, on the same uniform principle and by the same established law of conduction and radiation as it passes through *air*.

Should it, therefore, now be demonstrated that sound does not and can not travel through rock, iron, water, or other solid and liquid substances, by the wave-motion of such conducting mediums, or the oscillation "to and fro" of their particles, a child must see that it can not travel by wave-motion through air, and hence that the whole undulatory theory falls to the ground. The sequential correctness and necessity of this conclusion are unquestionable.

Let us approach this impracticable feature of the theory gradually and with careful deliberateness. First, I would seriously ask the reader if he believes it possible that the scratch of a grasshopper's feet or the chirruping of a cricket upon one end of a long pine tree is capable of throwing the entire mass of wood into undulations? He must believe it if he is ready to subscribe to the wave-theory, since such a sound can be distinctly heard at the other end of the trunk, three hundred feet distant, if the ear is placed properly against it!

Would not the common sense of any unbiassed thinker revolt at the supposition that all the molecules constituting that mass of wood were actually caused to oscillate "*to and fro with the motions of pendulums*," which are the words employed by Professor Mayer, as well as by Professor Tyndall, in reference to the action of sound-waves in air? I use the phrase "common sense," for the reason that every one possesses more or less of that commodity who pretends to think at all. It does not require extensive scientific culture to grapple with this question. It is one of the simplest problems in the whole range of mechanics. No physical effect can be produced without an adequate corporeal cause; and in mechanics the common sense of a child assures him that an insect with scarcely appreciable physical strength could not stir such a mass of ponderable wood at all, or the hundred thousandth part of it, let alone throwing its entire substance into undulations by which each atom must make a separate "small excursion to and fro," and keep up these excursions at the rate of several hundreds a second!

Hence, this single fact that a sound produced by such a trifling mechanical force as the movement of an insect's feet, will permeate and pass through the entire substance of such a mass of wood, weighing several tons, is demonstrative proof, as strong as proof can be, that it is not done and can not be effected by the wave-motion of the tree, either internally or externally, or the displacement of its material particles, causing them to oscillate "to and fro with the motions of pendulums" several hundred times a second, which must obviously be the case if there is any truth in the wave-theory.

These remarks also apply equally and with even greater effect to the passage of sound through *rock* and *iron*, since they are denser, and must necessarily require greater mechanical power to throw their molecules into oscillatory motion; yet the scratch of a pin on one side of the Rock of Gibraltar could be heard through it by placing the ear against the opposite side, aided by a stethoscope. I aver that no well-balanced mind can believe, when it comes seriously to reflect, that a large mass of rock or iron through which such a sound passes is actually thrown into vibratory motion, and its separate particles made to oscillate "to and fro," as air-particles are supposed to oscillate by means of sound-waves. If not, then the particles of air do not so oscillate, or assume the character of waves, as the cause of sound, and hence the wave-theory breaks down.

Physicists have noticed the fact, when sound passes through a solid body, such as a mass of wood, from a vibrating instrument held against it, that such conducting body experiences a tremor corresponding to the vibrational rate of the sounding instrument, and this circumstance has led them superficially to infer that the tremor of the wood thus produced is the real cause of the sound. I have pointed out the superficiality of these childish observations in numerous places in the preceding chapter. If the vibrating instrument has sufficient *vis viva* while producing the tone to shake the conducting medium with which it is in contact, only for a limited distance around, such effects of course occur *incidentally*, and are, as already shown, no part of the sound produced, neither of its cause, any more than the incidental tremor of the air or recoil of the cannon when discharged is an essential part of the process which hurls the projectile.

These surface observations of sound investigators are unfortunately the very foundation on which the entire wave-theory of sound rests. There is not a physicist who notices the jarring of a membrane at a distance from a sounding body but will instantly jump at the conclusion that the entire body of air between the membrane and the source of the sound must necessarily take on the same vibratory motion! It seems impossible for them to grasp the simple thought that the substantial unisonant sound-pulse itself possesses an actual sympathy for the membrane tensioned to the same vibrational number of the sonorific instrument. They can not see how it is possible for such substantial sonorous corpuscles to dart off from the sounding body to the membrane with such periodicity as to act sympathetically on its unisonant quality and set it to oscillating, unless the entire mass of intervening air takes on a similar oscillatory motion.

It is this very superficial error, so thoroughly ventilated in the preceding chapter, on which the whole wave-theory rests. Yet these very physicists can look on a magnet and see it moving a magnetic needle at a distance and causing it to oscillate and quiver through plates of solid glass, without the remotest idea that such effect is

produced by any disturbance communicated to the intervening air! They even do not hesitate to concede that substantial but intangible corpuscles of some kind may radiate from the magnet to the needle, passing unimpeded through the glass, and thus mechanically move the needle. Yet they can not conceive of sonorous corpuscles radiating in synchronous pulses and in a somewhat analogous manner, acting in periodicity to a unison membrane, thus causing it to vibrate, without a corresponding motion of the *intervening air*.

One would really think that a physicist who had ever seen a steel magnet, and noted its action on a compass-needle through plates of impervious glass, would have found sufficient cause for at least suspecting the wave-theory of sound, if not for repudiating utterly the unspeakable impossibility of an insect shaking four square miles of atmosphere, and of exerting, by the simple movement of its feet, *millions of tons of mechanical force*, as demonstrably shown in the preceding chapter. (See pp. 133, 134, &c.)

We shall try to show the reader in this chapter, if it has not already been sufficiently done, the scientific distinction which must be borne in mind between *sound* as the primary result of instrumental vibration and those incidental effects of tremor produced upon the conducting medium near the instrument by the same motion which generates the tone.

Another preliminary proof that sound can not and does not pass through a mass of solid rock or iron by means of wave-motion is deduced from the essential definition of a sound-wave as given by physicists. Water-waves, which are referred to by all writers on sound as illustrative of air-waves, have room to rise and project the water above its surface-level in the form of ridges which necessarily leave corresponding depressions in its surface in the form of sinuses or troughs. But in the midst of the aerial ocean there is no atmospheric surface above which an air-wave can project itself in the form of a crest; hence the wave-theory teaches, as the only alternative, that the air must be *condensed* or *packed* into more closely compressed ridges to represent the crests of a system of water-waves, and be *rarefied* or expanded to represent the furrows, thus amounting to exactly the same thing. Professors Tyndall, Mayer, and Helmholtz, as fully quoted in the preceding chapter, have repeatedly told us that the only kind of a wave which sound can produce in the air is "a *condensation* and its associated *rarefaction*," representing the crest and furrow of a water-wave. "A *condensation* and a *rarefaction*, then," says Professor Tyndall, "*are the two constituents of a wave of sound.*" (See pages 125, 126.)

Now, as "a sonorous wave" in a mass of air, as Professor Mayer expresses it, "is *always* formed of two parts, *one half of air in a state of condensation, the other half of rarefied air*," then it follows, and Professor Mayer can not and will not deny it, that a sound-wave passing through a mass of *iron* must also be formed of "*two parts, one half of iron in a state of condensation, and the other half of rarefied iron*"; that is, according to this highly "scientific" theory, the molecules of iron or rock throughout the entire mass permeated by the sound must be alternately *compressed or squeezed more closely together*, and then *expanded more widely apart* several hundred or perhaps several thousand times a second, according to the pitch of the tone.

Is the reader prepared to accept this essential and indisputable feature of the wave-theory of sound, namely, that the stridulation of a locust, for example, sitting

on a rock, actually throws the molecules of the entire mass of granite first into *condensations* and then into *rarefactions*,—first squeezes the particles of stone more closely together, and then rarefies or expands them more widely apart? If he does not and can not believe this, then he does not and can not believe that sound passes through rock or iron by wave-motion at all, and hence that wave-motion is also out of the question in *air*, as this is the only possible form of a wave which can occur in the interior of a mass of any kind of substance such as *air*, *water*, *wood*, or *iron*, as distinctly taught by Professor Helmholtz and all writers on sound.

As such a preposterous result as the compression of the particles of a granite rock by the physical strength of an insect is revolting to every idea of mechanics, and overthrows all known relations existing between cause and effect, it follows that the idea of sound traveling through rock or iron by wave-motion must be a manifest scientific fallacy, and hence that wave-motion in air equally falls to the ground, since in the very nature of things, as before shown, there can be no two modes of sound-propagation through different substances.

It need not be said here that the sound of an insect would not permeate a rock. Why, the pulverizing of a granite rock a hundred feet square to powder would be almost as nothing to the task absolutely performed by a locust, according to the wave-theory, in converting four cubic miles of atmosphere into "condensations and rarefactions," exerting sufficient pressure and thus generating sufficient heat to add one sixth to the velocity of sound throughout this entire mass of air! (See pp. 145, 146.) The most trifling sound produced against a mass of rock ten feet thick, even the movement of an insect's feet, can be heard through it, as just remarked, by the aid of a stethoscope. According to the wave-theory this is only effected by the particles of stone being thrown into undulations, consisting of absolute "condensations and rarefactions."

But further, in the preparatory discussion of this argument, we are taught by Professor Tyndall and Laplace, as just intimated, that the *squeezing* of the *air-particles* together generates heat (as it necessarily must do), which adds *one sixth* to the velocity of sound in air; and hence it follows, as the same "condensations and rarefactions" must take place in a mass of iron, since there must be the same wave-motion and almost infinitely greater compression exerted, that they also must generate heat at each compression or condensation of the iron-particles, which should also augment the velocity of sound through all such solid substances in like proportion. But as iron once heated to any degree whatever can not instantly become cool, even if dipped into cold water, it would therefore be impossible for any one of the 440 condensations a second, produced by the stridulation of the locust, to cool off by its associated rarefaction before another condensation with the same heat would re-enforce it. Thus, the heat generated by one condensation of the iron could not have time to subside in any calculable degree before its re-enforcement by another, that by another, and so on, at the rate of 440 a second, if the pitch of the stridulation should be that of A, or the same as that of the second string of the violin. It is thus perfectly manifest, according to the wave-theory, that a locust by singing for one minute, sitting on a mass of iron, ought to raise its temperature to incandescence; for however little heat a single "condensation" would produce, this rapid accumulation, without time for sub-

sidence, would necessarily accomplish this miraculous result. But as not the slightest heat is generated by the passage of sound through iron or any other solid body, I care not how intense or how long continued such sound may be, it follows that no "condensation" and hence no wave-motion can take place in the passage of sound through any substance whatever!

All writers on sound tell us that the material particles of any body constituting the sonorous wave, though they do not travel forward with the undulation or swell, yet have a "to and fro" movement, once up and once down as each wave passes, as observed in the up and down movement of a chip floating on the surface of water disturbed by waves. Any one knows that without this there can be no such thing as wave-motion. This same "to and fro" movement of the air-particles is claimed to take place in the passage of a sound-wave by both Professors Helmholtz and Tyndall, and in fact by every authority on sound. I will quote a few sentences from these writers to make clear this principle, so the reader will not have to take my bare word for anything. Professor Helmholtz, in speaking of waves caused by throwing a stone into water, remarks:—

"The waves of water, therefore, continually advance without returning. But we must not suppose that the particles of water of which the waves are composed advance in a similar manner to the waves themselves. The motion of the particles of water on the surface can easily be rendered visible by floating a chip of wood upon it. This will perfectly share the motion of the adjacent particles. . . . By these examples the reader will be able to form a mental image of the *kind of motion* to which sound belongs, where the *material particles of the body merely make periodical oscillations*, while the tremor itself is constantly propagated forwards. . . . The process which goes on in the atmospheric ocean about us, is of a precisely similar nature. For the stone substitute a *sounding body* which *shakes the air;* for the chip of wood substitute the *human ear*, on which impinge the *waves of air* excited by the shock, *setting its movable parts into vibration.* The *waves of air* proceeding from a sounding body transport the tremor to the human ear exactly in the same way as the water transports the tremor produced by the stone to the floating chip."—*Sensations of Tone*, pp. 14, 15.

Professor Tyndall says:—

"The motion of the sonorous wave must not be confounded with the *motion of the particles* which at any moment form the wave. During the passage of the wave *every particle concerned in its transmission makes only a small excursion to and fro.* The *length* of this excursion is called the *amplitude* of the vibration."—*Lectures on Sound*, p. 44.

This is the universal teaching of the wave-theory of sound, namely, that the particles of the medium which conducts the sound make an "excursion to and fro" every time a sonorous wave passes, and that the length of the "excursion" of these physical particles constitutes the "amplitude of the vibration," which is the same as the distance in a water-wave from the top of the crest to the bottom of the sinus or trough.

Thus the materials accumulate in our hands by which to annihilate the wave-theory, if we only apply them properly to the question under discussion. Here we have it, in plain words, that a sound passing through *iron* or any other substance whatever, or, to use the exact words, "during the passage of a wave ☞ *every particle concerned in its transmission makes only a small excursion to and fro,*" and that "the *length of this excursion* is called the *amplitude of the vibration.*" This eminent writer will not pretend to say that this does not apply to *iron* as well as to *air.* He would not so stultify logic or insult reason. To attempt such a specious and wretched quibble to escape the consequences of wave-motion would be to make the advocate as ridiculous as the theory will soon be shown to be.

Now, are we able to arrive at a correct

and scientific idea as to this question of "amplitude," or to determine definitely the "*length of this excursion*" which the separate "particles" of *iron* must make "to and fro" in order to constitute a wave proper while a sound is passing through its mass? I assert that we have a definite and positive *law*, laid down by these writers themselves, which is as simple and as impossible to be misunderstood as any question in common arithmetic, telling us just how far these particles of *iron* or *air* must oscillate "to and fro" to constitute this "amplitude," which the reader can not fail to see and also to be astonished at in a moment.

We now come directly to a class of facts which no physicist will pretend to dispute. The only visible wave-motion of which we have any definite knowledge is that which takes place upon the surface of water or other liquid. Air-waves are invisible; and therefore, if they occur at all, as assumed by the wave-theory of sound, we can only understand their form, motion, velocity, &c., and their relation of *amplitude* to *wave-length* by reference to the form and motion of water-waves. Hence it is that physicists (without realizing the ruinous result to their theory) constantly refer us to the undulations produced on the surface of water as *exactly similar* to sound-waves produced in the air, and hence also in any other substance.

I do not exaggerate by saying *exactly similar*, but mean what the words literally imply. As this is essential to my argument, which I mean shall be so fortified at this particular point as to admit of no answer, I will now prove by Professor Helmholtz—the highest living authority on physical science—that sound-waves in air and water-waves are "*essentially identical*," of a "*precisely similar nature*," and travel "*exactly in the same way*"! Here is the evidence, a part of which has just been quoted:—

"Suppose a stone to be thrown into a piece of calm water. Round the spot struck there forms a little ring of wave, which, advancing equally in all directions, expands to a constantly increasing circle. *Corresponding* to this ring of wave *sound also proceeds in the air* from the excited point, and advances in all directions as far as the limits of the mass of air extend. The *process in the air is essentially identical* with that on the *surface of water*. . . . The *process* which goes on in the *atmospheric* ocean about us is of a *precisely similar nature*. . . . The *waves of air* . . . transport the tremor to the human ear *exactly in the same way*."—*Sensations of Tone*, pp. 14, 15.

Many passages from Professor Tyndall's works could be quoted "essentially identical" if not "precisely similar," all bearing on the subject "exactly in the same way"! But these are sufficient, and as explicit as could be desired.

Then what is the *law* revealed by water-waves, according to this emphatic language, as to the question of "amplitude" or "this length of excursion to and fro" of the particles of water constituting the undulation? It is this, and these learned authorities are particularly and earnestly invited to note the crushing fact, that in water-waves, whether large or small, the proportionate relation of *amplitude* to *wave-length* in feet, inches, or fractions thereof, is always about as 1 to 10 or 12, reducing this proportion slightly as the waves increase in size! That is to say, the smallest measurable system of waves, caused by drops falling on the surface of water, has a wave-length or distance from crest to crest of about *one inch*, with an amplitude or depth from crest to sinus of about a *twelfth of an inch*. Waves caused by throwing stones of about a pound weight into water have an amplitude of about two inches, and hence travel about twenty inches to two feet apart, as measured from wave to wave.

I have spent much time in observing and measuring waves of different sizes and generated in various ways, and find this law to be very nearly uniform in its application. Waves when running freely a foot high, after being produced by a passing steamboat, are invariably about ten feet from crest to crest,—while ocean billows, produced by a steady current of wind, if of an average amplitude of about five feet, may fall somewhat short of this average wave-length, being from forty to forty-five feet from crest to crest. Larger billows experience about a proportionate decrease in wave-length in relation to amplitude. Yet the law holds inviolate that the longer the waves from crest to crest the greater must be the amplitude from crest to sinus. There can, in the nature of things, be no exception to this rule.

The very nature of wave-motion precludes the possibility of this law being otherwise, since manifestly a system of ocean billows five feet high could not by any possibility run within a foot of each other, or with only a foot from crest to crest, as it would make their walls so nearly perpendicular that they would break over and blend into each other, thus reducing their amplitude to conformity with the law I have been illustrating. To prevent this breaking over of the wave-crests upon each other it is absolutely essential, as any one can see, that their distance apart must sustain such a proportionate relation to their amplitude or height as will give the sides of their walls the proper inclination or slant to prevent tumbling! Nothing can be plainer to a mechanical mind. Hence, this law of which I have spoken exists in the nature and necessity of wave-motion, and must hold good in waves of air or iron produced by sound, if they occur at all, as well as of water, since they are, as our great German authority teaches, "precisely similar" and "essentially identical."

It is partly this fact which causes the constant display of breakers on a beach. The front waves are retarded by the sand as soon as the water begins to get shallow, thus allowing those behind to approach so near as to vitiate this proportionate relation between wave-length and amplitude, making the walls too steep to support the crests in their symmetrical form, and the result is we see billows continually breaking over into foam on reaching shallow water. This result is also partly due, no doubt, to the fact that the lower portion of the wave being retarded by the sand allows the crest to outstrip the base, which adds to its perpendicularity and augments the tendency to break.

In like manner it would be equally impossible for a system of water-waves, produced by a single exciting cause, to run fifty feet from crest to crest while but an *inch* in amplitude! Such a system of waves was never seen except in the visions of physicists while dreaming possibly about the practical anomalies of the wave-theory of sound.

I have thus reached the culmination of this argument. If sound-waves and water-waves, as we are authoritatively assured, are "*essentially identical*," of a "*precisely similar nature*," and travel "*exactly in the same way*," then this law of proportion in feet and inches between *amplitude* and *wave-length* must hold inviolate in sound-waves as well as in water-waves, or otherwise they are "essentially" *opposite*, "precisely" *dissimilar*, and travel "exactly" in *a different way!*

It now only remains, in order to complete this annihilating argument, to find out if there is such a thing as a definite, measurable *wave-length*, in feet and inches, taught by the current theory of sound, for

each determinate pitch of tone. If such be the fact, and each determinate pitch of tone has a definite, measurable wave-length, in feet and inches, then we know, as a matter of course, what must be the *amplitude* of such a system of waves, or the distance the wave-particles have to oscillate "to and fro." There is no possible escape for physicists from this ratio, if sound travels by waves at all. If, for example, the wave-length of a certain tone should be ascertained to be ten feet, we know its amplitude must be about *one foot*, or about one tenth its length, for such we have found to be the infallible law governing water-waves, which are "essentially identical" and "precisely similar," and the only visible criterion we have for determining the mechanical nature of wave-motion! The catastrophe of the wave-theory thus gradually approaches.

I now state, what is well known to every tyro in science, that the wave-theory of sound necessarily teaches that every pitch of tone, throughout the entire range of the musical scale, has a different and determinate wave-length in feet and inches, which is distinctly inculcated by all writers on sound. I do not ask the reader to take my word for this important and pivotal fact in this argument. Here is the explicit evidence from Professor Tyndall:—

"Having determined the rapidity of vibration, the *length of the corresponding sonorous wave* is found with the utmost facility. Imagine this tuning-fork vibrating in free air. [The fork he refers to has 384 vibrations to the second.] At the end of a second from the time it commenced its vibrations, the foremost wave would have reached a distance of 1090 feet in air of the freezing temperature. In the air of this room, which has a temperature of about 15 degrees centigrade, it would reach a distance of about 1120 feet in a second. In this distance, therefore, are embraced 384 sonorous waves. Dividing, therefore, 1120 feet by 384 *we find the length of each wave to be nearly three feet.*" [Exactly 2 feet and 11 inches.]

"A series of tuning-forks stands before you, whose rates of vibration have already been determined by the siren. This one, you will remember, vibrates 256 times in a second, *the length of the sonorous wave which it produces being, therefore, 4 feet 4 inches.*"—*Lectures on Sound*, pp. 69, 172.

Thus we have the definite proof that a tone having 384 vibrations, or propagating that many waves in a second, has an actual wave-length of 2 feet and 11 inches; and if another pitch of tone happens to be composed of 256 waves in a second, its wave-length is literally "4 feet 4 inches" "from condensation to condensation," or from crest to crest.

Now, suppose I should ask Professor Tyndall to tell me the exact or even approximate *amplitude* of the vibrating air-particles in feet or inches for this system of waves which he has here shown to have a determinate wave-length of "4 feet 4 inches,"—could he do it? I answer, emphatically, he could not, and, if he could, he would not dare to; for it is a notorious fact that though these writers on sound are constantly calculating and recording the "wave-length," in literal "*feet*" and "*inches*," of tones of various degrees of pitch, *they have never once, in all their writings, so much as intimated even the approximate amplitude or width of swing of the air-particles in any single system of sound-waves!* The reason for this strange neglect is plain on its very face, of which the reader will soon be entirely satisfied. To name any definite amplitude, or to fix upon any determinate distance which the particles constituting a sound-wave must oscillate "to and fro" would be to at once annihilate the wave-theory if the same amplitude should be applied to a wave passing through a mass of rock or iron, or any other substance whose motion, if it has any, can be seen! Hence, writers on sound invariably speak of this "amplitude" or "excursion to and fro" in a vague and

indefinite way, sometimes intimating that if one sound is twice as loud as another it is because the air-particles constituting the wave have twice the "width of swing" in the one case as in the other; then again, when vexed with the problem of "superposition," this "excursion to and fro" becomes "infinitesimal"! I have searched in vain through every work on sound within my reach, to find one single instance where physicists dare come out and say, as any scientific investigator ought to say if he has a consistent theory to defend, how many inches or what fraction of an inch the air-particles travel "to and fro" for any given pitch or any degree of intensity. Should they venture to commit themselves on this subject, the reader must see that such a statement, but once recorded, would write the obituary of the wave-hypothesis.

The nearest to it I have been able to find is the language of Professor Helmholtz in speaking of tympanic vibration, as follows:—

"In this transference of the *vibrations of the air* into the labyrinth, it is to be observed that though the *particles of the air* themselves have *comparatively a large amplitude of vibration*, yet their density is so small that they have no very great moment of inertia."—*Sensations of Tone*, p. 199.

But suppose I should ask Professor Helmholtz what he means, in *inches* or the fraction thereof, by "*comparatively a large amplitude of vibration*," he would be as dumb as death! Though he had explicitly and repeatedly recorded what a "wave-length" is in feet and inches for every pitch of tone, and though he had taught that air-waves and water-waves are "essentially identical," "precisely similar," and travel "exactly in the same way,"—and though an investigator with a thousandth part of his intelligence could not help knowing that a system of water-waves with an ascertained wave-length of "4 feet 4 inches" must have an amplitude of at least 5 inches, in the very necessities of wave-motion, with every particle constituting the waves oscillating to and fro that distance,—yet neither he nor Professor Tyndall ventures an application of this consistent and universal law to these hypothetic sound-waves in air, because, as before intimated (whether they thought of it or not), it would instantly overthrow the wave-theory of sound if the same rule should be applied to iron, wood, water, or any other substance whose particles could be seen, and thus ocularly be demonstrated not to move at all!

In order to utterly expose the absurdity of the theory of sound-waves in *iron*, and hence in any other substance, including *air*, we have only to suppose that the particles of iron constituting a wave move only the hundredth part of an inch "to and fro with the motions of pendulums," and it is easy to see that a mass of the hardest steel, permeated by a sound constituted of several hundred waves in a second, would be pulverized to impalpable dust in less than a minute under such a grinding process. This is the reason, in a nutshell, why if would not do for "science" to specify any definite amplitude for the air-particles to oscillate to and fro, or even to utter one syllable on this subject of the proportionate relation of amplitude to wave-length, which so unavoidably prevails in water-waves, and without which they have no existence!

These profound scientific investigators know very well that the only actual wave-motion which can be seen and measured, and which they declare to be "precisely similar" to sound-waves, is governed by an unvarying law of proportion, just as I have stated it to be, and that waves of water could not exist at all unless this

ratio of about 1 to 10 were maintained between the amplitude or width of swing of the wave-particles and the measurable wave-length from crest to crest. Yet knowing all this, as they must, if they possess intelligence qualifying them to write on any scientific subject, and telling their readers at the same time, as they do, that such water-waves are "essentially identical" with sound-waves, they appear to have studiously avoided, in all their writings on the subject, ever giving even a hint as to the probable distance traveled to and fro by the particles constituting a sound-wave, though scores of times recording the actual wave-length in feet and inches! I leave the reader to characterize this kind of "science" as it deserves.

The fact is, physicists have supposed this hypothesis of "wave-length"—so easily deduced from the number of vibrations of a sounding body in a second, by dividing it into the observed velocity of sound—to be a harmless piece of mechanical calculation, which would assist in giving form and definiteness to the wave-theory without endangering its existence or being liable to be turned against it; though even this will soon be seen to be a fatal mistake. So long as "wave-length" alone was involved, the problem seemed amiable and safe. A definite and measurable *amplitude*, however, or even an approximate length of "excursion to and fro" of the wave-particles, in literal *feet* and *inches*, had no such an inoffensive look to these sage investigators! They evidently saw the faint outlines of a *cat* of considerable proportions concealed within this scientific meal-tub of wave-amplitude; and, like the intelligent old rat in the fable, intuitively concluded to keep at a respectful distance, acquiescing in his general opinion that "caution is the parent of safety." They saw, in plain language, if they should allow their "science" to extend far enough to commit the vital act, and thus chain them even to as small an amplitude as the *hundredth part of an inch* for the "excursion to and fro" of the air-particles in a wave-length of "4 feet 4 inches," that it would necessarily and at once involve the same length of "excursion to and fro" of the *iron*-particles in the passage of an *iron* sound-wave of the same length, which would be on its face too preposterous a supposition even for this unspeakably impracticable theory. Hence, the safest way appeared to be to circle all around the meal-tub, but never to directly approach it,—to talk vaguely all around this ugly-looking question of "amplitude" and this so-called "excursion to and fro," and in a non-committal kind of way speak of "wave-particles" as having "comparatively a large amplitude of vibration" and of their swinging "to and fro with the motions of pendulums," and all this; but not to perpetrate the fatal deed of recording the exact or even approximate distance this "excursion to and fro" signifies in any single instance! This was a wise policy in physicists, if even a cowardly one; *but not wise enough*, as the sequel will soon show.

Why have not physicists come out frankly, as candid scientific investigators, and said that "since the only wave-motion we can see and measure has an unvarying proportion of amplitude to wave-length of about 1 to 10, it would seem that sound-waves, if they occur at all, ought to have a similar proportion, or else they are not waves in the proper sense, since they should be essentially identical. And as any appreciable amplitude in iron or other solid body is out of the question, even to the extent of a proportion of 1 to 1,000,000, notwithstanding sound must necessarily travel through it on the same principle as through air, it would seem unavoidable that some

other law than wave-motion must be resorted to in accounting for the radiation, propagation, and conduction of sound."

Such a fair and candid statement of the case as this on the part of Professors Helmholtz and Tyndall would have been worthy of the cause of scientific research, and would at once have commanded the respect of the world. Instead of this, however, knowing as they must know that all water-waves necessarily have an amplitude of about one tenth of their wave-length, and knowing at the same time that so-called sound-waves in iron or any other visible substance are destitute of all perceptible amplitude, or any motion whatever to and fro of their particles, yet they go on assuming the wave-theory of sound as established, while flatly telling their readers that sound-waves are "essentially identical" with and "precisely similar" to undulations on the surface of a body of water! Candor compels me to say that this is a fair specimen of that boasted "science" which is to revolutionize the world and overthrow religion!

But we have not yet reached the enormity of this "scientific" idea of "wave-length" in the passage of sound through different substances. The more startling feature of the stupendous fallacy is yet to come.

We have just seen, as quoted from Professor Tyndall, that a tone with 256 vibrations to the second has a wave-length in air of "4 feet 4 inches." But what would be the wave-length of this same pitch of tone passing through a mass of *iron?* Did physicists ever think of this? If they did, they must have done so with their mental eyes shut, and their reasoning faculties half stupefied, or they would have at once realized its ruinous effects upon the wave-theory. Such a tone passing through iron would have a wave-length *seventeen* times as great as in air, or just *seventy-three feet eight inches* from crest to crest! Are such iron-waves reasonable or possible?

The reason for this increased wave-length in iron is plain. Sound passes through *iron* with a velocity *seventeen times greater* than through *air;* and hence the first sound-wave leaving an instrument held against a mass of iron must necessarily travel seventeen times further before the second wave starts than it would have done in air. Hence, sound-waves in iron are necessarily seventeen times as long from crest to crest, or, as these learned physicists prefer it, "from condensation to condensation, or from rarefaction to rarefaction."

I am not guessing at these data when I say that sound passes through *iron* with *seventeen* times greater velocity than through air. Professor Tyndall says:—

"The velocity of sound in water is more than four times its velocity in air. *The velocity of sound in iron is seventeen times its velocity in air.* The velocity of sound along the fiber of pine wood is ten times its velocity in air."—*Lectures on Sound*, p. 47.

But now we reach the culmination of this enormous fallacy. The low E of the double bass has 40 vibrations to the second, which, divided into 1120 feet, the velocity of sound in air, gives its atmospheric wave-length as 28 feet exactly. By holding this instrument against a mass of iron, therefore, and allowing its sound-waves to pass through it, traveling as they necessarily do seventeen times faster than in air, these iron-waves are found to have the prodigious length of *four hundred and seventy-six feet from crest to crest!* Does any man in his senses believe the existence of such *iron-waves* possible, I care not how small the amplitude or so-called "excursion to and fro" of these iron-particles may be? If he does not believe it, then he does not believe in the wave-theory of sound at all;

for this, as every tyro in science knows, is just as true as any other part of the theory.

Thus ends all this courageous talk of Professors Tyndall and Helmholtz about the actual "*wave-length*" of determinate sounds in feet and inches, which looked so harmless on paper, and appeared in the distance to be nothing but *meal;* but which has turned out to be one of the most destructive and prodigious *cats* ever seen in science!

The serious part of the trouble, however, for the wave-theory is still in abeyance. *Amplitude* will not down at the wish or bidding of any physicist. It asserts its claim to recognition and its right to oscillate "to and fro" in every wave, of whatever substance constituted, and refuses to be lugged clandestinely, at the behest of Professors Tyndall, Helmholtz, and Mayer, into incompatible relationship with pretended waves, which are a bald scientific sham. It will not allow its identity to be ignored or obscured. These assumed iron sound-waves, having an indisputable wave-length, according to the current theory of sound, of *four hundred and seventy-six feet*, as every physicist will at once admit, which are "essentially identical" with water-waves and move "exactly in the same way," must necessarily have an amplitude of corresponding proportion to wave-length, the same as in water, if they exist at all; and the iron-particles constituting these enormous billows must therefore make a proportionate "excursion to and fro" as in the case of water-waves of similar length, or they are not "essentially identical" with them, can not be "precisely similar," and do not propagate themselves "exactly in the same way"!

To admit the existence of such iron sound-waves 476 feet long from crest to crest, which are "essentially identical" with water-waves, and then quietly ignore or explicitly deny all practical amplitude, when it is well known that no water-wave can exist at all without a visible and measurable amplitude proportioned to its length as about 1 to 10, would be a quibble and trick unworthy of science, and only supposable in a pettifogging barrister in case of some desperate extremity.

Hence, we reach the logical mechanical conclusion that sound-waves from the low E of the double bass, passing through a mass of iron with a wave-length of 476 feet, must of necessity have an amplitude, making the proportion as 1 to 10, of 47 feet from crest to sinus; or, in other words, the particles of iron constituting the entire mass permeated by the sound must keep up an "excursion to and fro" a distance of 47 feet, making 40 of these complete oscillations every second!

If there was anything strained, exaggerated, or unfair, about this argument, or the slightest misrepresentation of the teaching of physicists, or misstatement as to the laws and principles of science involved, it would certainly be a great relief to Professors Tyndall and Helmholtz in this terrible ordeal of their favorite theory. But even this poor consolation is denied them. They are compelled to stand awe-struck and speechless in the presence of these prodigious sonorous billows permeating a mass of iron *four hundred and seventy-six feet long* "from condensation to condensation," and *forty-seven feet high* from the top of the compressed ridge to the bottom of the rarefied furrow, with all the iron-particles composing the mass rushing "to and fro with the motions of pendulums"! To deny the existence of such iron-waves, at least 476 feet long, is to deny the truth of the wave-theory altogether, either as relates to air or any

other substance; while to deny this proportion of amplitude or "width of swing" of 47 feet in billows having such an admitted wave-length is for Professors Tyndall and Helmholtz to repudiate their own language, and proclaim to the world that there is no sort of resemblance between water-waves and so-called sound-waves, instead of them being "essentially identical," "precisely similar," and traveling "exactly in the same way."

The question of questions on this subject, then, is, will these eminent authorities, in view of such overwhelming facts, abandon the wave-theory of sound as a practical and self-evident absurdity, and accept in its place the beautiful and every way consistent hypothesis of substantial corpuscular emissions? We shall see.

But we are not yet done with this question of amplitude. No physicist, after his attention is called to the question, will pretend to doubt the correctness of the calculation here made as to such sound-waves in iron having an actual wave-length of 476 feet from "condensation to condensation," or from "crest to crest," if the phrase suits better; that is, if the mass of iron is large enough. Either Professor Tyndall or Helmholtz would admit at once, if asked by any one, that, according to the principles of the wave-theory, the sound of the low E of the double bass would have the wave-length in iron just as given in my calculation. But while admitting this, what would they or could they say about *amplitude?* They would unquestionably be obliged to admit some amplitude, or evidently they would not be waves at all, since manifestly a water-wave without amplitude would be without crest or furrow, and hence a nonentity.

Professor Tyndall could not get away from his own words, already quoted, even if he wished to, that "*during the passage of the wave every particle concerned in its transmission makes only a small excursion to and fro,*" and that "the *length* of this *excursion* is called the *amplitude of the vibration.*"—*Lectures on Sound*, p. 44.

We must constantly bear in mind that there can be but one mode of sonorous propagation through any substance, according to the wave-theory, and that is *wave-motion*,—that while waves on the surface of a body consist of crests and furrows, waves in the interior of a mass, whether it be *air*, *iron*, or any other substance, have been defined over and over again by these writers as consisting of "condensations and rarefactions" of the materials constituting the waves, while these again have been as clearly described as the alternate *squeezing of the particles more closely together and separating of them more widely apart*, thus causing this "small excursion to and fro" which constitutes the "amplitude of the vibration," making it the same practically, so far as motion and amplitude are concerned, as if the waves were produced on the surface of the body, and took the ordinary form of crests and troughs. Hence, an iron sound-wave, whether on the surface of the mass as a "crest and sinus," or formed as a "condensation and rarefaction" in its interior, must possess the same "amplitude of vibration," "width of swing," or "excursion to and fro" of the iron wave-particles as a similar wave would have in air, or there is no consistency nor congruity in the theory, and all this talk about "condensation," "rarefaction," "excursion to and fro," "width of swing," "amplitude," or even "wave-motion," is an imposition upon the scientific public.

I now ask Professors Tyndall and Helmholtz,—and hereby send my inquiry across the Atlantic Ocean,—if the wave-theory be true, and if there be such a thing pos-

sible as a *sound-wave* in any substance, *what is the amount of this "amplitude of the vibration," or the length of this "excursion to and fro," or "width of swing" of the particles constituting a sound-wave in iron?* Answer something, if it is but the millionth of an inch! Don't, for the sake of science, be non-committal any longer! Silence and candor are wholly incompatible on such a vital question as this. If the iron-particles move at all, or make the least possible "excursion to and fro," as so distinctly taught by the current theory of sound, say so; and if they do not, say so; and then abandon the wave-theory! I pause for a reply.

But the reader, I imagine, will not pause or be satisfied to wait to hear from the other side of the ocean. He wants the matter to be settled at once. Hence, I must answer for Professors Tyndall and Helmholtz till they shall have time to speak for themselves. My answer is as follows: *This assumed amplitude in iron sound-waves, or this so-called "excursion to and fro" of the particles of iron constituting these billows, is practically nothing, and they know it!* That is, to use their own language when closely pressed, it is "infinitesimal," if it is anything at all, since the most powerful microscope ever constructed fails to reveal the slightest molecular movement in a mass of iron, or any other solid or liquid substance, permeated by the intensest sounds. Hence, it is within the truth to say that these supposititious sound-waves are absolutely devoid of amplitude, and therefore are not *waves* at all!

Here then, reader, according to this theory, we have the grand scientific (!) spectacle of iron *billows* with an actual and admitted "wave-length" of *four hundred and seventy-six feet, and no amplitude!* Yet these physicists call them "*waves*" with a license unparalleled for its absurdity!

To realize the enormous character of the fallacy here being exposed, the reader has only to imagine, if he possibly can, *ocean billows* (which are always referred to by writers on this subject as appropriate illustrations of sound-waves) having the prodigious wave-length of *four hundred and seventy-six feet* from crest to crest, and a depth of furrow—well, say, of *one inch!* Though this would be a ridiculous caricature on wave-motion, yet such furrows would be a million times deeper than the furrows of these boasted sound-waves in iron, if they possess any amplitude at all, notwithstanding their acknowledged wave-length of nearly a tenth of a mile! And knowing all this to be true, as we must assume to have been the case with these representative scientists of the age, how can we account for the reiterated language already quoted in comparing sound-waves and water-waves—"*essentially identical*," "*precisely similar*," moving "*exactly in the same way*," while one lacks *amplitude*, the only thing, in fact, which constitutes a wave in any substance?

But if such a pitch of sound as I have assumed passes through iron in this way, having an actual wave-length of 476 feet and a depth of "amplitude" so "*infinitesimal*" that the most powerful magnifying glass fails to reveal it, then how much, I ask, does it lack of a straight course? If a line were drawn 476 feet so nearly straight that a powerful microscope could not reveal the least deflection, is there a mathematician on earth who would not, without a moment's hesitation, pronounce that a *right line?* Am I not justified, therefore, when I assert that so far from sound passing through rock, iron, water, wood, or even air, by wave-motion (which has no existence at all without *amplitude*), its route can only be a direct line?

And if it is practically and mathemat-

ically a *straight line*, it is exactly what the corpuscular hypothesis requires and teaches, namely, that sound passes through all bodies in the form of sonorous pulses radiated from the sounding instrument in *straight lines*, and that these primary systems of corpuscles radiate secondary systems also in *straight lines*, these others, and so on, permeating all parts of the conducting medium, whether that be air, water, wood, or iron. Which, I now appeal to the intelligence of the reader, is the more consistent and rational system? That which encounters no contradiction and no absurdity, or that which is only contradiction and absurdity from beginning to end?—which admits sound-waves in iron to be 476 feet long, telling us at the same time that "sound-waves" move "*exactly in the same way*" as water-waves, are "*essentially identical*" and "*precisely similar*," but which turn out, on examination, to have no *amplitude* (the only thing that really constitutes a wave), not even amounting to the millionth of an inch! I might well stop here, and risk the result of this investigation without submitting another point, letting the fate of the wave-theory hinge upon this single argument. But I have an abundance of other considerations equally pertinent and unanswerable, some of which will be even more surprising to the unscientific reader.

One would think that a competent scientific investigator ought to see at a glance that the physical motion of a gross body, like iron, if *too small to be observed* when the eye is aided by the microscope, must be *too small to sensibly affect any other sense-nerve*. Surely the eye is the most sensitively acute of all the senses in perceiving that which comes within its proper scope, such as the *motions* of a physical visible body. It is a fact undeniable that a movement a thousand times smaller than could be possibly recognized by touch in the most sensitive portion of the human organism, could be readily seen under a powerful magnifying glass. Is it reasonable, then, that the *motion* of a visible body (for it can be only *motion* according to the wave-theory) which eludes the recognition of this most searching sense, thus aided, should address and impress another sense entirely unaided, which is surely not so acutely adapted to the phenomena of motion in physical bodies as either sight or touch? It must seem, therefore, viewed from every possible standpoint, unphilosophical and in violation of all true science to designate as *wave-motion* a supposed movement in the particles of a gross physical body, which has never been observed under the strongest magnifying power, particularly when such hypothetic movement is unnecessary for the solution of any problem in science, and especially in view of the probable truth, not to say beautiful consistency, of the corpuscular hypothesis, which necessarily involves the propagation of sound in *straight lines* through all bodies, and which the wave-theory is at last compelled to admit.

I now propose, in concluding this phase of the argument, to show that physicists, in thus referring to *water-waves* as illustrative of *sound-waves* in air, have necessarily and unmistakably abandoned sound-waves altogether, either in air or in any other conducting medium! This surely will be more than these astute writers on science contracted for in their careful analysis of water-waves, and their studied efforts to show how the superposition of tiny wavelets, traversing the surface of large rollers, corresponds to the superposition of air-waves, constituting sound and making up the "algebraical sum" of their different systems of wave-motion.

The truth is, these writers, in their enthusiasm on the subject of air-waves as the cause of sound-propagation, and in their usual habit of jumping at conclusions, appear to have rushed headlong, so to speak, not stopping to think where their argument would lead them, or what would be the consequence when their reasoning should force them up against a mass of rock or iron, or into a body of water, which admits of palpable and visible investigation.

A more reckless and short-sighted course of argumentation perhaps was never adopted or recorded even in the crudest scientific speculations of any half-civilized philosopher of ancient or modern times. Air being wholly invisible and almost intangible, these eminent investigators have felt safe in bravely assuming its particles as oscillating "to and fro with the motions of pendulums," and as having "comparatively a *large amplitude* of vibration," and all this, because no one could see to the contrary, and therefore they seemed intuitively to think that no one could contradict them! But this superficiality, like that of the Ptolemaic philosophers, has at last to meet its fate, since this reasoning explodes itself, as we have seen, the moment the "*large amplitude of vibration*" and "excursion to and fro" are carried into a mass of visible iron, having sound-waves just *seventeen times longer* than in air, and consequently which should have seventeen times this "large amplitude of vibration," according to all laws of symmetrical proportion governing water-waves, which are so repeatedly claimed to be "essentially identical" and to move "exactly in the same way"!

But here comes, as just intimated, what I consider the utter abandonment of the idea of sound-waves, either in air or in any other substance. When Professors Tyndall and Helmholtz were so confidently illustrating sound-waves in *air* by the action of "water-waves" which were "essentially identical," they appeared absolutely to forget, for the time being, that *sound traveled through water at all!* This unfortunate slip of memory now proves ruinous to their theory, *since a sound-wave in air being of course* and admittedly nothing more nor less than an *air-wave*, it follows therefore that a sound-wave in water must necessarily be nothing more nor less than a *water-wave!* There is no escape from this. If a sound-wave in water does not constitute a *water-wave*, in the true and literal sense, then it becomes demonstrative proof that a sound-wave in air does not constitute an *air-wave* at all, and consequently the bottom falls out of the wave-theory. But as universal observation assures us that a sound, however intense, passing through water does not produce the slightest undulatory effect, or stir the particles of water through which it passes, it follows that *wave-motion* in both *air* and *water* has broken down!

Every one knows what a "water-wave" is, and that it has no double or doubtful meaning. Fortunately in *water* we do not need these mysterious and almost meaningless "condensations and rarefactions" so essential to the wave-theory in fabricating hypothetic *air-waves* in the midst of the "aerial ocean," which seems to grow out of the fact that *we can not get at the surface of the atmosphere.* In water we have an actual, tangible, ponderable liquid, with a visible surface on which "water-waves" are easily produced and visibly observed. And hence, if Professors Tyndall and Helmholtz speak of a "water-wave," we know exactly what they mean, namely, an undulation on the surface having a visible crest and sinus, with an actual amplitude, which oscillation to and fro has

invariably a proportion of about 1 to 10 of wave-length. Hence, when they assure us, as they so often have done, that a sound-wave in air is "essentially identical" with a "water-wave," we have to understand, as a matter of course, that a sound-wave in *water* is also "essentially identical" with a "*water-wave*"! This must be so, or there is no meaning in the scientific teaching of these physicists. But as no "water-wave" is produced by sound passing through it, even under microscopic observation, it shatters the whole wave-theory, and proves that *air-waves*, as the result of sound, are just as fallacious as "*water-waves*." Can anything be more conclusive than this?

Physicists will hardly venture to resort to the disingenuous quibble that there are two distinct kinds of water-waves,—one kind *visible* and the other *invisible*,—one kind with *crests*, *furrows*, *wave-lengths*, and *amplitude*, the other kind with *wave-lengths* but with neither *crests*, *furrows*, nor *amplitude;* and that these *invisible*, *inscrutable*, and *crestless* water-waves are the ones produced by sound, while the *visible* and *measurable* waves are the kind produced by throwing a stone upon the surface of a piece of calm water! If they really should venture to assume any other class of water-waves than *visible* ones, such as everybody understands by the term "water-wave," it would have been a good thing in their repeated use of the term in their works on sound to prefix some sort of qualifying word when speaking of "water-waves," that their readers might not be at a loss to know which class of waves they referred to! For example, when speaking of a sound-wave in air being "essentially identical" with a "water-wave," and traveling "exactly in the same way," the reader is obliged to ask, "Which class of 'water-waves'?—those with *crests* and *troughs*, or those without?" By having neglected this precaution they naturally leave us to infer that there is but one class of "water-waves," as every one understands, and as they themselves know! In fact, it is little less than inexcusable negligence, if these physicists ever intended to teach more than one kind of "water-waves," that they should have studiously kept it to themselves, and never once given an intimation of such *crestless* and *invisible* billows in water, with wave-lengths from 10 to 100 feet!

Seriously, this convenient *invisible* dodge can be played in *air* to almost any extent, since the motion of its particles is not observable; but it will turn out about as much of a scientific failure when attempted in *water* as it has done in *iron*, with billows having a wave-length of 476 feet but with an amplitude so small that the most powerful microscope fails to reveal a trace of it! Such invisible shifts will prove also too shallow in water. It is a well-known fact that sound travels through water with over four times the velocity as through air, and hence with over four times the wave-length from crest to crest. Yet not a semblance of wave-motion or any other motion can be detected in water from the action of any sound passing through it, even with the aid of the microscope, notwithstanding a *sound-wave* is "essentially identical" with a *water-wave*, which always has an amplitude or a "to and fro" motion of its particles an actual distance equaling one tenth of the wave-length.

But even supposing there was another class of "water-waves" possible as the product of sound, what difference could it make with my argument? None at all, since such sound-waves in water would still be "essentially identical" with the visible waves caused by throwing a stone upon its surface, and would move "exactly in the same way"! It surely would do

the wave-theory no good, therefore, to resort to such hypothetic "water-waves" as being produced by sound, after admitting that they are "precisely similar" to "water-waves" produced by a stone, and that they are propagated "exactly in the same way." That "the way of the transgressor is hard" is no less a truism in science than in religion!

To show that sound in passing through water does not produce the slightest wave-motion in the interior of its mass, we have only to take a glass jar of water charged with some kind of coloring matter which will float through it in granules, and then examine it with a microscope under a strong light, while holding the stem of a tuning-fork in the water. That the sound of the vibrating fork permeates the water and passes through it in all directions is evident, since it is conducted to the table on which the jar sits, and is caused to ring out by its resonance with augmented volume. Yet the particles of coloring matter suspended in the water do not stir nor go through the least perceptible oscillation.

We see none of Professor Mayer's swinging "to and fro with the motions of pendulums," nor of Professor Helmholtz's "comparatively large amplitude of vibration," nor of Professor Tyndall's "small excursion to and fro"! Yet the sound-waves produced by this tuning-fork in water are more than four times as long as the waves in air would be from the same fork, according to the wave-theory, and hence the "excursion to and fro" in water, if there is any such excursion, should be over four times as large as in air! If there is any truth in the wave-theory, and if sound travels through water by means of wave-motion, why do not the floating particles in the water permeated by sound show some sign of oscillation?

It is true a visible circle of delicate waves may be seen on the surface of the water of the jar directly around the fork; but, as I have repeatedly explained in the preceding chapter, this is purely incidental, as the effect of the tremulous movement of the tuning-fork's stem, and not as the result of the action of sound at all. But since these learned physicists are just about superficial enough, as proved by their general investigations on this subject, to make a point of this diminutive wave-motion produced by the stem of the fork, I had better meet it in advance, and once for all, in a single brief paragraph, as follows:—

As a proof that these tiny wavelets are not "sound-waves" at all, let us suppose the fork to have one hundred vibrations in a second. By actual observation the wavelets sent off from its stem over the surface of the water are found to have a wave-length of *not over an eighth of an inch from crest to crest;* whereas, if they were really sound-waves, or even "essentially identical" with them, they would necessarily have a wave-length between 40 and 50 feet from crest to crest in water, or 11 feet 4 inches in air, as every physicist at all conversant with the current theory well knows! Thus, the only plausible argument or appearance of one in favor of actual sound-waves in water (for which the theory is indebted to my own experiment) has been ingloriously exploded in advance!

But the final and overwhelming evidence that "water-waves" can not, by any possibility, constitute sound-waves, or be the means of sonorous propagation in water, is drawn from the fact that if we throw a stone, weighing a pound, for example, into a piece of calm water, its waves will only travel at a velocity of *three feet a second*, as ascertained by careful observation and measurement; while sound, as recently quoted from Professor Tyndall and as all

authorities agree, travels in water with a velocity of fully 4,500 feet a second, or *fifteen hundred times faster than visible water-waves!*

Is it reasonable or conceivable that one system of "water-waves," caused by a *stone*, should be "essentially identical" with another system of "water-waves" caused by a *sound*, and that both systems should be propagated "exactly in the same way," while one system travels *three feet in a second*, and the other system *four thousand five hundred feet in the same time?*—one system having always an amplitude of about *one tenth* of its wave-length, while the other system, though it may have the same definite wave-length in feet and inches, yet has no amplitude at all?—one system of waves being visible to the naked eye, even if its wave-length be only the quarter of an inch from crest to crest, while the other system, even with a wave-length of over a *hundred feet* can not be seen at all under the magnifying power of the microscope? The absurdity of the idea glares contemptuously into the faces of modern physicists.

Hence, we reach the most demonstrative proof that sound does not and can not travel in water by wave-motion at all, since these measurable waves—the only class of water-waves ever observed—have but the *one fifteen hundredth* the velocity of sound!

If these candid investigators of physical science should claim, as just discussed, some other kind of water-waves not visible to the naked eye, or even by the aid of the microscope, which might possibly have a greater velocity than the above, or travel more than *three feet in a second*, such waves, as already shown, would evidently do their theory no good, *since they would not be sound-waves at all*, according to their own repeated statements, *unless they were "essentially identical" with visible "water-waves," and traveled "exactly in the same way"!* Thus, the closer we follow up this question, and the more rigidly we pin down these learned authorities to their own voluntary admissions, the more hopelessly demoralized the wave-theory becomes.

The conclusion is thus unavoidable that sound produces no wave-motion whatever, either in air, water, iron, or any other conducting medium, whether it be solid, liquid, or gaseous; but must travel through whatever medium conducts it in straight lines, according to the beautiful and consistent laws and principles unfolded and enunciated by the corpuscular hypothesis.

I could extend this argument, based on the analogy drawn from water-waves,—the only basis for any correct scientific knowledge of wave-motion,—but I have concluded to reserve the most crushing of all the arguments against the current theory of sound, based on such analogy, as a suitable and demonstrative culmination of this monograph.

In view of facts thus hastily passed in review, and especially in view of sound-waves in iron 476 feet long from "condensation to condensation," yet without amplitude, according to the teaching of physicists and as an unavoidable concomitant of the wave-theory, it becomes impossible to even attempt a rational explanation of the marvelous want of perspicacity in scientific investigators which has not permitted one of all the thousands who have studied the phenomena of sound to even suspect the manifest fallacy of a theory so fraught with impossibilities and absurdities. It wholly surpasses comprehension that among the greatest analytical thinkers the world has ever contained,—those particularly accustomed their lives long to searching and critical investigations,—not one has been found to expose the laughable weakness and pitiable puerilities of this

hypothesis, with so many self-evident impracticabilities confronting it, which, on their bare mention, demonstrate it to be one of the most enormous scientific errors of this or any other age.

In presenting these sonorous difficulties to a scientific friend—by the way, a firm disciple of Professors Tyndall and Helmholtz—he promptly confessed the absurdity of actual iron-waves, with "condensations and rarefactions" and a "small excursion to and fro" of the real particles of iron throughout the "amplitude" of the wave-motion, and suggested, as a probable and reasonable way to escape the difficulty and still believe in the wave-theory, the supposition that it might be the *air* in the iron which served as the undulatory medium for sound-propagation, since all bodies are porous, and contain more or less air. But this was instantly shown to be untenable by referring to Professor Tyndall's *Lectures on Sound*, where he gives tables showing the velocity of sound in all kinds of metal, wood, liquid, and gas, according to their density and elasticity, in *contradistinction to its velocity in air*, showing that sound-waves are thus admitted to be composed of iron, rock, wood, water, and gas, when passing through them, just as they are composed of air-particles when passing through air!

Besides, if it was *air* in the iron instead of the iron-particles themselves which constituted the sound-waves, how does it happen that sound travels *seventeen times faster* in iron than in air, as calculated by such scientists as Newton, Laplace, Chladni, Savart, Despretz, Helmholtz, and Tyndall? (See Tyndall's *Lectures on Sound*, p. 39.) As all these substances just named are placed in contrast with air, each transmitting sound-waves with a different velocity, it is no more logical or reasonable to claim that it is the air in iron which furnishes the undulatory motion for sound than to suppose it to be the air in *hydrogen gas* which meets the same necessity, since sound passes nearly four times faster through such gas than through air!

But this attempted evasion is utterly overthrown by the fact that sound passes through water from which all air has been extracted by heat with *four times the velocity of its propagation in the atmosphere*, proving that sound-waves in any solid or liquid body, if they occur at all, must be constituted of the absolute particles of such conducting medium.

Thus the question of sound-propagation was left with my friend in a state of hopeless demoralization, because it was impossible, as he thought, for Tyndall and Helmholtz to be wrong, and it was equally impossible for sound to go through solid iron in waves, with "condensations and rarefactions" and a "small excursion to and fro" of all the iron-particles composing such waves, especially such inconceivable waves as those required by the theory —*four hundred and seventy-six feet long* from "condensation to condensation"! I left him, therefore, with the incubus of an iron billow the tenth of a mile long, having a crest or "condensation" forty-seven feet high, pressing on his mental vision, but with a promise to candidly investigate the subject and report at our next meeting.

To my surprise, I found him at the next interview cheerful and light-hearted, having evidently shaken himself free from the fearful load left on his mind a few nights previously. He now was able, he declared, to solve the problem of sound passing through iron in waves of any required size and dimension without the aid of air, and without the fatal and pulverizing necessity of the "small excursion to and fro" of the iron-particles constituting the wave. He also had discovered, he asserted, an

important solution of the problem of sound passing through air in *real waves*, which would obviate the enormous absurdity of a locust compressing four cubic miles of atmosphere sufficiently to add one sixth to the velocity of sound, thus exerting the energy of more than fifty million horses! With astonishment I awaited the unfolding of the new hypothesis, which was to save the wave-theory from hopeless disaster and give a new lease of life to a philosophical doctrine which I had, as I conceived, utterly demolished.

My friend then proceeded to divulge the important secret of his discovery, namely, that sound passes through all substances, even through air, by means of *ethereal* undulations,—that it is not the *air*, nor the *iron*, nor the *water*, nor the *gas*, which is thrown into waves by the action of sound, but the *ether* which permeates all bodies, and which constitutes the undulatory motions which we term *light* and *heat*. Hence, he contended earnestly and enthusiastically that there was not the least difficulty in a locust filling four square miles with undulations of this substance, which was probably a thousand million times less dense than the most attenuated gas, while not the least absurdity would be met with in sound passing through iron, with waves a quarter of a mile long, having an amplitude of a hundred feet if necessary, since such undulations, instead of disturbing the texture of the iron in the slightest degree, were only the molecular movements of that *ether* which circulates freely through the substance of a diamond, and without which light could not exist!

The reader may guess the Doctor's consternation when this marvelous scientific palace of Aladdin was caused to fall into shapeless rubbish at his feet by touching it with the wand of a single fact which the whole scientific world admits, namely, that *sound will not pass through a vacuum at all, while a vacuum is just as certainly filled with this hypothetic ether, since light passes as freely through a vacuum as through air!* Thus, by a single touch this beautiful *ethereal* castle in the air fell to the ground.

Besides this annihilating fact, I referred him to the conclusive argument just employed with reference to air in iron as the means for producing sound-waves. If *ether* pervades all bodies, and if sound-waves are only *ethereal* undulations, why should sound travel seventeen times faster in iron than in air? It is evident that there is more room for *ether* in air than in a dense body like iron. It therefore turns out, according to this brilliant discovery, that the less the quantity of ether the greater the velocity of sound,—which, carried far enough, would prove that if there were no *ether* at all the velocity of sound would be still greater! Thus, it turned out that this important discovery of my friend had just about as much weight as the substance on which it was based.

To satisfy the Doctor as to this terrible demolition of his grand creation, I then turned to Professor Tyndall's work on "Sound," and read numerous passages in which he distinctly and unequivocally teaches that it is the "*air-particles*" themselves which are "moulded" into "waves," with "condensations and rarefactions," and which actually make the "small excursion to and fro," and that it is the physical atmosphere which is thus *heated* by the passage of these sound-waves, and its "temperature" so raised as to actually increase its "elasticity" "one sixth," by which "one sixth" is added to the velocity of sound. I also showed by these quotations that Professor Tyndall (my friend's great mentor) never dreamed of *ether* in the air being the medium of sound-waves,

and hence that *ether* can not so act in iron, because he particularly shows on page 7 of his treatise on "Sound" that although a vacuum is full of *ether* yet sound can not travel in it. Among these quotations overthrowing this *ethereal* palace of my friend were the following, some of them already quoted on pages 78 and 79:—

"Figure clearly to your minds a harp-string vibrating to and fro; it advances, and causes the *particles of air* [not particles of *ether* or some other element existing in the air] in front of it to *crowd together*, thus producing a *condensation of the air*. It retreats, and the *air-particles* behind it *separate more widely*, thus producing a *rarefaction of the air*. . . . In this way the *air through which the sound of the string is propagated is moulded into a regular sequence of condensations and rarefactions which travel with a velocity of about* 1100 *feet a second*." —"The pitch of a note depends solely on the number of *aerial waves* which *strike the ear* in a second. [Showing that these "*aerial waves*," which are "moulded" by the string, actually travel the whole distance within which the sound is heard, if a dozen miles, since such *waves* "strike the ear."] The loudness or intensity of the note depends on the *distance* within which the *separate atoms of air vibrate*. This *distance* [Mark it, a real "*distance*," increasing according to loudness or intensity,] is called the *amplitude of vibration*."—"We have already learned that what is *loudness* in our sensations, is, outside of us, nothing more than *width of swing*, or amplitude of the *vibrating air-particles*." —"Imagine one of the prongs of the vibrating fork swiftly advancing; it compresses the *air* [not the *ether*] immediately in front of it, and when it retreats it leaves a partial vacuum behind. . . . The whole function of the tuning-fork is to *carve the air* [not carve the *ether* or some other substance] into these *condensations and rarefactions*."—TYNDALL, *Lectures on Sound*, pp. 48, 62; *Heat as a Mode of Motion*, pp. 225, 372.

I then proved to the Doctor that his favorite physicist, Professor Tyndall, was not alone or peculiar in thus teaching that sound-waves were constituted of the real particles of the substance through which they pass, by taking down from his own magnificent library numerous authors who teach exactly the same thing. In the article on "Sound," for example, in Appleton's *American Encyclopedia*, Professor Mayer, a high authority, distinctly teaches that it is the air-particles themselves which, in a sound-wave, have a regular isochronal movement, and "*swing to and fro with the motions of pendulums*" as the sound travels, keeping up the same oscillations "to a distance." Professor Mayer remarks:—

"It is evident that the ultimate effect of the passage of *sonorous waves through the atmosphere* will be to cause the *molecules of the air* [not the molecules of *ether*] *to swing to and fro with the motions of pendulums*. It is also apparent that all the characteristics of the periodic motion at the source of the sound *will be impressed on the surrounding air, and transmitted through it to a distance*."

I also referred him to Professor Helmholtz, where he distinctly teaches that in the passage of a sound-wave through the air the particles of the atmosphere—not of the *ether*—take on "comparatively a *large amplitude of vibration*," as recently quoted.

In addition to these, and numberless passages which might be quoted from high authorities on the subject, I pointed out to my friend the fact that in Professor Tyndall's *Lectures on Sound* he devotes several pages (26 to 37 inclusive) to an elaborate calculation, condensed from Laplace, the great astronomer and mathematician, to show why sound travels through air at the freezing temperature 1090 feet a second, notwithstanding Newton's basis of sound-velocity, deduced from the density and elasticity of the air, proves that it can not exceed 916 feet a second. Professor Tyndall accounts for this difference of 174 feet a second (about one sixth) between Newton's law and the observed velocity, by the hypothesis so often quoted, that all sounds in passing through the atmosphere produce waves which cause "condensations" of the air, and thus generate *heat* throughout the entire distance the

sound travels, and that this augmentation of the air's temperature increases its "*elasticity*," which makes up the discrepancy in Newton's calculation by adding *one sixth* to the velocity of sound. In all this elaborate calculation by Professor Tyndall, too long to quote, the operation is shown by an engraving to be performed by the actual *air-particles* first pressing forward into one portion of a wave where they become heated by pressure, and then oscillating backward into another portion where they become cooled off.

From all this, I showed him that it was simple folly to try to evade the fatal consequences of wave-motion, which explicitly inculcates that the actual particles of the substance through which sound passes—whether it be air or iron, wood or water, —*constitute the undulations*, and literally make up the "small excursion to and fro" as each sound-wave passes; and that any serious effort by a physicist to evade this consequence would be to abandon the whole wave-theory.

I was thus exorbitantly particular on this point of the *wave-particles* themselves actually making the "excursion to and fro," and in showing that I did not misconceive nor misrepresent the wave-theory, that by no possible contingency should the appearance of a quibble or evasion intervene to save the scientific monstrosity from destruction. At the close of this second interview I had the satisfaction, if not of fully converting my friend to the new hypothesis of substantial sonorous pulses, at least of obtaining from him the voluntary admission that such a thing as literal undulations in iron by the passage of sound, causing its particles to oscillate "to and fro with the motions of pendulums," to say nothing of iron billows with a wave-length of *four hundred and seventy-six feet* from "condensation to condensation," which the theory necessarily requires, was too infinitely preposterous a supposition for any scientific mind to entertain for a single moment.

I now assert that it is safe to predict that the elaborate argument and calculation just referred to, in which Professor Tyndall unwittingly proves by careful figures and illustrations that the stridulation of a locust raises the temperature of the condensed half of four square miles of atmosphere, and thus increases its elasticity and adds one sixth to the velocity of sound, will be regarded by future generations as one of the most laughable philosophical curiosities ever placed on record by a sane mind, and by the side of which the Ptolemaic absurdities (of making the earth the center of the universe, with the sun, moon, and stars revolving around it every twenty-four hours) sink into insignificance. While the amused reader, hundreds of years hence, will find no difficulty in framing ample excuse for the Ptolemaic school of philosophers on account of the manifest physical appearances of the heavens, he will be able to find nothing in the scientific literature or the advanced state of mental cultivation of this age of steam presses and lightning telegraphs on which to base the least foundation for an excuse palliating so stupid a theory as this of which Professors Tyndall, Helmholtz, and Mayer are the popular and acknowledged champions,—compared to which the silliest scientific hypothesis of Aristotle becomes sound philosophy.

Take the following as one of the many inevitable results of the atmospheric wave-theory of sound. The hypothesis that each particular tone consists of a regular sequence of air-waves, with condensations and rarefactions which travel in symmetrical succession throughout the distance the sound is heard, sometimes for many

miles, without the tone being marred or distorted in the least degree, as distinctly taught by all writers on the subject, is met by the following insurmountable difficulty in the very operation itself,—a difficulty which, when properly weighed, must break down the hypothesis without the aid of another argument.

Waves of water, to which sound-waves are always compared, meeting each other from three or four different directions, will clash together and become broken up, disappearing in an indistinguishable mass of irregular hillocks, without the possibility of an approach toward reconstruction after collision. This is a fact well known to any one who has ever taken the trouble to observe the action of ripples meeting on the surface of a pond from the effect of three or four stones dropped into the water a few yards apart. No possible continuity of symmetrical waves can be traced after such collision and commingling, since a system of waves from one direction could move no farther in regular form and order after meeting a system of equal amplitude from another direction. Much less could twenty such systems of undulations, coming from twenty different directions, meet, clash, and intermingle indiscriminately, and then each series move on as *waves*, undisturbed or undistorted, which is absolutely the case with atmospheric sound-waves according to the current theory, since twenty musical instruments may be playing at the same time in different directions around you, with their sonorous waves necessarily crashing through each other and breaking up like water-waves into manifold and irregular hillocks, yet by an effort of attention the notes of each instrument can be distinctly recognized as pure and unbroken as if nineteen other systems of sound-waves were not dashing through them in different directions!

Need we ask a clearer demonstration that the tones of these various instruments do not consist of air-waves which Professor Helmholtz assures us, as already quoted, move "exactly in the same way" as water-waves, are "essentially identical," and "of a precisely similar nature"? If these sounds were really constituted, each of a "regular sequence" of atmospheric undulations moulded and sent off by its respective instrument, as Professors Tyndall and Helmholtz teach all through their books, it would inevitably follow that not a single tone could reach the ear undistorted, or in its proper vibrational form, if at all, as the waves would surely clash and be broken into a confused mass; for, let it be distinctly remembered that if sound is constituted of *waves*, then, whenever the waves are ruptured or disintegrated, as they would be if a number of systems clashed together, the sound would be changed from musical tones to mere *noise*, if not destroyed altogether! Is not this self-evident to every mind competent to investigate scientific matters, especially in view of the fact that air-waves are "essentially identical" with water-waves?

When on another phase of the sound-theory and when trying to illustrate the operation of his "condensations" and "rarefactions" in creating a "phase of opposition" and producing "interference," Professor Tyndall distinctly teaches that if *only two* equal systems of waves, whether of sound or water, should happen to "interfere" by the *crests* of one system falling into the *furrows* of the other system, they would *mutually destroy each other*. I will quote his words:—

"In the case of *water*, when the *crests* of *one system of waves coincide* with the *crests* of *another system*, higher waves will be the result of the coalescence of the two systems. But when the *crests* of one system coincide with the *sinuses* or *furrows* of the other system, the two systems in whole or in

part *destroy each other.* This *mutual destruction* of two systems of waves is called *interference.* The same remarks apply to *sonorous waves.* If in *two systems of sonorous waves condensation coincides with condensation* and *rarefaction with rarefaction,* the sound produced by such *coincidence* is *louder* than that produced by either system taken singly. But if the *condensations* of the one system *coincide* with the *rarefactions* of the other, a *destruction* total or partial of *both systems is the consequence.* . . . If the two sounds be of the same intensity their *coincidence* produces a sound of four times the intensity of either; *while their interference produces absolute silence.*"—*Lectures on Sound,* pp. 284, 285.

There is no misunderstanding this citation; for if two systems of equal waves from two unison forks, for example, "*interfere,*" by the forks being placed half a wave-length apart, so that the "condensations" from one fork "coincide" with the "rarefactions" from the other, "their *interference produces absolute silence.*" Yet, as we see, twenty different sounds, with their twenty different systems of air-waves, will infallibly reach the ear from as many different directions, while each individual sound will be as distinctly heard by special attention and as perfectly unbroken as if no other sounds crossed its path. Is it possible to suppose that twenty different systems of actual, corporeal *air-waves,* from as many points of the compass, can thus crash through each other, but invariably, without a single exception, while being fretted and broken into inexplicable tumuli, as they must be if actual waves, each proceeds separately on its journey, and undistorted enters the ear with its "condensations" and "rarefactions" unmarred, —as must be the case to represent the appropriate tone? Yet *two systems* of sound-waves are just as liable to *interfere* and cause "absolute silence" as to *coincide* and be *heard!*

Nothing, it would seem, but desperation in support of a theory could prevent a mind competent to reason on a scientific subject from seeing the contradiction and practical fallacy of the wave-theory, from this consideration alone. Yet so far from throwing a ray of suggestive light on the mind of Professor Tyndall, so absolutely wedded seem all his intellectual powers to the manifest folly of air-waves, that he not only is willing to accept the stupendous impossibility of twenty such systems of atmospheric undulations breaking through each other and yet continuing undistorted, without the shadow of "interference," but he raises the number to a "thousand" systems of such waves passing through "the same air" "at the same time," and each tone addressing the tympanic membrane, if listened to by the proper act of attention. As there is no possible way of knowing that "the same air" can accommodate a "thousand" tones from a "thousand instruments" at "the same time" only by hearing them, it utterly explodes this idea of the "interference" of air-waves, and with it the existence of such waves as the means of sound-propagation. For, if sonorous air-waves really exist, and if two systems stand an equal chance of destroying each other by interference, what would become of a "thousand" systems from a "thousand instruments" passing through the same air at the same time? Professor Tyndall remarks:—

"The same *air* is competent to *accept* and *transmit* the *vibrations of a thousand instruments at the same time.* When we try to visualize the *motions of that air*—to present to the eye of the mind the *battling of the pulses direct and reverberated*—the imagination retires baffled at the attempt."—*Lectures on Sound,* p. 257.

No wonder "the imagination retires baffled" at the legitimate consequences of a theory so practically impossible and absurd, in the very nature of things! We have only to reflect that the cylinder of air entering the ear is no larger than a

straw, and that this small body of air has to receive the *waves* from "a thousand instruments at the same time," and that these are actual, physical air-waves, with "condensations and rarefactions," some of them measuring *five*, *ten*, and *twenty* feet from crest to crest and of proportionate amplitude, each instrument sending into this small cavity from *forty* to *many thousand* such waves each second, and yet that all these billows of air, crashing through each other from different directions at a velocity of 1120 feet a second as they approach the ear, fall undistorted against the tympanic membrane, while, *let it not be forgotten, any two systems of equal waves stand the same chance of "interference" and consequent "absolute silence" as of being heard!* No wonder that "the imagination retires baffled"!

The same difficulty applies with equal force to the Undulatory Theory of Light. The waves of *ether*—a substance which Professor Tyndall supposes to resemble a "jelly"—from a distant star, after crashing through a million other systems of *ethereal* undulations from as many stellar bodies, liable to infinitely complicated distortions, seem to enter the eye without the mark of a collision on their polished billows!

Had Professor Tyndall informed his class of scientific students how a single air-wave from E of the double bass, 28 feet long and of at least two or three feet amplitude, if symmetrically proportioned as it should be if "essentially identical" with water-waves, could make its way unbroken through a cylinder no larger than a quill, so as to make a proper impression as a *wave* on the tympanic membrane, he would have solved a problem incomparably of more importance than any sonorous demonstration made during his eight lectures, and the class could then have well afforded to let him "retire baffled" in regard to how "a thousand" such waves could all enter the ear at one time!

While these difficulties, which could be greatly increased in number, are utterly unanswerable by the wave-theory, not one of them applies with any force against the hypothesis here maintained that sound consists of corpuscular emissions radiated in sonorous discharges.

Sound, being thus an incorporeal substance, not subject to the physical laws which control air-particles or any other corporeal molecules, acts without regard to interfering objects, only as to their conductibility, just as the intangible particles of magnetism, darting from the poles of a magnet, know no interference of even the most solid and imporous substances. Yet, as shown in an earlier chapter of this work, such magnetic currents must be emanations of attenuated substance, since they actually produce corporeal effects—moving ponderable masses of iron. How simple, therefore, that sound, as constituted of corpuscular emissions, under a somewhat similar law of diffusion, should defy the interference of counteracting currents of the same substance by their passing through each other without disruption? Yet how plainly impossible is this action with air-currents when the undulations from two fans clashing in a room, with sufficient smoke admitted to visualize the air-movements, will distort and completely obliterate each other's system of waves, demonstrating that even two systems of any corporeal undulations, coming into collision, will annihilate each other and prevent all further orderly progress?

I now invite the reader to a most demonstrative argument against the wave-theory of sound, and which at the same time as conclusively demonstrates the corpuscular hypothesis to be the only satisfactory or rational solution of the problem.

I refer to the well-established scientific fact that sound is wholly unaffected by the *wind*, only so far as relates to the small effect from the *bodily movement of the atmosphere as a conducting medium*, which, in that respect, would be no different from a body of iron or water moving with or against the direction of sound while conducting it.

Contrary to the popular idea, it has been proved by the careful observations of scientific men employed in our Signal Service, as well as in the service of other nations, that fog-horns and steam sirens are many times heard against a violent gale much farther than with it, even when the atmospheric conditions seemed to be the same. This being the fact, would not the ratiocination of any reflecting mind force the conclusion that sound is something else than physical air-waves, which, so far from traveling against the wind a distance of from ten to fifteen miles, and at a velocity of over a thousand feet a second, *can not travel against it at all* even a dozen feet, when forced from the mouth of the most powerful fog-horn in the service? If the mind reasons at all from this annihilating fact so clearly arrayed against the atmospheric wave-theory, would it not at once be driven to the conclusion that sound must be some kind of corpuscular emanation which moves uninfluenced by the gross or ponderable materials through which it passes, save so far as relates to laws of conduction, somewhat analogous to those governing electricity?

General Duane, of our Signal Service, in his report to the Government, says:—

"The signal is often heard a great distance in one direction, while in another it will scarcely be audible at a distance of a mile. *This is not the effect of the wind, as the signal is frequently heard much farther against the wind than with it.* For example, the whistle on Cape Elizabeth can always be distinctly heard in Portland, a distance of nine miles, during a heavy northeast snow-storm, *the wind blowing a gale directly from Portland toward the whistle.*"

But the reader might query as to whether Professor Tyndall would be willing to admit such a fatal state of facts against his favorite theory of sound consisting simply of air-waves moulded and sent off from a fog-horn or from any other sound-producing instrument. I will allow Professor Tyndall to testify on this most essential question, as he does in his Third Edition of *Lectures on Sound*, in which he introduces a special chapter on Coast Signals. At page 296, reporting his observations off the South Foreland, he says:—

"At a distance of 9¼ miles from the station the whistles and horns were plainly heard *against a wind with a force of* 4; while on the 25th, *with a favoring wind* the maximum range was only 6½ miles. *Plainly, therefore, something else than the wind must be influential in determining the range of sound.*"

"Plainly, therefore," Professor Tyndall, sound must consist of "something else than" air-waves; for if it were only atmospheric undulations, as the wave-theory so clearly teaches, it could not be heard against a wind "with a force of 4" twenty feet from the mouth of the most powerful fog-horn ever constructed. It must be an exceedingly slow wind which would not counteract the speed of air-waves sent off by the *vibrations* of a horn, which I have shown in a former argument can not reach to a distance of but a few feet in still air, while their velocity does not exceed five to ten feet a second even in a quiet room! A breeze which can be felt at all would travel faster than that.

One of the central errors of the wave-theory, and one on which its very existence hinges more completely, perhaps, than on any other, is this pivotal supposition that the vibratory motion of a sounding body,

such as a string, tuning-fork, reed, or horn, acts upon the elasticity or spring quality of the atmosphere, and, by shoving its particles ahead, transmits a shock or "push" to other particles still in advance, these to others, and so on, by which means an air-wave or condensed pulse is driven off to a distance with the observed velocity of sound.

No greater mistake was ever perpetrated by physicists than to suppose such a thing as this possible with a body like our atmosphere, possessing perfect *mobility* and such trifling density, with no measurable or appreciable elasticity or spring-force, under slow displacement, *unless confined as in a tube and acted on by a piston.* I propose, therefore, at this point, to make a brief digression from this question of wind and its supposed influence on the range of sound, at least long enough to take up and analyze this problem of the so-called spring-power of the air, and with it this vital supposition of the wave-theory that the vibratory motion of a sounding body is capable of transmitting a pulse to a great distance from particle to particle of the air with the observed velocity of sound.

In the preceding chapter it was shown in different ways that there was no such a thing, in fact or in philosophy, as this so-called "spring-power," or elasticity of the atmosphere when unconfined, which would tend to transmit a pulse from particle to particle even a single foot in advance by the vibratory motion of a tuning-fork or other sounding body. Yet Professor Tyndall, in his introductory lecture on sound, teaches, in the most conspicuous manner, that the air acts in transmitting tone the same as a spiral spring, when shoved longitudinally, acts upon its own substance; and that if one particle of air should be suddenly pushed, it will communicate the push to the next particle in the same direction, it to the next, and so on, at the observed velocity of sound, and throughout the entire distance a sound may be heard, if ten miles!

To make sure that his audience did not fail to catch and retain a correct idea of this fundamental principle of the wave-theory of sound, the Professor proceeded to illustrate it, thus to impress it on the memory, by placing a row of *glass balls in a groove* so closely together as to touch each other, the end one of which being pushed longitudinally in the direction of the row would transmit the impulse through the entire line, driving off the farthest ball, just as the air-particles at a distance from a sounding body are claimed to be finally driven against the tympanic membrane, thus causing it to vibrate.

He also illustrated the same idea by employing a row of *boys*, each with his hands resting on the shoulders of the one in front throughout the line of half a dozen, more or less, the hindmost one of whom being pushed forward would communicate the impulse, by the spring-power of his rigid arms, to the next, he to the next, and so on, the last boy being pushed over, having no other boy in front of him to receive the shock! But I must quote the lecturer's words, in order to properly convey the idea:—

"I place these balls along a *groove*, thus, Fig. 1, each of them touching its neighbor. Taking one of them in my hand, I urge it against the end of the row. *The motion thus imparted to the first ball is delivered up to the second*, the motion of the second is delivered up to the third, the motion of the third is imparted to the fourth; each ball after having given up its motion returning itself to rest. The last ball only of the row flies away. *Thus is sound conveyed from particle to particle through the air. The particles which fill the cavity of the ear are finally driven against the tympanic membrane*, which is stretched across the passage leading to the brain. This membrane, which closes the 'drum' of the ear, *is thrown into vibration*," &c.

Speaking of the row of boys, he says:—

"We could thus transmit a *push* through a row of a hundred boys, each particular boy, however, only swaying to and fro. *Thus also we send sound through the air and shake the drum of the distant ear, while each particular particle of the air concerned in the transmission of the pulse makes only a small oscillation.*"—*Lectures on Sound*, pp. 3, 5.

Now, I emphatically protest that this entire argument, from beginning to end, as thus illustrated, is the sheerest scientific nonsense, and contains not one scintilla of philosophical truth. Nothing but the manifest sincerity of the lecturer while elaborating these illustrations prevents one from suspecting that, so far from seriously intending them as a pertinent inculcation of scientific truth, he was adroitly attempting to play a practical joke on his class, or possibly might have been trying to ascertain, as a psychological experiment, to what extent an intelligent audience could be duped to believe in the most monstrous and ridiculous fallacies when inculcated as science!

To teach, as he did, that the vibrating prong of a tuning-fork moving in one direction *at the trifling velocity of only seven or eight inches in a second* (which he must have *jestingly* called "swiftly advancing"!) through a substance having the *fluxidity* and small *density* of air, should give to its particles any kind of a forward impetus or "push" which could affect the atmosphere a foot in advance of the prong, is so clearly foundationless in reason that it can only be accounted for on the supposition of a practical joke, a psychological experiment, or, if serious, as an indication of the densest innocence of all true scientific knowledge on the part of the speaker.

There evidently can be no justifiable or even pardonable excuse in a great scientist deliberately comparing this assumed *spring-power* of the free particles of air to the action of "glass balls" secured in a "groove," which must necessarily be destitute of all lateral *mobility* or power of escaping sidewise, and hence are mechanically compelled, when pushed in the manner described, to communicate their motion from the balls in the rear to those in front! Had the lecturer been illustrating the action of air *confined in a tube* and operated on by a closely fitting piston, as was done by Professor Mayer (see pages 111, 112), there would have been some appropriateness in thus exhibiting to his audience the row of glass balls restricted to a "groove." As it was, however, these balls having been employed to illustrate the spring-power of air perfectly free to move *laterally*, and to show how a body like the prong of a tuning-fork, by moving slowly through it, would shove its particles ahead, and thus transmit the "push" from one particle to another, the illustration becomes as absurd as it is unscientific and superficial.

As well might this lucid philosopher exhibit to his audience a ball of *platinum* as a pertinent illustration of the density and specific gravity of a similar ball of *cork!* Such a performance would be so flatly ridiculous that it could not be even mitigated by calling it a *joke*. Yet it would not be a whit more monstrous than to thus present the action of a row of glass balls secured in a "groove" as a suitable and pertinent illustration of unconfined air-particles circulating in free space! He might safely and pertinently exhibit the ball of platinum to elucidate the *contrast*, or point out the *difference* between it and the ball of *cork*, but not otherwise. So he could have appropriately employed the row of glass balls thus secured in a "groove" to point out the *difference* between the spring-force and elasticity of atmosphere confined in a tube, and its marvelous mobility, freedom from spring-power, and

tendency to equilibrium, when circulating in open space! But really to occupy the time of his audience with the action of the row of balls, *thus secured against the possibility of lateral motion*, as a proper illustration of free air-particles, and to prove that they tend to shove each other straight ahead, as did this eminent physicist, is simply a laughable travesty on an illustrated scientific lecture; and I am astonished that any audience of sufficient intelligence to be attracted to such an exhibition could permit the speaker, however renowned, to escape scot free, and not "pin him down," to use his own words, and pulverize him on the spot, after inculcating such transparent philosophical nonsense and calling it science!

On page 112 I charged physicists with utterly ignoring the *mobility* of the air,—that is, its tendency to flow in all directions, and then form an equilibrium, whenever disturbed,—one of its most persistent and remarkable characteristics. I ask the candid reader if we have not here, in this unmistakable illustration of the row of glass balls, the clearest proof that my arraignment was just? It is entirely manifest, as any one can see, that a single word from Professor Tyndall, on the occasion of this exhibition, as to the lateral mobility of the air, or its tendency to get out of the way of a passing object by moving to the right or left, and thus take its place behind it, would have hopelessly ruined his lecture, by neutralizing every point he attempted to make out of his elaborate illustrations of the balls and the row of boys! To have taught, as he did, first that a sound is simply an air-wave transmitted as a "push" from particle to particle of the atmosphere, the same as the motion of the hindmost ball is communicated through the row, and then to have added that unlike the row of balls confined in the groove, the air-particles possess lateral mobility *and are free to slip around behind and not be pushed at all*, it must be manifest to any one would have literally shelved his whole argument, and brought down the house in laughter at such a philosophical fiasco.

He can not deny the correctness of this criticism, because, according to the clearly expressed intention of his argument as thus illustrated, and as absolutely required by the wave-theory, the air-particles in front of the tuning-fork's prong have no more tendency or power to get out of the way, to the right and left, by exercising their mobility, and thus avoid being compressed and pushed ahead, than had the glass balls confined in the "groove"! If atmospheric particles have any such a power, then away goes all this talk about transmitting condensed air-waves to a distance.

The *lateral mobility* of the atmosphere being thus wholly incompatible with that wave-motion or spring-power of the air-particles required by the current theory of sound, hence the suppression of any reference to it in the writings of physicists when discussing sonorous propagation. I assert that *not one such reference can be found in any work treating on this subject!* It speaks illy enough for the advancement of true science to have the charge justly thrust into the faces of physicists that a well-known physical fact, such as this unquestionable law of pneumatics, has to be ignored because it is in direct conflict with the pivotal and central principle of the wave-theory of sound!

Yet it stands on record, and can not be controverted, that, according to the evidence adduced all the way through the preceding pages of this monograph from the writings of these great authorities, the wave-theory of sound is continually forced

to ignore the simplest laws of mechanics, pneumatics, and acoustics, in order to maintain its existence. Even if it has to assume that a trifling insect is capable of displacing and oscillating to and fro a mass of ponderable matter weighing *two thousand million tons*, as was abundantly demonstrated in the preceding chapter, this is nothing to the importance of *tympanic vibration*, for example, because that is a part of the wave-theory, and must not be suppressed! So the *mobility* of the air, exactly as self-evident as its *compressibility* or *elasticity*, must be quietly suppressed, that the ridiculous hypothesis of atmospheric spring-power in the free air may survive and be taught as a part of the current sound-theory! But ignore it as they may, physicists can rest assured that as certain as the day of doom overtakes every false theory sooner or later, just so certain does this single physical fact of the *mobility* of the air ring the death-knell of the wave-theory of sound the moment it is understood and brought to bear on the question. As well might physical philosophers attempt to ignore the fusibility of lead or undertake to suppress the law of gravitation, as to try to ward off the fatal effects of the principle of atmospheric mobility in neutralizing this so-called spring-power of the air as illustrated by the row of glass balls! This stubborn law of physics will not down at the bidding of any philosophical formula, and refuses to be suppressed or ignored any longer at the behest of any so-called scientific theory.

I do not charge these authorities with the *wilful* suppression of this scientific fact of atmospheric *mobility*. They may have done so unpremeditatedly, and I do not wish to be understood as insinuating to the contrary. Yet there is such a thing as being *scientifically dishonest* without meaning to be, or even knowing it. As paradoxical as this may seem, yet in one sense it may contain the elements of truth. Is it not possible to be so wedded to a favorite theory, and to be so in the habit of bending all our energies to its support, that in discussing its principles and the laws involved, we many times involuntarily ignore difficulties which thrust themselves in our way, and, rather than be annoyed with what we allow ourselves to fancy for the time as temporary troubles, we shut our eyes to real objections, and, by thus putting off the evil day and refusing to face them at once, absolutely ignore obstacles which, if taken up and analyzed, would have overthrown our hypothesis? Be this as it may, no man is in a condition to properly investigate the details of a scientific theory till he is able to suppress and utterly stamp out this defective tendency of human nature, and to look at physical phenomena, however they may cross his path, with the sole object of arriving at the truth, whichever way it may lead, and of accepting its principles and laws, even if his most cherished hypotheses are thereby dashed to the ground.

It is on this basis that I make my complaint and enter my charge against Professor Tyndall as a popular instructor on questions of physical science, and insist that a public lecturer so recklessly careless of accuracy, or else so blinded by the influence of a pre-adopted theory, and hence so uninformed on the scientific subjects he attempts to discuss, as not to know that the movement of the open hand through the air at a velocity of only *seven* or *eight* inches in a second could produce no effect whatever on the air-particles a foot in advance, owing to this principle of *mobility* (let alone conveying a "*condensation* and *rarefaction*" of the atmosphere to a distance of hundreds of yards, and at a velocity of over a thousand feet a second),

justly earns and ought to receive the ridicule of the whole scientific world. Yet such a motion of the hand, by being continuous throughout the second, instead of being divided up into segmentary motions of *sixteenths* of an inch but of no greater velocity, ought to have more than twenty times the effect of utilizing this so-called spring-power of the air and of transmitting a condensed pulse to a distance that a tuning-fork's prong would have, being twenty times as large and passing through the air with the same velocity.

Does not every scientific thinker, who is competent to reason at all on this subject, know that if the movement of the *hand* through the air at a speed of *seven or eight inches in a second* would not send a pulse or condensation to a distance at the observed velocity of sound, then certainly the movement of the same hand *the sixteenth of an inch* in the same direction and at the same velocity could not produce any greater effect? And if the *hand* moving a *sixteenth of an inch* at that trifling velocity would produce no such condensation of the air at a distance, then pray tell us, ye astute physicists, how it is that a tuning-fork's *prong*, only one twentieth as large, moving exactly the same distance and at the same velocity, should send off an atmospheric condensation and rarefaction at a velocity of 1120 feet a second?

It was demonstrated mathematically in the preceding chapter that the prong of any tuning-fork can move only at a velocity of *seven or eight inches in a second in one direction*, and consequently that it is the essence of absurdity to suppose, as acousticians have always done, that the sound generated by a vibrating body, like a fork or string, was caused by condensed waves sent through the air by a movement of such trifling velocity. As the reader will recollect, I took the liberty of laying down for the first time the new acoustical law by which the true cause of the generation of sound was clearly expressed, to which I would again earnestly call the attention of physicists. (See pp. 92, 93.)

Nothing, in fact, but this superficial and universal misconception of supposing that a tuning-fork's prong "swiftly" advances when its movement is almost snail-like (not half as fast as a child a year old can walk, as proved at page 99), could ever have so misled physicists in regard to this erroneous idea of "moulding" and "carving" and "sending off" air-waves at the enormous velocity of sound-pulses. If it had ever once flashed across the minds of these investigators of acoustical phenomena that a sounding string or prong of a tuning-fork was never known to travel as fast as *one foot in a second in one direction*, all this nonsense about the spring-power of the free air, and of the slowly moving prong or string *carving* and *moulding* it into *condensations* and *rarefactions*, and sending them off at a velocity of 1120 feet a second by such snail-like displacement, would long since have disappeared from works on science, and physicists of to-day would be looking back with astonishment at the superficiality and stupidity of their brethren of the past, just as astronomers of the present time are often amazed at the want of perspicacity in mathematicians of the Ptolemaic school, who believed the earth to be the center of the universe, and that the sun, moon, and stars revolved around it every twenty-four hours.

As inconceivable as it must seem to the scientific students of our colleges all over the land, and as an illustration of my present argument, it is an indisputable fact that even this greatest and most reliable of modern investigators of physics, Professor Helmholtz, honestly supposed that the prong of a tuning-fork necessarily

travels "*very much faster*," to use his exact words, than the ball of a swinging pendulum, as already quoted, while any scientific mechanic knows, or may know by a moment's calculation, that a pendulum having beats of two seconds each, and oscillating through a third of a circle, actually travels more than *twenty times* "*faster*" than the motion of the prong of any tuning-fork ever constructed! (See quotation from Helmholtz, page 92.)

This same investigator, looked up to as the highest standard authority on all questions of physical science in our colleges and universities, honestly supposed (because it appeared to harmonize with the requirements of the wave-theory of sound) that a violin-string oscillates normally with a velocity "*ten*" times greater than that of the bow in the player's hand, while, as it was fully demonstrated in the preceding chapter, the average velocity of the string in playing was not one fourth that of the bow, or not more than *one fortieth* as much as supposed by this world-renowned authority! (See quotation and exposition, pages 95, 96, and onward.)

Then look for one moment at the words of our most popular English authority on Sound, Light, and Heat,—Professor Tyndall,—whose works are so sought after as to be translated into most of the languages of Europe:—

"Imagine one of the prongs of the vibrating fork *swiftly advancing* [at the enormous velocity of *seven or eight inches in a second!*] It compresses the air immediately *in front* of it [Mark the language,—not to the *right* nor to the *left* of it, but "immediately *in front* of it," just as the glass balls in the "groove" push each other straight ahead if we shove the hindmost one!], and when it retreats it leaves a partial vacuum *behind*, the process being repeated at every subsequent advance and retreat. The whole function of the tuning-fork is to *carve* the air into these *condensations* and *rarefactions*."—*Lectures on Sound*, p. 62.

"Figure clearly to your minds a harp-string vibrating to and fro; it advances, and causes the particles of air *in front* of it [the same as the tuning-fork's prong, not to the *right* or *left*, but "in front," just as the glass balls and the boys push each other, straight ahead, without *lateral mobility!*] to *crowd together*, thus producing a *condensation of the air*."—*Heat as a Mode of Motion*, p. 225.

Now, it is entirely plain, if there is the slightest appropriateness in the illustration of the row of glass balls in connection with the language here used, *that sound should only travel in a line directly in advance of the moving body which generates it, since the sound is only produced by the compression of the air, and the air can only be condensed "immediately in front" of the fork or string*, just as the glass balls can only communicate their motion from one to another in the line of the "groove," no provision whatever being made for the transmission of their motion to the right hand or to the left, since all *lateral mobility* of the balls as well as of the air-particles is ignored!

Thus, the illustrations of the glass balls and the row of boys have the rare merit of consistency, being in perfect harmony with the teaching of the same authority as to the manner in which sound is sent off by a vibrating body,—namely, in *advance* only, as just quoted. In perfect keeping with this notion of *spring-power*, and according to the expressly worded language here cited, the *prong* as well as the *string* "*advances*" and "*compresses* the *air* immediately *in front* of it," and, like the balls, producing no effect either to the right or left. But when we come to consider the well-known fact that the *sound* of a tuning-fork is actually heard and equally as well at the right and left of the prong, where there is no lateral motion whatever, and consequently *where there can be no compression of the air*, what becomes of this beautiful row of glass balls and this accommodating file of performing boys? The

truth is, the wave-theory of sound breaks down right here, unless logic and reason have been banished from the earth, requiring no other argument to shatter it than the illustrations and the teaching of Professor Tyndall, as just quoted; for, since the row of balls ignores the *lateral mobility* of the air, and since the prong of the tuning-fork only "compresses the air immediately in *front* of it," having no motion to the right or left, and hence no compressive force in that direction, the single well-known fact that sound is heard in that direction as well as in the line of its oscillation, demonstrates that sound is not produced by atmospheric condensations at all, and hence that this spring-power of the free air by which hypothetic sound-waves are sent to a distance is purely chimerical, having no foundation in fact.

We thus reach the unavoidable conclusion that this assumed spring-power of the free air, by which a pulse or wave may be driven off by means of a slowly moving body like the prong of a tuning-fork, amounts to absolutely *nothing*, and any physicist worthy of the name ought to know it. If I move my open hand through the air at the velocity of a tuning-fork's prong (seven or eight inches in a second), instead of the particles of air being compressed and pushed ahead on the principle of a spiral spring or in any manner analogous to the row of glass balls, thus sending a "condensation and rarefaction" off at a velocity of 1120 feet a second, any one with the faintest idea of the laws of pneumatics knows or ought to know that the air-particles in front of my hand, bringing their mobility into play, move to the right and left as the hand advances, circle around it, and in the most orderly manner take their place behind it, thus re-establishing the equilibrium and equalizing the displacement caused by the moving hand, without, in all probability, stirring the air a foot from my hand in any direction.

Did Professor Tyndall, I would ask, observe any such phenomena, while presenting these illustrations to his London audience, as the front balls slipping out of the groove to the right and left passing around and taking their place in the groove behind, as he gave the row a push? If he did not, then there was not the slightest pertinency in his illustration, or similarity to the manifest action of air-particles, since the main thing always resulting from the movement of an object such as the hand through the air, is not to cause a pulse to travel ahead to a distance or in any direction, but for the disturbed air to accomplish an equilibrium, and make good the displacement of its particles by the shortest possible route. I do not insist that an illustration shall go on all fours, or that it shall be coerced, to elucidate points not essentially involved in the argument, but I deny that there is any illustration of aerial displacement at all in this movement of these glass balls, or the semblance of analogy between the shoving of them straight ahead while confined in a "groove" and the disturbance of the freely circulating air by a slowly moving body like a tuning-fork's prong; and hence the attempt by this lecturer to represent the two actions as in the slightest degree analogous, I insist was simply practicing a deliberately contrived, though perhaps unintentional, imposition upon his audience.

Had his performing boys been half as bright as they might have been, with a few minutes' private training before they made their appearance on the platform to assist in this farcical illustration of aerial disturbance, they could have produced a genuine sensation, as discomfiting to the lecturer as it would have been beneficial

to his auditors, and one which would have caused Professor Tyndall to open his eyes as they were perhaps never opened before. It would have only required the front lads of the row to gently slip out of line to the right and left and fall back to the rear as the Professor gave the hindmost boy a "push"! They would in this manner have at least conveyed some faint idea of the action of air when disturbed by a body passing through it, instead of utterly misrepresenting it, as they were forced to do under the tuition and manipulation of this great physicist! Had the boys been a dozen years old, and possessed the advantages of an ordinary education up to that age, I very much doubt, if they had been left to their own common sense, whether they might not have been able to explode this great lecture in the way intimated without any private prompting, while the audience would have evidently gone home with a good deal more of practical scientific knowledge in their heads by the trick than they received in witnessing such a worthless "comedy of errors."

But I have said enough on this question of the so-called spring-power of the air to convince, as I believe, any unbiassed mind that the small vibratory motion of a sounding body, even such as a fog-horn, would be incapable of transmitting a condensed wave to a distance of a single foot against the slightest breeze which could be felt at all, to say nothing of counteracting and traveling against a gale moving with a velocity of thirty miles an hour, or forty-four feet a second.

The sound of the fog-horn must, therefore, consist of something else than air-waves. What can it be, I ask the unprejudiced reader, if the wave-hypothesis fails to explain it, as it manifestly does? Surely there is no middle ground to assume between wave-motion and the emission of some kind of imponderable corpuscles generated by the vibratory motion of the sounding body, analogous to magnetic particles, which propagate themselves through the air and through other substances in defiance of such physical conditions as atmospheric currents.

If my hypothesis is, therefore, the true one, it would seem that this imponderable sonorous substance, whatever it may consist of, should travel at the same velocity against the wind as with it, minus the velocity of the atmosphere itself, which, being the conducting medium of the sound-particles and traveling bodily in an opposite direction must necessarily subtract that much from their speed. That is to say, if a gale is blowing twenty miles an hour, with a temperature of sixty degrees Fahrenheit, sound, which travels in still air 1120 feet a second, would move against this current but 1091 feet a second, because the air itself moves in the opposite direction 29 feet a second, which must necessarily be deducted. It is just the same in principle as if electricity traveled 1000 miles a second through a wire, while the wire was itself drawn a mile a second in the opposite direction. It requires no argument to show that the forward advance of the electric pulse would be but 999 miles a second instead of 1000. I will here venture the prediction that this formula as to the effect of wind will be found accurate whenever future science shall, by careful experiment, ascertain the facts, which will show that sound-pulses or sonorous discharges travel absolutely unaffected by air-currents, thus furnishing a clear demonstration that air-waves, with "condensations and rarefactions," and a "small excursion to and fro" of the air-particles composing the waves, have nothing whatever to do with sound-propagation, since they could not travel against the wind at all.

One would think that this fact alone, of sound traveling with nearly the same intensity and to the same distance against the wind as with it, so clearly shown by the testimony recently quoted, ought to have opened the eyes of scientific men long ago to the self-evident impossibility of sound traveling by means of atmospheric undulations driven off from a vibrating body like a fog-horn. It would really seem that a logical mind ought not to reflect on the problem one minute, in view of this evidence, without being forced to the conclusion that air-waves, with the oscillation "to and fro" of all the particles involved in the transmission, utterly fall short of explaining the phenomena of sound-propagation. That physicists have not long since reached this conclusion can only be accounted for by the fact that such a thought as calling in question the truth of the long-established and universally accepted wave-theory of sound was too preposterous a supposition to find a resting-place in their learned heads,—though they have told us over and over again, as recently quoted, that sound-waves in air move "exactly in the same way" as water-waves, are "essentially identical," and "precisely similar." Yet there is not to-day an engineer who would not laugh in the face of a man who should assert that a steamboat, anchored in a rapid stream, could send the waves from its revolving wheels as far up-stream as down, or even send them at all against the current, provided its movement was as rapid as the motion of the revolving paddles; while this same engineer, if he happened to be a disciple of Professor Tyndall, would see not the least absurdity or inconsistency in a vibrating fog-horn, which could not stir the still air over twenty-five or thirty feet from its mouth, sending *actual air-waves* against a violent gale at a velocity of a thousand feet a second and to a distance of a dozen miles with such force that the oscillating air-particles would be sensibly dashed against the tympanic membrane, causing it to physically vibrate!

It staggers human credulity that men can be found to believe such an enormous fallacy, without once calling it in question; for there is not to-day in the mythology of all heathendom a superstition involving results without adequate means more absurdly ridiculous than is the mechanical result involved in this universally accepted scientific superstition, which absolutely converts a tiny insect, as I have already demonstrated, into an engine of 50,000,000 horse-power! Yet the scientists who hold to such a monstrous impossibility, which hurls defiance into the teeth of all known laws and forces of Nature, are the very men to look with sardonic pity on a man who is so superstitious as to admit the existence of a God or to believe in the immortality of the soul!

The great diversity observed in the range of sound, when no perceptible difference exists in the state of the atmosphere, is just now the puzzling question with the scientific world, particularly with those engaged in the Signal Service of the various civilized nations.

Professor Tyndall devotes an entire chapter to this inexplicable problem, leaving it after all about where he found it, with the mere opinion that this diversity of range in clear air is due to *banks* or *clouds* of *invisible vapor* of more or less conductibility or resistance, as the case may be, to the air-waves sent off by the fog-horn! This surmise is about as satisfactory as the hypothesis of an invisible and intangible *ether* like a "jelly," filling all space and all solid bodies, by which to account for the useless undulations of light

and heat, rather than admit them to be substantial emanations.

That a fog-horn or steam siren should be heard sixteen miles in a still, clear atmosphere, one day, and the next be inaudible a distance of two miles in the same direction and with the same atmospheric conditions precisely, so far as ordinary observation can determine, may well be a mystery to cause scientists to marvel, and I venture the prediction that it will never be explained satisfactorily till the true substantial nature of sound is made a factor in the investigation.

Are physicists sure they understand all about even the substantial structure of our atmosphere? Perhaps if they did, such improbable guesses as *banks* and *clouds* of *invisible vapor*, sufficiently dense to counteract *air-waves* and stop their progress, might be rendered unnecessary. Let us see if some *guess* in regard to the air itself will not more likely furnish a basis of solution for this puzzling problem than the supposition of *clouds* of *vapor* which can not be seen, yet so formidable as to stop aerial undulations!

What right have we, for example, to assume that our atmosphere is homogeneous or structureless,—the particles of which, Professor Tyndall says, swing in *ether* like suspended grains? How do we know that the molecules of the air, even in a state of rest and when comparatively free from aqueous vapor, as in a clear day, may not have been left in a relation to each other similar to that of the molecules of wood or other tangible bodies, having a lamellar structure analogous to *grain* or *fiber*, running either with the sound or at right angles to it? And how do we know but that the next current or cool night which intervenes may reconstruct these invisible strata of this wonderful substance called air, by throwing them into "pi," as the printer would say, or transversing the arrangement of their particles?

It is a well-known scientific fact that sound travels *with the grain* through certain kinds of timber, such as *fir*, with nearly six times greater velocity than crosswise of the grain, or at right angles to its exogenous rings, while it is reasonable to infer that its *range* would be correspondingly enhanced with the grain, could a sufficient body of such wood be brought together into a solid mass to test it. (See Tyndall's *Lectures on Sound*, p. 41.) This fact alone ought to have suggested the possible explanation that the same sonorous corpuscles which will select the most favorable arrangement of the molecules of wood or other solid substances for the greatest velocity or range, might also elect the most favorable arrangement of the ever-shifting air-particles, suited one day for a greater penetration than another, even when to visible appearance the conditions seem exactly the same.

If this hypothesis should be admitted (and it surely seems more reasonable than that banks of invisible *aqueous vapor* should stop the progress of sound, when it is known that *water* is a fourfold better conductor of sound than pure *air*), it at once accounts for the problem of diversity of range, with all its attendant phenomena, when atmospheric conditions appear the the same.

Take the remarkable occurrence of *echoes*, often heard returning from a clear atmosphere but a few hundred yards distant, with not a cloud in sight, and when no moisture can be detected in the air. Suppose, instead of clouds of invisible vapor (which all considerations go to render improbable), that the *grain* of the air, so to speak, or the lamellar stratification of its molecules, happen to be such as to run across the direction of the sound-discharges

at a distance of a quarter of a mile from the sounding body, it would present a less penetrable surface to the sonorous pulses, and a rebound or echo would be the consequence. But the rebounding of simple *air-waves* from a bank of pure *air* is a self-evident absurdity.

There are very few persons who have not at some time or other observed that the ringing of a church or steamboat bell, the roar of a train of cars, or the noise of a cataract, would sound out with great intensity, when at other times it would be scarcely audible in the same positions. Almost universally this has been supposed to be caused by the direction of the wind, while the smallest attention shows this to be a popular mistake, since the same effect will occur exactly when there is not a breath of air stirring either way, and even when the atmosphere is comparatively free from vapor. What law, then, can explain this remarkable phenomenon so beautifully, and, at the same time, so simply, as the possible *stratification* of the air, as I have supposed? That such *grain-like texture* in the air-molecules has not been known heretofore may alone be attributed to the fact that atmosphere itself, though a corporeal substance, is invisible.

How many times, also, has it been observed, as an inexplicable mystery, by men employed in the Signal Service, and as noted by General Duane, that a sound from a siren which can not be heard at a distance of two miles in a still, clear air, can at the same time be heard distinctly six or eight miles farther on in the same direction? What hypothesis can so simply and beautifully explain this as the one here suggested? We have only to suppose that a sloping bank of air, presenting opposing *grain*, may rest on the water at a distance of two miles from the station, and that the sound-discharges, striking its slanting roof, glance over the heads of the observers, and striking another body of air with favoring grain, or with its molecular laminæ arranged longitudinally with the sound's direction, find no difficulty in penetrating it and thus reaching the ears of observers inclosed by it. The mere possibility of this explanation being the true solution, with its great simplicity, being applicable to every conceivable variety of such phenomena, most of them now regarded entirely inexplicable, would seem to commend it to favorable attention. The greatest difficulty it will have to encounter will be the mischievous idea of homogeneity wherever heterogeneity can not be distinctly traced, or where structural arrangement can not be identified under microscopical observation or by philosophical tests, which has done much to forestall explanatory investigation in more than one branch of science, as will be seen when we come to consider Professor Haeckel's evidence of spontaneous generation in the next chapter.

I do not venture the foregoing as absolutely the true explanation of the puzzling problem of diversity in the range of sound under apparently similar conditions of atmosphere, but throw it out for what it is worth, willingly trusting the science of the future to unfold a more rational solution.

In view of the facts which this single question of atmospheric currents and their influence on sound has developed, and in view of the numerous problems which seem hopelessly unsolvable by the current theory of wave-motion, may we not safely predict that a revolution is near at hand, when light, as by a new scientific revelation, shall break upon the world, and when the old hypothesis of sound-waves will be utterly abandoned by physicists for the vastly simpler and more rational view of corpuscular emanations,—against which,

as the attentive reader must have observed, lies none of the immeasurable difficulties which everywhere confront the wave-theory? With this always consistent solution of every conceivable problem which the phenomena of sound can suggest made the rule of our scientific faith and practice on this question, might there not be discoveries made now undreamt of, and processes of sonorous penetration devised for piercing the densest fogs, which would not only defy the supposed stratification of the air, but all banks and clouds of vapor, visible and invisible? That such discoveries have not yet been made may be safely attributed to the erroneous basis of all our investigations on the subject of sound-transmission, or all true conceptions of even what sound is. To be wholly ignorant of the nature of sound would seem necessarily to involve very imperfect apprehensions as to its true mode of propagation or manner of conduction, as well as to the most efficient means of utilizing it to the best advantage. Truly may Professor Tyndall say, as he does in his Third Edition of *Lectures on Sound*, page 328:—

"Assuredly *no question of science ever stood so much in need of revision as this of the transmission of sound through the atmosphere.* Slowly but surely we mastered the question; and the further we advanced the more plainly it appeared that *our reputed knowledge regarding it was wrong from beginning to end.*"

How literally yet unintentionally does this great authority express the present state of true scientific progress upon this whole question of sound, and how unwittingly has he confessed the truth when he says "that our reputed knowledge regarding it was wrong *from beginning to end*"? When he comes to realize that his own oracular words are broadly true, and that the very foundation of all knowlege on the subject—the Undulatory Theory itself—is an absurd fallacy "from beginning to end," he will then be able to call for "revision," with all that the term implies.

A few pages back I took occasion to animadvert somewhat severely on the first two illustrations employed in Professor Tyndall's course of lectures, namely, the row of *glass balls* in a groove, and the row of *boys*, in which he attempted to show that a body moving through the atmosphere pushes the air-particles ahead of it, or, which is the same thing, communicates motion directly ahead, as the balls and the boys communicate their motion one to another in a forward line when the hindmost ones receive a push.

I now call the reader's attention to another illustration (Fig. 4, in *Lectures on Sound*), by which the lecturer attempts to convey a similar idea, but which, if anything, is a far more signal failure than the others, because its fallacy is so clearly self-evident.

I will first briefly describe his illustration and the lesson taught by it, as shown in the engraving, which represents a tin tube fifteen feet long and two inches in diameter, having a wide flaring mouth at one end and a small conical outlet at the other for the purpose of concentrating and directing the *sound-pulse*, as he calls it, against a lighted candle-wick, thus showing how a sound-wave may be actually made to "*blow the candle out*"! He essays to demonstrate all this before his audience by placing the candle-flame directly in front of the conical outlet of the tube, and then clapping two books together at the other end, thus directing the discharge of sound or the compressed wave generated thereby into its bell-shaped mouth. The result is, the candle is, of course, *blown out;* and, on the strength of it, this accurate scientific authority declares to his audience and to the world that it is the *sound-"pulse"* and not a "*puff of air*" which

produces this result! But I must quote his own literal words, or I am sure the scientific reader, if unacquainted with his book, would be tempted to doubt the accuracy of my representation:—

"At the distant end of the tube I place a lighted candle, *c*, fig. 4. When I clap my hands at this end, the flame instantly *ducks down*. It is not quite extinguished, but it is forcibly depressed. When I clap two books, B B, together, *I blow the candle out*. You may here observe, in a rough way, *the speed with which the sound-wave is propagated*. The instant I clap, the flame is extinguished; there is no sensible interval between the clap and the extinction of the flame. I do not say that the time required by the *sound to travel through this tube* is immeasurably short, but simply that the interval is too short for your senses to appreciate it. To show you that it is a *pulse* and not a *puff of air*, I fill *one end of the tube with smoke of brown paper*. On clapping the books together, *no trace of this smoke is ejected from the other end*. The *pulse has passed through both smoke and air without carrying either of them* along with it."—*Lectures on Sound*, p. 12.

As astonished as the reader no doubt is at this quotation, it is absolutely the language of Professor Tyndall, whose name is as familiar on questions of science as any household word to persons who are accustomed to reading the papers. To suppose it possible that a physicist could be found, making any pretensions as a public lecturer, who could have deliberately written out and published to the world such a statement of a scientific experiment in which he so utterly misapprehended the entire operation, passes belief, and would be scouted at once, except for the fact that we have the evidence before us in such unmistakable words that it can not be gainsaid. And it equally staggers credulity that an intelligent audience, composed largely of scientific students, could attentively listen to this lecture and not have detected the fallacious character of the doctrine taught and the misguiding tendency of the illustrations presented.

These critical students, however, looked on approvingly, and saw this eminent lecturer clap the books together in such a manner as to force the air through the tube and thus extinguish the candle, and yet never suspected the transparent nature of the deception, even after the Professor had flatly stultified himself by saying that "when I clap two books together, I *blow* the candle out"! Why did they not ask him to explain how he could "*blow*" a candle out without a "puff of air," or a "puff" of some other material substance? He might as well talk of *washing* his hands without some kind of *fluid!* Sound can not "*blow*" out a flame, or even stir it, unless it should happen to be tuned in unison, as elsewhere explained, of which the reader will soon be abundantly convinced.

This jumbling of a "sound-pulse" and a condensed air-wave together, as one and the same thing, by which the candle was *blown* out, is in exact keeping with this same lecturer's memorable solution of magazine explosions and the breaking of all the windows at Erith by a "sound-pulse," as so completely turned against the wave-theory at pages 104, 105, and onward, which the reader would do well to re-examine. Believing it possible, as does Professor Tyndall, for a "sound-pulse" to "blow" down a house, or even "blow" human beings to fragments, as has hundreds of times been done near an exploding magazine, it would have been strange indeed and flatly contradictory for him not to teach that it was a *sound-pulse* instead of a "puff of air" which *blew* out the candle when the books were clapped together at the big end of the tube! A scientific authority who was capable of believing and teaching, as he did in the same lecture, such infinite nonsense as that a church could be wrecked by a *sound-pulse*,

however intense or however produced, and who was incapable of distinguishing such a pulse from a compressed air-wave, could not be expected to possess a very correct comprehension of this experiment with the tin tube, or to apprehend the true nature of the action on a lighted candle of clapping two books together. To have admitted the simple and undeniable truth that it was really a "puff of air" and nothing else which *blew* out the candle, would have been to utterly stultify all he was about to say a few pages ahead in regard to magazine explosions, since the two phenomena would have been directly opposite.

Readers of this review, if disciples of Professor Tyndall, and especially those scientific students who so quietly and approvingly listened to his lectures, will now have an abundant reason to smile at their own credulity in ever believing such a babyism as that it could have been a *sound-pulse* or anything save a "puff of air" which produced this effect of *blowing* out the candle. I ask them to give me their unbiassed attention for a single moment.

As a proof that it was "not a puff of air" which produced this result, but a "sound-pulse," look at the ocular demonstration which the lecturer had ready at hand, and which seemed to be such a clincher as to silence and literally overwhelm any scientific doubting Thomas who might happen to be in the assembly! "I fill *one end* of the tube with the "*smoke of brown paper*"! Which "end," Professor? Why, of course he was too shrewd and skilled a public lecturer and experimenter to fill the *wrong end* of the tube, or the one nearest to the candle, for he well knew (or if he did not know it he is to be pitied) that if he had filled the small end with smoke, instead of the large end fifteen feet away, *a visible "puff" would have greeted his audience every time the books came together*, and would thus have ingloriously exploded the whole deception! Hence, he was cautious enough to put the smoke into the large end of the tube, so that it would be compelled to travel *fifteen feet* before it could pass out at the small end, which would have required at least five or six powerful *claps* of the books to carry it that distance! Of course this was purely accidental, as we must charitably suppose, since it never occurred to this able and authoritative investigator of science to fill the *entire tube* "with the smoke of brown paper," and then see whether it would "puff," which would have been more easily done than filling "one end" of it, because special care had to be used not to let the smoke creep ahead too far into the tube, or too near to the outlet, lest an accidental "puff" should undeceive the audience,—while this critical class of scientific students equally forgot to request him to do so! They constituted, to say the least, an audience remarkable for deference to authority if not for scientific perspicacity, and proved themselves unprecedented for the marvelous character of their amiability,—literally sitting there and taking down the logic as well as "smoke of brown paper," without asking a question or offering the least interruption except to applaud!

It is true it seemed impossible to suspect a trick of prestidigitation or anything wrong on such an occasion, especially from the apparently frank and candid style of the lecturer. He did not hesitate to tell his auditors, in the plainest language, that it was "*one* end of the tube" only which he filled "with the smoke of brown paper," and they saw distinctly, when he put the lighted brown paper into it, which "end" of the tube he meant; so there was apparently nothing unfair or disingenuous

in the performance. Then, after filling this particular "end of the tube," he honestly clapped the books together in front of the bell-shaped mouth, without "a trace of this smoke" being "ejected from *the other end*"! After such a conclusive demonstration, is it any wonder that he should have so triumphantly added: "*the pulse has passed through both smoke and air without carrying either of them along with it*"?

But now I ask, seriously, how did Professor Tyndall know that no *air* was carried out of the small end of the tube when he clapped the books? Evidently in the same way exactly in which he knew that no *smoke* was carried out,—*he did not see it!* The reason why he did not see the *smoke* pass out was because it could not get out, since it was impossible for it to travel the whole length of the tube at a *single clap!* This, to say the least, was a good and sufficient reason. Smoke being a *visible* substance, it was absolutely essential to the success of the experiment that it should not pass out when the books were clapped, or it evidently would have been seen by the audience. Hence, as before stated, that was mechanically provided against by placing the lighted brown paper in the proper end of the tube fifteen feet away from its outlet. But the air being entirely *invisible*, it made no difference if the tube was full of it, as it necessarily was, and it mattered not a whit if the air puffed out at the small end every time the books came together, as it manifestly did, it was the easiest thing in the world for this eminent lecturer to assume and announce to his audience that "the pulse has passed through both smoke and *air* without carrying *either of them* along with it," because he knew very well that the most argus-eyed scientific student present could not see a "puff of air" even if it did pass out!

Here, again, we have this same *invisible* dodge which was so convenient in discussing the *amplitude* of sound-waves, in which the air-particles were claimed to oscillate "to and fro with the motions of pendulums," and as having "comparatively a *large amplitude of vibration*," yet which turned out to be no amplitude at all—not even enough to be seen by the aid of a microscope—when brought to bear on iron with waves admitted to be *seventeen times as long!* Air being wholly *invisible*, these physicists seem to claim the right of assuming anything in regard to it which happened at the time to suit their theory, appearing to feel safe against adverse criticism, since no one can see a "puff of air," and therefore, as they suppose, dare not contradict them!

But I have concluded that this *invisible* dodge shall end here and now. It has been played by these learned investigators of science and imposed upon a credulous world just about long enough. I here undertake to suggest a few practical scientific tests in connection with this experiment of the tin tube, each one of which is worth a thousand such shallow legerdemain tricks as filling "*one end* of the tube with the smoke of brown paper,"—tests which any student can at once demonstrate for himself who is at all interested in ascertaining the truth or falsity of the wave-theory of sound, or who may care to know the exact scientific weight of Professor Tyndall's authoritative statements, even on simple questions of fact. These experimental tests are as follows:—

1.—Take a common paper bag, such as grocers use for putting up packages, having the air completely pressed out of it, and, after tying its mouth closely around the small end of the tube, proceed to clap the books at the large end as described by Professor Tyndall, and I pledge my scientific veracity and all the reputation I ever

expect to have, that the first clap will partly fill the bag, and that it will be distended more and more at each succeeding clap till it is entirely filled and rounded out with air!

This high authority on science, whose achievements are in every one's mouth, assures his audience that no air is "ejected from the other end" of the tube,—nothing at all, in fact, but sound, since "the *pulse* has passed through both *smoke* and *air* without carrying *either of them* along with it." Hence, we have the astonishing phenomenon of a paper bag *stuffed full of sound*, which can be transported from place to place like so much sugar or salt!

Who will dare hereafter to look upon Munchausen's story of the frozen horn as an improbable narrative, with its music thawing out in melodious strains hours after it had been congealed while the bugler was blowing it? It may turn out to be no acoustical joke, as generally supposed, if there is the least truth in the foregoing description of the "scientific" experiments of this eminent investigator, whose discoveries in connection with a simple *tin tube* utterly distance the *telephone* and its lineal descendant the *phonograph;* for these only claim to transmit by electricity the *motions* which generate the sound, and then preserve their impressions on foil, by which they can be repeated in the same manner, and, if desired, at a future time,—while Professor Tyndall's great improvement *actually bags up the tone itself*, like dessicated fruits, in pint or quart packages, ready for use! There is no mistake about this startling deduction; for whatever passes through the tube, on clapping the books together, fills the paper bag, whether it be *air*, *smoke*, or *sound;* and as Professor Tyndall, with the whole force of his great reputation as a scientist, has published to the world that it is nothing but *sound* which passes out of the tube, hence the undeniable correctness of the criticism.

2.—Place the lighted candle at the small end of the tube, as described by the lecturer, and, instead of clapping the books together toward the bell-shaped mouth in such a manner as to drive the compressed wave into it, let the books be held sidewise toward the expanded entrance, and, although they may be clapped with ten times the force and produce a sound ten times as loud, this learned physicist will find to his confusion that it will neither "blow the candle out" nor make it "duck," simply because in this position it drives no "puff of air" through the tube, notwithstanding the actual sound passing through it may have ten times the intensity as when the candle was extinguished. It does not require a scientific reader to see that this single fact completely annihilates Professor Tyndall's whole argument based on this experiment of a tin tube, and with it the wave-theory of sound, which, in every one of its phases, is in perfect keeping with this experiment, so transparently absurd that even a stupid schoolboy ought to be ashamed to make it.

3.—Vary the test by leaving the candle as before, and instead of clapping the *naked* books together so as to cause a *report*, let their sides be *cushioned*,—or, rather, which is better, let them be prevented from coming entirely together by an intervening piece of soft rubber, and although no audible sound will be produced, yet such a noiseless "clap" will "blow the candle out" exactly the same as in the former case, where the clapping of the books generated a sharp report, and for the same reason, namely, that it was not the sound at all which extinguished the flame, but the "puff of air" which will pass through the tube with precisely the same facility when books are cushioned

and noiseless as when they are naked and produce a sharp sound. Yet this renowned lecturer, notwithstanding all his reputed scientific skill, could think of none of these simple and practical tests, by which to have so easily demolished his illustration of the tin tube and lighted candle, and by which he had so cleverly, though perhaps unintentionally, deceived the public. I say perhaps *unintentionally*, because I am not yet ready to believe that this lecturer knew any better, but rather that he actually supposed that it was a *sound-pulse* and "not a puff of air" which *blew out the candle.*

For my own part, however, I would about as soon have the reputation of being a little tricky in my public experiments on scientific questions as to prove myself so superficially innocent of all practical or theoretical knowledge of the simplest laws of mechanics, pneumatics, and acoustics, while attempting to instruct the public. It seems strange, to say the least, that a physicist who was so *ingenious*, if not *ingenuous*, as to put "smoke of brown paper" into "*one end of the tube*," and to make sure that this end was the one fifteen feet away from the outlet, ought to have possessed sufficient originality to have thought of some one of the practical tests just named,—either one of which, if fairly made, would have utterly exploded that tin tube experiment, and with it the entire wave-theory of sound, because the principle involved in this experiment—that a condensed *air-wave* and *sound-pulse* are one and the same thing—lies at the very foundation of the current hypothesis, as every well-informed scientific student knows.

4.—And lastly, if our eminent physicist was really honest in his experiments (which common charity compels us to assume till the contrary is demonstrated), and did not know any better than to make such a careful blunder with the "smoke of brown paper," he has now an excellent opportunity, by a final and simple test which I will name, of not only informing himself on these fundamental questions of physical science, but of placing himself right upon the record by publishing to the world a correction of his book on "Sound," and thus undoing to the extent of his ability the mischief he has already wrought in so grossly misleading the public.

On reading this friendly criticism (for I assure him that these animadversions are entirely friendly, though necessarily severe), let him at once bring out his apparatus employed on the occasion of those lectures, and instead of filling "*one end* of the tube with the smoke of brown paper," let him fill the *whole tube*, and then proceed to clap the books together the same as he did to "blow the candle out," *and if he does not see a puff of smoke "ejected from the other end" every time the books come together*, he has the fullest permission to publish the author of the *Evolution of Sound* to the world as the great anonymous North American falsifier and slanderer, and all the people shall say "Amen!"

Should even this test not prove entirely satisfactory to the Professor that his whole experiment was a baseless and superficial mistake, after he has witnessed, as he will, the ejection of a dozen separate puffs of smoke, let him fill the tube with the fumes of burning sulphur, and then place his nose in the exact position previously occupied by the candle while his assistant claps the books, and I undertake to guarantee that after the first clap he will become a convert to the new theory, and get away as soon as possible, with a well-defined conviction, which will be apt to stay by him as long as he lives, that something besides *sound* passes out of the tube on clapping the books!

In view of the undeniable correctness

of the four or five tests here suggested, I now appeal to the logical intelligence of the readers of this monograph, if it is possible for a theory to be based on scientific principles which ignores such simple truths, and which is continually, as seen during the course of this discussion, forced to resort to such transparent fallacies as the experiments under examination.

Is it at all likely, or even conceivable, that a true scientific theory would have to depend for its existence on the most superficial and contradictory errors, the jumbling together of the most self-evident unanalogous effects and making them one and the same thing, as has been so clearly and repeatedly pointed out from the commencement of this review? How it is possible for a physicist to acquire such a world-wide fame, whose scientific writings from beginning to end are filled with just such self-contradictions, puerilities, and practical absurdities, as those here being exposed, defies the powers of human imagination to conceive.

While I freely admit that many of the illustrations presented in Professor Tyndall's book on "Sound" represent phases of sonorous phenomena on which there can be no controversy, such as the ringing of a bell in vacuo which gives off no sound, the vibratory motion of strings, the reflection and convergence of sound, the action of singing flames, &c.,—showing clear conceptions of the problems discussed, yet it may be safely asserted that not one single illustration can be pointed to which directly involves the truth or falsity of the wave-hypothesis which can not be shown to be based on a pure misconception of the principles and laws of mechanics, acoustics, and pneumatics, involved. I fancy the attentive reader of this treatise has already seen enough to create at least a strong presumption in his mind that there may be a good deal of truth in this general arraignment of the theory, as well as its most popular exponent; at all events, sufficient to warrant a careful examination of what is to follow.

Not to make this discussion too extended, I shall undertake to examine only the very strongest points made by Professor Tyndall during this course of lectures in favor of the current hypothesis, knowing, as the reader must, that if the arguments deemed most conclusive fall to the ground, the weaker ones do not require refutation.

I now call attention to an experiment made, apparently, for the express purpose of demonstrating the truth of the wave-theory, and which, if based on a truthful representation of facts, would have been most difficult to explain except in conformity with that hypothesis. I may add that to a superficial reader it would perhaps come nearer what might be called demonstrative evidence than any other illustration in the book. But the facts being entirely misapprehended by the lecturer, as I proceed to show, the argument built upon them must necessarily break down on simply correcting the facts.

To prepare the reader for this experiment, I will state that it is known to every student of acoustics that a tuning-fork, when sounded over the mouth of a jar, having a depth corresponding exactly to its own pitch or vibrational number, will produce a loud and very pure sound, caused by the resonance of the column of air vibrating in unison with the sounding fork; whereas the slightest increase or decrease in the depth of this column, by pouring out or adding water, will correspondingly diminish this resonance, or destroy it entirely if the variation from exact resonant depth be carried to any considerable extent.

Professor Tyndall made this experiment before his audience with a tuning-fork having 256 vibrations in a second, and a consequent wave-length, according to the current theory, of 52 inches from condensation to condensation,—that is, supposing the velocity of sound to be 1120 feet in a second, as it is at a temperature of about 60 degrees Fahrenheit.

The lecturer held the sounding fork over the jar in the usual way, while gently pouring in water from a pitcher till the column of air had reached the exact resonant depth corresponding to the pitch of the fork, when the sudden outburst of tone warned him to desist. And right at this point comes in the supposed conclusive argument in favor of the wave-theory of sound. With a two-foot rule he measured the depth of this chamber in the presence of his audience, and declared it to be 13 inches, or exactly one quarter of the wave-length from a fork of that pitch, or having that number of vibrations per second.

Of course this was, to say the least, a singular and even surprising coincidence, on any other supposition than the truth of the wave-theory. But his explanation of the matter made the remarkable character of the coincidence still stronger. He explained the problem in this wise: The *condensation* of the sound-wave sent off from the fork passes down to the water and back (26 inches) in half a second, succeeded by the *rarefaction*, which makes the same round trip in the same time, thus making the complete wave-length of 52 inches in a second, as it ought to be according to the requirements of the theory.

Under the circumstances, I can not blame his auditors for applauding this beautiful experiment, as it was not possible for them to detect any trick or misrepresentation of facts, seated in the auditorium, as was so clearly apparent, and ought to have been detected even by a schoolboy, with the illustration of the "tin tube" and "smoke of brown paper," just examined. Without having practically gone over this somewhat complex experiment with the suitable apparatus, no one would have been inclined to doubt the actual results as given by Professor Tyndall, especially with prejudices already in favor of the current hypothesis of sound. I am not therefore surprised that the lecturer succeeded in completely deceiving his auditors (whether intentionally or unintentionally the reader shall decide), and sending them away satisfied with the truth of the wave-theory. But a day of reckoning has to come sooner or later for all our errors, whether sins of commission or omission. The learned physicist has no more right to expect immunity from a just retribution than the most ignorant pretender and upstart in science; and, in fact, not so much, since to whom much is given of him shall much be required.

Before undertaking to expose the fallacy of this illustrated argument, I must, as usual, and in justice both to myself and to Professor Tyndall, quote his exact words, or at least make a sufficient citation to convey his meaning in his own very clear and explicit language:—

"A series of tuning-forks stands before you, whose rates of vibration have been determined by the siren. This one, you will remember, vibrates 256 times in a second, the length of the sonorous wave which it produces being, therefore, 4 feet 4 inches. The fork is now detached from its case, so that when struck against its pad you hardly hear it. I hold the vibrating fork over this glass jar, A B, fig. 87, 18 inches deep; but you still fail to hear the sound of the fork. Preserving the fork in its position, I pour water with the least possible noise into the jar. The column of air underneath the fork becomes shorter as the water rises. The sound, you observe, augments in intensity; and when the water reaches a certain level it bursts forth with extraordinary power. . . . Experimenting thus I learn that there is one particular length of the column of air which,

when the fork is placed above it, produces a maximum augmentation of the sound. This re-enforcement of the sound is named *resonance*. . . . Our next question is, *what is the length of the column of air which most powerfully resounds to this fork?* By measurement with a *two-foot rule* I find it to be *thirteen inches*. But the length of the *wave* emitted by the fork is 52 inches; hence, the length of the column of air which resounds to the fork *is equal to one fourth of the length of the wave produced by the fork. This rule is general, and might be illustrated by any other of the forks instead of this one.*" —*Lectures on Sound*, p. 172.

To satisfy myself as to the exact facts in regard to this experiment, and to be certain that my statements in review should be correct, I obtained from Professor Robert Spice, the eminent acoustician of Brooklyn, N.Y., an accurately tuned, tested, and stamped tuning-fork, having exactly 256 vibrations in a second, that there should be no possible error committed in overhauling this celebrated experiment and the argument deduced from it, as published to the world by Professor Tyndall.

Thus equipped, I proceeded to test a glass jar, straight from bottom to top, by pouring in water while the fork was sounding over it, as was done by Professor Tyndall, till the greatest resonant depth was obtained. I now declare, after testing a number of different jars of various diameters, from four to two inches (which, by the way, give a uniform result), that the length of column or greatest resonant depth for such a fork, at about 60 degrees Fahrenheit, is invariably $11\frac{3}{4}$ inches instead of 13, as stated by this "highest living authority," thus making the wave-length 47 inches instead of 52, as it should be according to the wave-theory! With 47 inches as the wave-length, multiplied by the number of vibrations (256), we would make the velocity of sound but 1002 feet in a second, at 60 degrees Fahrenheit, instead of the observed and well-known velocity of 1120 feet a second! Thus the wave-theory is overthrown by the very argument adduced to sustain it, while the reader undoubtedly asks how could it be possible for Professor Tyndall to perpetrate such a glaring mistake, with the glass jar before him, and with a proper tuning-fork and a correct "two-foot rule" in his hand! The error, as we see, is a fatal one, since it makes a positive difference of 118 feet a second, as any tyro in mathematics can instantly determine, between the observed velocity of sound and what it is forced to be according to the formula of Professor Tyndall, in trying to sustain an untenable and foundationless theory.

But I will now try to relieve the mind of the reader, and tell him in unmistakable words how this mistake occurred in Professor Tyndall's calculation; and also, I may add, in the calculation of Professor Helmholtz, who agrees with Professor Tyndall fully that the greatest resonant depth of a jar is *one quarter of the wave-length of the determinate tone thus augmented;* so that these two great physicists fall, as usual, side by side, whenever one is tripped.

Those having access to a copy of the *Lectures on Sound* will observe that the engraving represents a jar having an *expanded or bell-shaped mouth!* This single fact is the key which unlocks the mystery and solves the whole problem, giving the true reason for Professor Tyndall's trouble in a nutshell. In order to demonstrate the correctness of this solution of the difficulty, I had three jars made specially for this experiment, all of the same diameter and height,—one straight from bottom to top, one with an expanding mouth, the expansion being about one half the diameter of the jar and extending down a couple of inches, and the third with the mouth contracted or drawn in about as much and about in the same proportion as the other was expanded.

By means of a series of careful tests with the same fork—256 vibrations to the second—I found that while the straight jar gave invariably a resonant depth of 11¾ inches, the one with the bell-shaped mouth gave a depth of 12¼ inches, while the one with a contracted mouth gave a depth of but 11¼ inches. The conclusion was thus scientifically reached that with the mouth of the jar sufficiently expanded, and carrying the expansion a sufficient distance down, a resonant depth of exactly 13 inches might be finally attained, and in this way the experiment could be made to precisely harmonize with the necessities of the wave-theory, making 52 inches the wave-length instead of 47,—as results, and must always result, from using an honest jar!

It is not at all likely that this lecturer, in the presence of an intelligent audience of scientific men, would have stated that the resonant depth of this jar was *thirteen inches*, by actual measurement with a "two-foot rule," when it was but *eleven inches and three quarters!* And it would not be fair to suppose that he had a bogus "two-foot rule," or that he was capable of playing any such "tricks that are vain" as running the rule up his sleeve while making the measurement! We are bound, therefore, to admit that his measurement was honest, and that the jar showed an actual resonant depth of 13 inches; but, at the same time, we are driven to assume that the mouth of the jar *flared*, as his engraving indicates, just enough to make up this deficit of 1¼ inches, thus to sustain the wave-theory!

Now, I do not intend to insinuate that there was any conspiracy between the Professor and his glass jar by which its mouth was to *flare* just enough and not a whit too much to make up these thirteen inches of resonant depth! As a supposition so flagrantly unkind is out of the question, it becomes one of the most remarkable coincidences known to science that such a long glass vessel should be blown with a mouth flaring just enough to answer the purposes of this theory, and that it should have occurred fortuitously, or without pre-calculation, design, or intention, on the part of anybody! A man who could believe this would require but little stretch of his credulity to believe, with Mr. Darwin, that man, with all his complicated powers, might have been accidentally developed by a series of fortunate spontaneous variations to what he now is, from a horned toad or a soft-shell clam.

The serious part of the whole matter, however, viewed from a scientific standpoint, seems to be this: Even supposing that particular jar, having just such a flaring mouth, should have fallen into the lecturer's hands accidentally on that particular occasion, which so luckily hit the nail on the head and demonstrated the truth of the wave-theory, is it conceivable that this great sound-expert and experimenter, who had devoted much of his life to the investigations of sonorous phenomena, including this same beautiful problem of resonance, never happened at any other time to try this experiment with a *straight* jar, or, in fact, with any jar not flared exactly to that extent? If he ever held a tuning-fork of any determinate pitch over a *straight jar*, and then brought into requisition his "two-foot rule," *he certainly must have seen that the resonant depth thus resulting was considerably less than the one quarter of a wave-length of the particular fork employed!*

To meet the difficulty, and rescue this eminent lecturer from the fatal effects of his own argument, we are forced to assume that in all his experience he never used but the one jar, having that particular

flare to its mouth, and never saw such an experiment tried by any one else as holding a tuning-fork of a determinate pitch over a *straight* jar from bottom to top, or over any other jar having a bell-shaped mouth differing in the slightest degree from the one which so fortunately fell into his hands for that special occasion!

Whatever explanation may be attempted of these singular and uncomfortable facts, and however this lecturer may essay to rescue his experiment from the suspicion in the mind of the reader of a conspiracy between *somebody* and that particular *glass jar*, one thing is settled beyond all possible doubt by the unfortunate dilemma in which this eminent physicist has involved himself, which is this: the wave-theory of sound has fairly and utterly broken down, judged alone by the strongest argument ever employed to sustain it, since the theory's own explanation of the supposed wave-length contradicts the observed velocity of sound, when an honest jar is used, by just 118 feet a second! Oh, for some modern Laplace to help Professor Tyndall out of his difficulty by a new formula of heat and cold—condensation and rarefaction—to account for this discrepancy of 118 feet a second, as the original Laplace so triumphantly succeeded in *not* doing it with the deficit of 174 feet a second discovered by Sir Isaac Newton!

The next illustrated argument in this course of lectures on sound, to which I would invite the attention of the reader, is perhaps the most astonishing for pure baselessness ever presented in favor of a scientific theory, being particularly remarkable for two things: the first, that it is advanced as a specially conclusive evidence in favor of atmospheric wave-motion (which it certainly would be if true); while in the second place, there is not the semblance of scientific truth in even the assumed facts on which the whole argument is based. The correctness of this apparently exaggerated assertion will be abundantly evident to the reader as the analysis of the position advances.

I have pondered frequently over the argument to which I now refer, and every time with undiminished amazement to think that a careful physicist and competent investigator of scientific phenomena should have been so presumptuous as to imagine it possible for a person, claiming to reason at all, to accept the pretended facts so deliberately assumed and specifically paraded. At times I confess to having been inclined to half suspect my own want of perspicacity in not catching the true meaning of the text, it seeming so entirely inconceivable that a person, pretending to even ordinary scientific knowledge, should have assumed as facts, simply because a theory happened to require it, what a very stupid schoolboy a dozen years old could readily have seen to be without a shadow of foundation;—facts as preposterously and transparently out of the question as if he had stated to his audience that the *swaying shadow of a tree had weight and momentum sufficient to knock a man down should he come in contact with it!* But after discussing the matter and comparing views with others,—even believers in Professor Tyndall's theory of wave-motion,—and finding that the most critical scientific thinkers were obliged to place the same construction on his language that I had done, there was nothing left but to accept his literal statement of assumed scientific facts, and then meet his extraordinary argument. With these preliminary remarks, I will now, as usual, proceed to briefly state the argument before giving the exact words of the lecturer, that the reader may know what specific point to expect.

As is well known to every scientific stu-

dent, and as previously shown by quotations, the wave-theory assumes that two systems of sound-waves, from two unison instruments, traveling through the same air together, may so travel as to assist each other or augment each other's sound; that is, when they travel in such a manner that the *condensations* of one system of waves coincide with the *condensations* of the other system, and the *rarefactions* of the one with the *rarefactions* of the other, the same as two systems of water-waves will make higher billows when they travel together in such manner that the *crests* of one system coincide with the *crests* of the other, and the *furrows* of the one with the *furrows* of the other.

It is also well known that if two equal systems of water-waves travel together in such manner that the *crests* of one system coincide with or fall into the *furrows* of the other system, they will mutually destroy or neutralize each other, producing a level, or nearly so. This is called *interference*. But as atmospheric sound-waves are claimed to be "essentially identical" with and "precisely similar" to water-waves, hence it seemed unavoidable, as a vital feature of the wave-theory, that physicists should teach, just as they do, that if two unison systems of sound-waves should happen to travel in such relation that the *condensations* of one system should coalesce with or fall into the *rarefactions* of the other system, they must necessarily neutralize each other or produce *absolute silence*.

As I saw that this was the evident and unavoidable reasoning of physicists, I undertook, when first investigating the wave-theory, to expose its fallacy by showing that if it were so, then two unison pipes, forks, or reeds, sounded *half a wave-length apart*, could not be heard at all by a listener stationed in the line of the instruments, because in that direction the two systems of waves would be compelled to travel in complete *interference*, the *crests* or *condensations* of one system matching into the *furrows* or *rarefactions* of the other, thus producing a *level*, or neutralizing each other's effect; whereas, if the instruments were sounded a *whole wave-length apart*, then their united sound would necessarily be much louder in the line of the instruments than either would be alone, because the two systems of air-waves would reenforce each other by coincidence,—their *condensations* would run together as well as their *rarefactions*, and thus augment each other's effect on the air the same as shown in water-waves.

Of course I supposed that I was advancing a *new* argument against the theory, and one so self-evidently fatal to it, being the unavoidable consequence or natural outgrowth of this "law" of *interference* that the moment physicists would see it they would necessarily be compelled to abandon the wave-hypothesis as a self-stultifying absurdity, since such an idea as two unison instruments not being heard when sounded in line, whatever distance apart, whether a half or a whole wave-length, was so transcendently absurd and contrary to all observation and reason that I did not consider it necessary to more than state the fact in order to annihilate the assumption of atmospheric sound-waves! I never dreamt of such a thing as that physicists had thought of the same argument, much less that they had appropriated and adopted it as a part of their system. The reader can guess my astonishment to find, in carefully reading Professor Tyndall's *Lectures on Sound*, that my own crushing argument against the wave-theory had been clearly anticipated and coolly presented to his audience as an illustration of this very law of *interference*, and the manner

in which sound can be so added to sound as to produce silence!

Thus, we come at last to the argument to which my preliminary remarks had reference. In elucidating this law of "interference" in his book, Professor Tyndall has presented engravings representing two unison tuning-forks placed first a wave-length and then half a wave-length apart. Suppose each of the two forks to have exactly 256 vibrations in a second, and a consequent wave-length of 52 inches, he shows by the most careful explanation that if the two forks should be placed 26 inches apart (half a wave-length), and be then made to vibrate ever so vigorously, no sound would be heard in the line of the two instruments, which is illustrated in the engraving by a smooth and uniform shading passing off from the forks, thus representing the quiescent condition of the air. He also shows by the other figure that if the two forks are placed 52 inches (a whole wave-length) apart, the sound will be distinctly heard in line, the waves of which he represents by alternate dark and light shadings passing off from the forks in the same manner, thus teaching that any two unison musical instruments, however intense their tone may be, if thus sounded half a wave-length apart, would neutralize each other, and not be heard at all in the line of such sounding bodies.

With this explanation before the reader, I will now quote Professor Tyndall's own words, to show that it is not a misconception of his meaning:—

"Now let us ask what must be the *distance between the prongs A and B* [one prong of each of the two forks] when the *condensations* and *rarefactions* of both, indicated respectively by the dark and light shading, *coincide?* A little reflection will make it clear that *if the distance from B to A be equal to the length of a whole sonorous wave* [52 inches] *coincidence between the two systems of waves must follow.* The same would evidently occur where the distance between A and B is two wave-lengths, three wave-lengths, four wave-lengths,—in short, *any number of whole wave-lengths.* In all such cases we should have *coincidence* of the two systems of waves, and consequently a reinforcement of the sound of one fork by that of the other. . . . But if the prong B *be only half the length of a wave behind A* [26 inches] what must occur? *Manifestly* the *rarefactions* of *one of the systems of waves will then coincide* with the *condensations* of the other system, and we shall have *interference:* the *air* to the right of A *being reduced to quiescence.*"—*Lectures on Sound*, p. 259.

Before commenting on the above citation, which distinctly teaches what I have asserted, I wish to guard against the remotest suspicion of misconceiving the Professor's meaning of "condensation," "rarefaction," "coincidence," "interference," &c. It is of the highest importance, also, that the reader shall know from the lecturer's own words that I have not misapprehended him in the slightest degree. To this end I now quote a passage which leaves no possible doubt. He says:—

"In the case of *water*, when the *crests* of *one system of waves coincide* with the *crests* of *another system*, higher waves will be the result of the coalescence of the two systems. But when the *crests* of one system coincide with the *sinuses* or *furrows* of the other system, the two systems in whole or in part *destroy each other.* [Of course, no one doubts the truth of this statement as applied to water-waves, because there we have actual wave-motion.] This *mutual destruction* of two systems of waves is called *interference.* The same remarks apply to *sonorous waves.* If in *two systems of sonorous waves condensation coincides with condensation* and *rarefaction with rarefaction*, the sound produced by such *coincidence* is *louder* than that produced by either system taken singly. But if the *condensations* of the one system *coincide* with the *rarefactions* of the other, a *destruction* total or partial of *both systems is the consequence.* . . . If the two sounds be of the *same intensity* their *coincidence* produces a sound of four times the intensity of either; *while their interference produces absolute silence.*"—*Lectures on Sound*, pp. 284, 285.

This language can not be misunderstood. Two equally intense systems of sound-waves from two unison instruments,

placed *half a wave-length* apart so that their waves "interfere," must of necessity destroy or neutralize each other, and thus produce "*absolute silence*" *either way in the line of such instruments*, if there is any truth in this pretended law of "*interference*."

It must, therefore, be entirely plain to the reader, if the wave-theory be true, and if any such phenomena as atmospheric *sound-waves* do actually occur in sonorous propagation, having *condensations* and *rarefactions*, *amplitude* and *wave-length* in feet and inches, that this law of "*interference*" must also inevitably follow, just as physicists have represented it, for such is indisputably the law which prevails in water-waves, where we know that a veritable *amplitude* and *wave-length* exist. Hence, to have ignored this law of "*interference*" in sound would have been to ignore sound-waves altogether; and therefore, as was naturally to be expected, Professor Tyndall teaches undisguised "*interference*," with its resultant "neutralization" or "*absolute silence*," in the manner here quoted.

But just as true as "interference" is a necessary law growing out of wave-motion, whether in *air* or in *water*, just that certain is it that the whole wave-theory falls to the ground whenever this law of sonorous "interference" is shown to be without foundation in fact. I now undertake to assert that such a law, in relation to sound-propagation, is purely visionary and monstrously chimerical, having no existence in Nature, and not even the appearance of a properly understood fact to warrant it. Strange as this may sound to physicists, they will be more than satisfied of its correctness before this chapter is finished.

As one evidence that the law is without foundation in science or in fact, we need no better proof than the test here distinctly prescribed by this lecturer himself, namely, the placing of two unison instruments half a wave-length apart, and then sounding them with listeners stationed in line either way to determine by actual observation the truth or falsity of the principle enunciated. Professor Tyndall distinctly tells us that two such instruments would not be heard in line, however loudly they might sound or however distinctly one alone could be heard if the other was silenced. It would really seem that an intelligent reader need scarcely be informed that there is not one scintilla of scientific truth in this whole statement; and how a physicist, having any regard for accuracy or the just respect of the scientific world, could have published such a fabrication as part of a scientific lecture, to meet the necessities of any theory, however firmly established, is more than I can imagine. That the wave-theory requires such a "law" of interference as well as such practical fruits in the form of "neutralization" and "absolute silence" there can be no question. In fact, its very life depends upon the truth of Professor Tyndall's statement, or otherwise, as just shown, there can be no such thing as sound-waves at all, and the whole wave-theory consequently breaks down. Believing, as did this eminent scientist, that the wave-theory could not be otherwise than true, and knowing that if true, the law of "interference" and its effect of "absolute silence" must follow, as a matter of course, with two unison instruments sounding half a wave-length apart, hence he seemingly shut his eyes to the necessity of testing the matter, and ran headlong into this ridiculous position, which a schoolboy with two penny whistles of the same pitch and a couple of babies for assistants, could instantly have shown to be without a particle of foundation in truth!

As a final and unanswerable experiment

for the purpose of testing this supposed law of "interference," on which, of course, the existence of the wave-theory depends, the reader has only to figure before his mind's eye two immense organ-pipes of equal capacity which sound the low E of the double bass, having each 40 vibrations to the second, and a consequent wave-length in air of exactly 28 feet. Then figure these two pipes placed precisely 14 feet apart in an open field, free from any reflecting surfaces, each pipe supplied with wind from a powerful bellows, and the witnesses stationed on either side in line with the pipes. It is manifestly evident when these pipes are sounded in this position that their two systems of unison waves (if they produce waves at all, or if the wave-theory has any foundation,) will travel in the direction of this line in absolute "interference"; that is to say, the *condensations* of the waves from one pipe will exactly coincide with, or fall into, the *rarefactions* of the waves from the other, and hence along that line the witnesses would hear no tone if this law of "interference" has any existence in sound, while another jury of witnesses placed to the right and left, equidistant from the two pipes, would hear their united sounds *with four times the intensity of either pipe sounded singly!*

I now appeal to the reader to decide if there can, by any possibility, be a grain of philosophical truth in this supposed result of "interference," so explicitly taught by Professors Tyndall, Helmholtz, and all writers on sound. If not, then, as a necessary consequence, the wave-theory breaks down, having no foundation on which to rest. I must say here that with one moment's thought Professor Tyndall himself could not help but admit that the two organ-pipes named would be heard precisely the same in line when 14 feet apart as when separated 28 feet, or rather a trifle louder, since the farthest pipe would be nearer the listener when separated from him by only half a wave-length. To say that this eminent savant would deny that the pipes could be heard in line when 14 feet apart, or that he would still insist on his law of "interference" and "silence" after his attention was directly called to the question, is to assert what I do not and can not believe till such time as the Professor shall flatly compel me to do so.

It will not do to say that though we may hear the sounds of these pipes thus stationed half a wave-length apart, it is not their *fundamental* tones we hear, but their principal *over-tones*, and that this law of "interference" only supposes the neutralization of the *primary sounds* of the two instruments, whose waves are necessarily of the same length! This objection, though presented to me by a sound-expert of considerable reputation, is wholly foundationless, and can be set aside by a single fact, since any person, having two unison forks, and causing them to be sounded over two resonant jars of proper depth placed half a wave-length apart, can hear their tones exactly the same in line as at right angles, or when a whole wave-length apart; while according to the testimony of Professor Helmholtz, the very highest authority on the subject, *such sounds are destitute of accompanying over-tones!*

The truth is, there is no force whatever in the objection. Every one knows a *fundamental tone* from its *octave*, which is the *first* or *principal over-tone;* and by sounding any two unison pipes half a wave-length apart and listening in line, one can instantly tell by the evidence of his ears alone that the fundamental tone does not cease at all, neither is weakened, but is rather heard exactly the same in quality and quantity, according to distance, as when

the pipes are a full wave-length apart, no difference whatever occurring in this respect; and a man who is not capable of comprehending the truth and force of this self-evident declaration never ought to let the sacred word "science" escape his lips.

But I do not need to depend upon argument, however conclusive, to show that no such thing as this so-called "*interference*" can take place between the sounds of two unison instruments stationed, as described by Professor Tyndall, half a wave-length apart. As has so often been done during this discussion, it is only necessary to quote another passage from the same authority in order to show the most startling and point-blank contradiction of the whole position here assumed in regard to "interference." I have frequently suggested that a radically false theory can not avoid self-contradiction, in the very nature of things, when it comes to the discussion of details, and here we have another illustration of it. I will now array Professor Tyndall against himself, producing a practical case of "interference" and "neutralization," and then let him or his friends settle it as best they can:—

"I have already had occasion to state to you that when *several sounds traverse the same air each particular sound passes through the air as if it alone were present.*"—*Lectures on Sound*, p. 281.

How, then, in the name of all that is called science, can two sounds "traverse the same air" in such a manner as to neutralize each other and produce "absolute silence" by the two systems of sound-waves *interfering*, when "*each particular sound passes through the air as if it alone were present*"?

We thus have the most overwhelming evidence from Professor Tyndall himself that all this reasoning about the possibility of the sound-waves of two unison forks neutralizing each other by so-called *interference* is a pure fabrication, without the plausibility of ordinary fiction; and hence that there is not the slightest foundation either for this law of "interference" or for the hypothetic sound-waves from which it is deduced, since it is evident if air-waves exist at all, two sounds would be just as apt to clash and neutralize each other as to be heard, making the last quotation clearly false.

The general conclusion, therefore, to which I am logically forced, is, that this eminent authority never tried this experiment at all, either publicly or privately, of sounding two unison instruments half a wave-length apart, and thus producing neutralization by this so-called law of "interference," but rather that he gives the illustration in his book, and explains this law on general principles, based on the blind assumption that it must be so, because the wave-theory must be true and necessarily requires it, when it would not have taken him half an hour to make a careful experimental test with two unison forks or other instruments, which would have instantly dissipated the delusion, and opened his eyes to the fact that this pretended law of "interference" in these so-called sound-waves is a pure and simple chimera, contradicted by reason as well as by the observation of all mankind.

Thus again, as so frequently witnessed during this discussion, one of the strongest arguments in favor of wave-motion in sound-propagation turns out, when unlocked by the combination key of truth and common sense, to be a magazine which explodes and annihilates the theory; for, as we all know that two unison instruments can positively be heard the same in any direction when sounded half a wave-length apart as when separated a whole wave-length or any other distance, as an illiterate rustic might easily ascertain, it

follows that there is no such a thing as "interference" in sound-waves; and if no interference, then no waves to interfere, since water-waves, as every one knows, will interfere under just such conditions as this physicist lays down, and mutually destroy or neutralize each other, thus demonstrating the wave-theory to be a fallacy of science by the very argument advanced to maintain it!

"But do you deny the *interference* of sound under any circumstances, or such a thing as a *phase of opposition?*" I am asked by the intelligent scientific reader. I answer, emphatically, "Yes!" in any sense which could be analogous to the interference which takes place in wave-motion. A certain kind of interference or opposition resulting from a forced departure from unison in two instruments sounding in close proximity, as observed in so-called "beats," and caused by the same affinity which produces sympathetic vibration, is no doubt possible, and which I will try to elucidate before the close of this chapter. But prior to this, I undertake to meet and explain the principal class of facts relied on by physicists as favoring the common view of interference, as just exemplified in the argument about two unison forks, or as caused by supposed waves with condensations and rarefactions.

One of the strongest arguments favoring such a law is drawn from the action of the *double siren*, which, it is claimed, demonstrates beyond question that two systems of sound-waves from two unison *sirens*, operated together in such a manner as to cause alternation of sounds in what is supposed to be half wave-lengths, neutralize each other, and thus produce "absolute silence"; while it is also claimed that the same effect is observable in the action of light, under certain optical conditions in which two rays, by interfering, will neutralize each other and cause absolute darkness! It was this phenomenon, Professor Tyndall tells us, which first led to the Undulatory Theory of Light. His words are:—

"We have here a phenomenon, *which, above all others, characterizes wave-motion. It was this phenomenon*, as manifested in optics, *that led to the undulatory theory of light, the most cogent proof of that theory being based upon the fact that by adding light to light we may produce darkness, just as we can produce silence by adding sound to sound.*"—*Lectures on Sound*, p. 259.

I propose to show, in a few moments, that this whole matter, as regards the *double siren*, is a clear misapprehension on the part of these writers, and that no such effects as they describe can possibly occur with this or with any other unison instruments,—that no such thing as "silence" is or can be caused by any possible combination of the two rotating disks of this instrument or the tones they produce, and consequently that both Professors Tyndall and Helmholtz have entirely mistaken the action of the *double siren*,—and that in attempting to explain it to favor this law of "interference," they have perpetrated one of the most glaring and laughable blunders recorded in the annals of science.

This language, I admit, must seem to a physicist almost if not quite preposterous, particularly with reference to Professor Helmholtz, who invented the very form of siren on which the experiments about to be examined were made. Is it possible, the reader may pertinently ask, that this eminent physicist and musician does not comprehend the action or acoustical effects of his own instrument? I answer that it is possible, and now undertake to clearly demonstrate it; while such a fact ought to be no more surprising, if proved, than the already demonstrated fact that the same acoustician utterly misapprehended the action of the violin *bow* in relation to

that of the *string*, supposing the latter to normally move *ten times* swifter than the former, though he was, at the time he perpetrated this fiasco, a practical violinist, as reviewed at pages 95, 96, and onward. The question of fact, therefore, whether Professors Tyndall and Helmholtz have in a similar manner misapprehended the sonorous effects of their own favorite *double siren* shall stand or fall on its merits after their explanation has been fairly examined. As they both give substantially the same explanation of their experiments with this instrument, agreeing in every essential feature, I shall confine my strictures almost entirely to that of Professor Tyndall, whose language is more explicit, not having had to pass through the ordeal of a translation into English.

Before directly considering the explanation of this author, which is so confidently supposed to embody one of the most explicit proofs in favor of the law of *interference* in sound-waves, it will be quite necessary that I should describe briefly the simplest form of this modern acoustical instrument called the *siren*, and then show how two sirens are operated together, making what is known as the *double siren*, in order that this demonstrative evidence may be duly appreciated.

Imagine a circular disk, about a foot in diameter, secured to an upright spindle passing through its center. Then imagine 12 half-inch holes through this disk in a circle near its outer edge, and that these holes are equidistant apart. Now suppose that a half-inch pipe leading from a wind-chest is so adjusted that its open end presses against the lower side of this disk at the exact line of the circle of holes. This may be said to constitute a single *siren*.

The disk now stands still, and one of the 12 holes is exactly over the open end of the pipe. If air is forced through the pipe from the wind-chest, it will pass in a jet up through this aperture in the disk; but should the disk slowly revolve while the pipe remains fixed, it is evident that the orifice of the pipe will soon change from the aperture in the disk to one of the spaces between these perforations, thus cutting off its jet of air; and the disk continuing to revolve, a puff of air will occur as each perforation passes in line with the outlet of the pipe.

It is manifest that by a more rapid rotation of the disk the puffs of air will occur in more rapid succession, till, by increasing the speed of rotation, as is proved by the operation of the instrument, the puffs will succeed each other so rapidly as to blend into a continuous tone, resembling that of a whistle, the pitch of which becomes higher in the exact ratio as the speed of rotation is increased, which, of course, correspondingly increases the number of puffs per second.

It will now be understood that each one of these air-puffs is exactly the same thing as a separate *vibration*, or equivalent in effect to a single oscillation of a harp-string, tuning-fork, or any other sound-producing instrument. Each rotation of the disk, therefore, causes 12 puffs or vibrations; and should the motion of the disk be increased to $36\frac{2}{3}$ rotations per second, it will exactly sound the letter A, which requires 440 vibrations to the second,—thus giving a beautiful demonstration of the universal law in acoustics—that the pitch of every fundamental sound, from whatever instrument, corresponds precisely to the number of vibrations in a second which generates the tone.

By means of a proper registering device, with a dial geared to the rotating spindle, the number of rotations of the disk in a minute to any particular pitch may be re-

corded, which, multiplied by the 12 holes in the disk and divided by 60 seconds in a minute, determines the number of vibrations per second, giving thereby the true pitch of the *siren* at that speed of rotation, and of any other instrument to which it may be compared.

A *double siren* consists in the attachment of another disk like the one described to the same spindle a foot or more above the lower one, but turned upside down so that their two sets of puffs project the air toward each other. The upper disk may be so secured to the common spindle that by turning a handle it may be adjusted so that its puffs or vibrations will occur simultaneously with those of the lower disk, or alternately, just as the operator may desire; or, which is the same thing, the pipe which conducts the air to the upper disk may be shifted backward or forward, causing the same effect. If the two disks or their pipes are adjusted to puff at the same time, or in synchronism with each other, the tones of the two disks are in exact unison, and will continue so no matter whether the disks revolve slowly or rapidly, or whether the pitch of the two tones is thus raised or lowered. But should the upper disk or its pipe be so shifted that its puffs will occur alternately with, or half way between, the puffs of the lower disk, then, instead of unison, we have that condition which Professor Tyndall calls a "phase of opposition," in which the two systems of waves are in "interference," with the crests or condensations from one disk coinciding with the furrows or rarefactions from the other, and in which condition the two sets of puffs neutralize each other, "and we have no sound."

I have now, if the reader has closely followed me in this explanation of the *double siren*, prepared him for Professor Tyndall's remarkable demonstration, in his own words, by which he proves that we "can produce *silence* by adding sound to sound," just as "by adding light to light we may produce darkness," and I especially request that the Professor's conclusive language shall be carefully perused. It is as follows (*Lectures on Sound*, page 291:—

"But in the case now before us, where the circle is perforated by 12 orifices, the rotation through 1-24th of its circumference causes the apertures of the upper wind-chest [I have simplified the description by supposing a single pipe leading from the wind-chest] to be closed at the precise moment when those of the lower siren are opened, and *vice versa*. It is plain, therefore, that the *intervals* between the puffs of the lower siren, which *correspond to the rarefactions of its sonorous waves*, are *here filled by the puffs or condensations* of the upper siren. In fact, the *condensations of the one coincide with the rarefactions of the other*, and the *absolute extinction of the sounds of both sirens is the consequence.*"

The "absolute" self-contradiction and absurdity of this assertion immediately follows, in Professor Tyndall's own words:—

"I may seem to you to have *exceeded the truth* here; for when the handle is placed in the position which corresponds to *absolute extinction, you still have a distinct sound.* And when the handle is turned continuously, though alternate swellings and sinkings of the tone occur, *the sinkings by no means amount to absolute silence.* The reason is this: The sound of the siren is a highly composite one. By the suddenness and violence of its shocks, not only does it produce *waves corresponding to the number of its orifices*, but the *aerial disturbance breaks up into secondary waves* which associate themselves with the *primary waves* of the instrument, exactly as the harmonics of a string or an open organ-pipe mix with their fundamental tone. . . . Now, by turning the upper siren through 1-24th of its circumference, we *extinguish utterly the fundamental tone. But we do not extinguish its octave.*"

Here, reader, we have the *demonstrative proof*, in a citation which is the most astounding confession of weakness and untenableness of position perhaps ever seen from the pen of a scientific writer. It only

needs to be taken apart and looked at carefully to place this lecturer in a most unenviable light as a physicist.

He first assures us, in words of ringing positiveness, that we can "produce *silence* by adding sound to sound," and that this is "the most cogent proof" of the undulatory theory of light, as it can be shown in a similar manner that "by adding light to light we may produce *darkness*." He then brings forward the *double siren*, the only instrument adapted to this experiment of forced alternation, and gives us his "most cogent proof" that his former assertion was to be believed. After completing the experiment he tells his audience that "the *absolute extinction of the sounds of both sirens is the consequence*," and then innocently adds, "when the handle is placed in the position which corresponds to *absolute extinction you still have a distinct sound*," and "the sinkings *by no means amount to absolute silence*"; and finally, after a confused attempt at qualifying, to smooth off the "suddenness and violence of the shocks" of his contradictory statements, by "*secondary waves* which associate themselves with the *primary waves*," he sums up his "most cogent proof" by profoundly telling his class that "we *extinguish utterly the fundamental tone. But we do not extinguish its octave*"!

In the name of science and reason,—in the name of acoustics and common sense,—what should have been expected but this very result? By operating the two sirens together (making them practically but one instrument) in such a manner as to cause their puffs to occur alternately, *he actually doubled the number of puffs or vibrations*, which, as every tyro knows, *must necessarily raise the fundamental tone to its octave!*

With all the experiments in which Professor Tyndall had just been engaged, stopping off a string in the middle to raise its fundamental tone to the octave *by doubling the number of its vibrations*, yet he could not see that by placing the upper siren so that its 12 puffs should *alternate* with the 12 puffs of the lower siren he produced 24 puffs to each revolution, exactly the same as if he had used but one siren with 24 perforations instead of 12! This must necessarily be the case when the two disks are within sympathetic distance of each other, as I will soon clearly demonstrate. By thus doubling the number of vibrations he naturally and legitimately raised the two unison fundamental tones to their octave, and the most astonishing thing in the whole matter is that Professor Tyndall should have been so astonished at the result that he falls into utter confusion in attempting to explain it, and ends by the contradictory statement just quoted that "the *absolute extinction* of the sounds of both sirens is the consequence," "*but we do not extinguish its octave*"!

Instead of at once recognizing the octave tone as the proper result, and the very one to have been legitimately expected from doubling the number of puffs, he tries to account for it to his anxious auditors as one of the incidental and inexplicable "clang-tints" or "over-tones" of this "highly composite" instrument, resulting from its "*secondary waves* which associate themselves with the *primary waves*"!

Though I was not present at this remarkable lecture, I can imagine the Professor in a confused perspiration listening to the two disks of his *double siren* whistling out their melodious *octave* (the very thing, of course, they ought to do, only he did not know it,) and wondering what to say to his curiously anxious and equally confused audience of scientific students!

He finally stops the machine, and after collecting his demoralized thoughts for a moment, he says, in substance:—

"You have all observed, during this conclusive experiment, that the sounds of both sirens were *absolutely extinguished*, and that you did not hear the least tone. [Applause.] You may think, some of you, that I have not told the truth. Well, in fact, I haven't. You did hear the *octave*, but that, you must remember, is just the same as no sound at all, so far as my argument is concerned, and the reason why you *hear* it and you *don't* hear it [Hear! hear!] is because the double siren is a *highly composite* instrument, having a number of distinct tones and clang-tints that don't properly belong to its number of orifices, but are accidental, the same as a string or an open organ-pipe breaks up the air into *secondary waves* that associate themselves with the *primary waves* in such a manner that the *suddenness* and *violence* of the *shocks* make you think you hear it when you really don't. [Bravo!] But still I must confess that when the *handle* is turned to the point which would *indicate silence*, *you still hear a distinct sound*, and the sinkings and swellings *by no means amount to absolute silence*. [Students glance at each other anxiously!] But as that is only the *octave*, as before suggested, it, of course, as you all know, amounts to nothing, since the *fundamental tone is extinguished*. [Students reassured!] I trust, therefore, you all agree with me that this demonstration of adding sound to sound is complete, and that my former statement, on which the undulatory theory of light was so firmly established that the whole scientific world has adopted it, namely, that by adding sound to sound we may produce silence, has been fully sustained by the result." [Hear! hear!]

Seriously, was there ever a great lecturer so pitiably at sea in the midst of a simple scientific experiment, and that, too, with his own favorite and familiar apparatus? It need not surprise the reader in the least if the Professor, in his next course of public lectures on Sound, when stopping off a string in the middle to produce its octave, should suddenly become confused and tell his audience that "the *absolute extinction* of the sounds of both" halves of the string "is the consequence," though "*we do not extinguish its octave*"; and that the reason why "we hear no sound" is because "the sound of the" string is a "*highly composite*" one, and that "the suddenness and violence of the shocks" of the "secondary waves which associate themselves with the primary waves" produce a number of harmonics or over-tones not represented by the normal vibrational rate of the string proper, and thus cause the "absolute extinction" of the fundamental tone, though "we do not extinguish its octave"! This would be just as lucid as his explanation of the *double siren*.

Here, then, we have that "most cogent proof" of the undulatory theory of light, since the Professor can so clearly "*produce silence by adding sound to sound*"! If he is as successful in "adding light to light," there will be no question about his having produced "darkness," in one sense, at least.

Now, the only attempt which Professor Tyndall can possibly make to escape this crushing demolition of his explanation of the *double siren* is to assume that the 24 alternate and consecutive puffs, coming equally from the two disks a foot or so apart, do not produce the same effect of converting the fundamental tone into its octave as if all the puffs or vibrations emanated from one disk. I presume he will necessarily resort to this, if he speaks at all, to save himself and his theory, as there is clearly nothing else left for him to say, and hence I shall be obliged to cruelly snatch even this *straw* from the drowning physicist by quoting his own explicit admissions.

Before doing so I wish to reason one moment with the reader, to show the weakness of such a quibble. Let us suppose one of the *disks* of the *double siren* removed. I now ask, would not the fundamental tone caused by the 12 puffs of the other disk be exactly the same, if, instead of one circle

of 12 holes, there were two circles of 6 holes each, supplied with wind through separate pipes? Manifestly the effect would be exactly the same so long as the puffs from the two circles alternated or occurred intermediately, making 12 consecutive puffs in regular succession at each revolution of the disk. Professor Tyndall would not think of questioning the truth of this proposition, unless he wished to excite the astonishment of every scientific thinker.

Then, this being admitted, would it not produce the same effect exactly, supposing the disk large enough, if the two circles of 6 holes each were a *foot* apart,—that is, supposing they continued to puff alternately as before? No one can doubt but that the same fundamental tone would result in either case, as with 12 orifices in one circle. Then, why should not the same thing exactly occur, if, instead of one disk with two circles of 6 holes each, there were two disks placed no greater distance apart than these circles, with 6 orifices in each, so adjusted that their puffs occurred in the same perfect alternation? Thus, link by link the chain of logic is being coiled around this fallacious explanation of the double siren. Although I do not expect the force of this reasoning to be acknowledged by Professor Tyndall, I propose to let him speak from his published lectures, and thus confess the absurdity of his whole argument:—

"The *puffs of a locomotive* at starting follow each other slowly at first, but they soon increase so rapidly as to be almost incapable of being counted. If this increase could continue until the *puffs numbered* 50 or 60 a second, *the approach of the engine would be heralded by an organ-peal of tremendous power.*"—*Lectures on Sound*, p. 50.

Query: Would it make any difference with this "organ-peal of tremendous power" coming from the distant engine, *should one half of the puffs come from the steam-cylinder on one side of the locomotive and the other half from the other—six feet apart—so they only alternated?* I do not think that even this lecturer would venture to assert, after his attention was called to the fact, that the "organ-peal" would depend in the slightest degree upon whether the puffs all came from one side of the locomotive or alternately from both sides, so there were 50 or 60 alternate puffs a second in regular succession! Hence, if his locomotive illustration contains a vestige of philosophical sense, it shows his complete misapprehension of the action of the double siren, and establishes the correctness of the explanation I have given, demonstrating that the true cause of the tone jumping from the fundamental to its octave was the shifting of one siren in such manner that its 12 puffs would occur intermediately between the 12 puffs of the other, thus making 24 puffs to each revolution of the spindle.

Professor Tyndall, the reader will recollect, attributes this octave not to the 24 *vibrations* caused by the 24 alternate puffs issuing from the 24 alternate orifices which he actually had right before his eyes and ears, but to some mysterious and indefinable breaking up of the primary air-waves which were produced by the 12 unison puffs "into *secondary waves* which associate themselves with the *primary waves of the instrument.*" Hence, he assures us that this particular *octave*, unlike all other octaves ever heard, was not produced by the required number of 24 *vibrations* at all, but by the disintegration of primary waves, though, as usual, it flatly contradicts his teaching in another place, where he says that *no octave*, from *whatever instrument*, can be produced without *doubling the number of vibrations which caused its fundamental tone!* Notice how explicitly his statements

demonstrate his law of "interference," and cause their own "neutralization" by "mutual destruction":—

"Placing a movable bridge under the *middle of the string*, and pressing the string against the bridge, I divide it into *two equal parts*. Plucking either of those at its centre, a musical note is obtained, which many of you recognize as the *octave of the fundamental note*. Now, *in all cases*, and *with all instruments* [the *double siren*, of course, as well as others,] *the octave of a note is produced by doubling the number of its vibrations*."—*Lectures on Sound*, p. 90.

Hence, we have the clearest possible admission that the *octave* produced by the *double siren*, on which the Professor becomes so terribly confused, was actually caused, just as I have urged, by the required 24 vibrations or puffs to the revolution issuing from the two disks in alternation, and not by the breaking up of primary air-waves at all, since "in *all cases* and with *all instruments* the *octave of a note is produced by doubling the number of its vibrations*"! Was there ever a more direct self-contradiction perpetrated by a scientific writer?

To suppose Professor Tyndall, while attempting to explain the double siren to his audience, really unaware of this well-known law in acoustics, that doubling the number of puffs or vibrations would necessarily raise the fundamental tone to its octave (which he entirely ignores in his explanation), is a supposition at once astonishing and incomprehensible; because, as we have just seen, he clearly recognized the law when experimenting with strings, and could hardly have forgotten it. To suppose that he knowingly suppressed this true and only explanation of the octave (and thus imposed upon the intelligence of his audience) in support of his former assertion that "we can produce silence by adding sound to sound" would be cruel, if not wicked. The charitable view would therefore seem to be that though he knew the law and was aware of the facts, yet in the complexity resulting from the "secondary waves which associate themselves with the primary waves" with the "suddenness and violence of the shocks" from that "highly composite" instrument, he became temporarily demoralized, and lost sight of the legitimate solution. Hence, the confused explanation involving such direct contradictions of what he had taught on other occasions.

But here a difficulty confronts us. If this contradictory and absurd explanation was the result of a momentary confusion, how are we to account for the fact that he has since published to the world in a carefully prepared book every detail of that extraordinary, and, I may say, ridiculous analysis of the *double siren*?—and not only so, but has superintended the work through various editions and translations into a number of European languages, with not one alteration from the original fiasco? The charitable view I have taken here looks like breaking down.

And it is equally astonishing that of the hundreds of scientific students who listened to that lecture, and the tens of thousands who have since read his book, not one has had the temerity or the kindness to tell the Professor what was the matter with his favorite *siren*, who, if she had not absolutely "lured him to destruction," had triumphantly succeeded in turning his head with her fascinating music!

It really seems incredible that a scientist of such reputed ability could not have seen that this close proximity of the two disks of the *double siren* to each other—revolving only a few inches apart—was the true cause of producing this octave, especially in view of the fact that their 24 alternate and successive puffs were the exact number required for such a result. The

shallow superficiality which was incapable of thus connecting the two series of puffs, making their effect the same as if issuing from a single disk, is as pitiable as it is surprising. The only serious and practical way of accounting for such want of scientific resource is the fact (as every one knows who has ever compared these *Lectures on Sound* with the work of Professor Helmholtz on the same subject) that the great German investigator *made the mistake first*, while Professor Tyndall, according to his uniform habit, took the whole matter for granted just because that eminent physicist had announced it as science.

Hence, because Professor Helmholtz had mistakenly employed this plain and legitimate octave of the *double siren*, generated by the requisite 24 vibrations or puffs, to illustrate his improved ideas of *over-tones*, there was, of course, nothing left for Professor Tyndall but to do likewise, and thus relegate this simple result of 24 vibrations or consecutive puffs to an indefinable atmospheric disturbance breaking up into secondary waves which associate themselves with the primary waves of the instrument, owing to the suddenness and violence of its shocks! He seemed to have become so infatuated with Professor Helmholtz, or this music of his *siren*, as to temporarily lose his memory, or he surely would have recollected what he had before so distinctly taught, as just quoted, that "*in all cases, and with all instruments, the octave of a note is produced by doubling the number of its vibrations*"! Had the "organ-peal of tremendous power," which the two cylinders of a locomotive might produce by sufficiently rapid alternate puffing retained a place in his memory he would never have been cajoled into such an unenviable plight by the superficial blunder of Professor Helmholtz, but would have been able to connect the alternate puffs of two disks only a foot apart into one system of 24 vibrations to a revolution as easily as he could the alternate puffs of two steam-cylinders six feet apart, which, as any one knows, could, if rapid enough, be legitimately combined to make an "organ-peal of tremendous power."

Look for a moment at the language of Professor Helmholtz, and note the family resemblance between it and that of Professor Tyndall:—

"The puffs of air in one box occur exactly in the middle between those of the other, and *the two prime tones mutually destroy each other*. . . . Hence, in the new position *the tone is weaker*, because it is deprived of several of its partials [over-tones]; but it does not entirely cease; *it rather jumps up an octave*."—*Sensations of Tone*, p. 246.

It seems that Professor Helmholtz even sets the example of *self-contradiction;* for how, in the name of reason, can "*the two prime tones mutually destroy each other*," when they *do not entirely cease, but rather jump up an octave?* If a man jumps up on the top of a fence, he is not *destroyed*, or *neutralized*, or *obliterated*, in any sense whatever. He has only exchanged a lower for a higher position! So the two fundamental unison tones of the two disks, caused by 12 puffs to the revolution, simply combine into one tone of 24 puffs to the revolution, which lifts it to a higher position in the musical scale, or, as Professor Helmholtz plainly puts it, the tone "jumps up an octave," without involving any such thing as mutual destruction or neutralization.

The reason why "the tone is *weaker*" in the "new position" seems to be a profound mystery to this eminent investigator, save on the supposition that it consists of the first or principal *over-tone* ("deprived of several of its partials"), which is always too weak to be distinctly heard by the unaided ear while the prime tone is being sounded. It of course never occurred to

this standard authority on Sound that the reason why the octave was "weaker" was simply because it was constituted of a *single* series of 24 successive puffs or vibrations to a revolution, while the prime tone was composed of two series of 12 *double* or *unison* puffs which necessarily re-enforced each other, and by which means their intensity was increased *fourfold*, as already quoted from Professor Tyndall. The "weaker" character of this *octave* is thus beautifully accounted for according to my explanation of the *double siren*, and would have been easily comprehended by Professor Helmholtz but for his pet brood of *over-tones* which he was just nursing into life, and on which account he pressed into service the assistance of this "highly composite" *siren* as a kind of foster-mother. But he will learn when he reads this review, if not before, that she has at last discarded the whole family as too conspicuously illegitimate and outlandishly ungeneric for even foster-children.

I now propose to Professor Helmholtz, with all deference and respect, and through him to the scientific world, a simple practical test of this whole problem, by which to demonstrate either the truth or falsity of my explanation of the *double siren*, and which will also and equally demonstrate the truth or falsity of his own solution, since one or the other of our explanations must necessarily fall to the ground.

Suppose, instead of a *double siren*, such as already described, having *two* disks, we construct a *triple siren*, having *three* disks, each disk containing a circle of 12 orifices and supplied with wind by a separate pipe, all three being secured one above another to the same rotating spindle. It is evident, if the pipes leading to the three circles of orifices should be so adjusted that when the spindle rotates the three disks shall puff simultaneously that they will unitedly make only 12 puffs to the revolution of the spindle, and hence the fundamental tone will be an intense triple unison.

Let us now suppose that the spindle makes exactly 11 revolutions in a second, producing 132 puffs, or the precise number necessary to generate the fundamental note C, with the three disks puffing simultaneously, and consequently all sounding the same note in unison. According to the explanation of Professor Helmholtz, the disks are not only sounding this prime C, but they are also faintly sounding several over-tones of different degrees of pitch, though they are not distinctly heard, owing to the loudness of the prime note. The first or principal over-tone, in point of intensity, he tells us, is C^1, exactly an octave above the prime, and that it was this over-tone, "deprived of several of its partials," which was heard as the *octave* in the experiment with the *double siren* when the two prime unisons were mutually destroyed by "interference."

As we now have three disks of 12 holes each instead of two, we can easily make them all "interfere" by so adjusting their pipes as to make them puff in regular succession one after another, with the intervals equidistant apart, thus producing 36 consecutive puffs to each revolution of the spindle. Supposing the rotation to continue at the same uniform speed after the pipes are thus shifted, it is manifest that 36 successive puffs will occur in the time of 12 puffs before the change. What, then, must take place? I here announce to the physicists of Europe and America—and earnestly request these high authorities on Sound to show that I am mistaken—that not only will the prime C vanish from the sound, but the octave C^1 will also not be heard at all; and that instead of C^1, which was alone heard issuing from the *double siren* (being in that case the proper

tone for the 24 puffs produced at each revolution), we will only hear from the *triple siren* the note G^1, or the fifth above the octave C^1, being the exact note corresponding to 36 puffs to the revolution under that uniform speed of rotation.

Will Professor Helmholtz accept the proposition here made, and join the writer in carrying out this test, by means of a *triple siren*, that the scientific public may know what to depend on? If he is as frank and candid a physicist and investigator of science as there is every reason to suppose him to be from his writings, he surely will not feel at liberty to refuse aiding in this conclusive solution of not only the action of the *double siren*, but also of the truth or falsity of this so-called law of "interference," as well as of the entire wave-theory of sound, since they all necessarily stand or fall together.

If this advanced scientist should deem the suggestion here made worthy of his attention, and if, on making this experiment, should find that the fundamental note C entirely vanishes as soon as the pipes are shifted so as to make 36 successive puffs to the revolution, he at once destroys this law of "interference" based on *half* wave-lengths and the coalescence of condensations with rarefactions, since in such a case as this it is only *third* wave-lengths, the pipes being shifted to speak at a third of an interval each from one fundamental puff to another.

Then, again, if he shall find that not only the prime C, but the octave C^1, is silenced, what, pray, has become of his first *over-tone*, which made all the music heard coming from the double siren after the two disks were placed in a phase of opposition? The three disks, when puffing simultaneously and producing the triple unison fundamental C, surely were sounding also their first partial or over-tone C^1, according to Professor Helmholtz! What, then, has become of these three unison first over-tones if they are not heard, which they will not be if my prediction is correct? They should be heard even louder than from the *double siren* after the shift takes place, having one additional re-enforcement.

Finally, if the only tone heard, after this so-called "interference," shall turn out to be G^1, a fifth above the octave C^1, and the very pitch of tone requiring the 36 vibrations to the revolution, as every physicist will admit, is there a scientific thinker on earth who would not at once decide that the explanation here given of the *double siren* as the cause of it *jumping up an octave* is the correct one, and that neither Professor Helmholtz nor Professor Tyndall understood the instrument they were exhibiting to the public or its acoustical effects?

As an evidence that this is a correct exposition of the problem, any acoustician will readily admit if the three disks should be perforated each with a circle of orifices in the following order—the lower one with 12, the middle one with 24, and the upper one with 36 holes, that when sounding together they would produce the chord C, C^1, G^1, if rotating with 11 revolutions to a second; whereas, if the lower and middle disks should be suddenly stopped off and silenced while thus revolving, the upper disk, with 36 orifices, would go on sounding G^1 precisely the same and producing the same intensity of tone as would the three disks if perforated with 12 holes each and if so adjusted as to puff in succession, as already described. It would be a singularly suggestive fact, to say the least, if this explanation, given by a writer who has never seen a *double siren*, should turn out to be the correct one, in opposition to the opinions of the greatest sound investigators of the age!

In conclusion, on this subject, I would say that I am entirely willing that the discussion shall end with the single experiment here suggested, and I feel sure that the intelligent reader will not hesitate to admit its extreme fairness as well as the conclusive character of such a crucial test as the one proposed of a *triple siren.*

As Professor Helmholtz owns a *double siren*—a luxury, by the way, entirely beyond the reach of this writer,—it would not seem to be a difficult or very expensive task for him to attach a third disk to the rotating spindle, half way between the other two, connected with a suitable air-pipe, for the purpose of carrying out the test here indicated; and it would seem to be the very least this learned authority should think of doing, in view of this formal arraignment and the arguments presented to support it, in order to satisfy the students of our colleges and universities that his claim to their consideration as a public instructor in matters of science is a just one; while he can rest assured that the same discerning and critical students will hold him rigidly to the charge of having wholly misunderstood the effects of his own instrument, till such time as this test is carried out, and the result shown to favor his exposition of these phenomena as published in the *Sensations of Tone.*

To expedite matters, the writer will gladly meet the entire expense of making this improvement in the double siren, if it would be any inducement to Professor Helmholtz, and can be communicated with at any time, or drawn on for the purpose through the American publishers of this book. I will only add that the foregoing suggestions are intended to apply equally to Professor Tyndall, who also, as I am informed, owns one of the Helmholtz improved *double sirens.*

From the last two arguments examined it becomes clearly manifest that writers on Sound have no fixed or definite idea of what they mean by this law of "interference," nor any settled views as to what constitutes a "phase of opposition," by which two systems of unison sound-waves may "neutralize" and thus "mutually destroy" each other, notwithstanding they make this assumed "law" a fundamental principle of the wave-theory, as they are unavoidably compelled to do on the ground of wave-motion. The truth of this charge against physicists, as to their indefinite and incongruous conceptions of their own theory, involving its most cardinal principles, needs no other confirmation than the self-evident contradictions embraced in these two illustrated arguments.

I refer, of course, to the manner in which "interference" is exemplified: first, by the two unison forks sounding "half a wave-length" apart,—by which means the *condensations* of one of the systems of air-waves are made to coalesce with the *rarefactions* of the other system, *regardless of the synchronism or alternation of their vibrations;* and then to the manner in which the same "interference" is explained by the action of the *double siren,* with its two disks puffing in *alternation* and mutually destroying each other's sound, *without the least reference to their distance apart!* The two explanations are not only clearly unlike, but are directly in conflict with each other, the two in turn mutually annihilating each other's pretended "interference," as a moment's consideration will show.

Let us, then, direct our attention to the two unison forks, placed half a wave-length apart, and first notice how they are said to produce their "phase of opposition" and the "mutual destruction" of each other's sound, with no regard to whether their vibrations occur *simultaneously* or *alternately.* Such a contingency as a possible *alterna-*

tion between the vibrations of these forks is not hinted at by the lecturer; and if it was thought of, it was cautiously concealed from the audience as too grave a difficulty to attack. Yet this circumstance,—the equal possibility of such *synchronous* or *alternate vibration*,—as will soon be seen, utterly breaks down and nullifies this law of "interference," because the two disks of the double siren are claimed to produce the same "phase of opposition" *alone* by *alternate vibration*, which the two forks do *alone* by vibrating *a definite distance apart!* Hence, the manifest self-disintegration of the two phases of this so-called "phase of opposition" which possesses such "marvelous flexibility," in the language of Professor Huxley, as to act on two opposite principles at the same time. A more suicidal law, I will venture to assert, never thrust its audacious claims into any scientific hypothesis. In one breath, "interference" and "mutual destruction" result alone from the two sounding instruments being placed half a wave-length apart, without reference to their equal chance of vibrating *alternately* or *synchronously*, while in the next breath,—only thirty pages further on,—the same "interference" assumes a new face as well as "phase of opposition," being caused alone by *alternation*, without reference to what distance the instruments may happen to vibrate from each other. Is it possible that a "law" can be relied upon as having any foundation in science which is first one thing and then another, as suits the caprice or emergency of a whimsical and self-contradictory theory? A pretended scientific "law" can surely have no substantial claims upon the consideration of any mind competent to reason philosophically, which is forced to change its very nature and mode of operation within thirty pages, under the manipulation of its ablest exponent, especially when such metamorphosis involves its own absolute self-neutralization, as I will now endeavor to illustrate.

First, as to the two unison forks sounding half a wave-length apart. Professor Tyndall explicitly tells us that a "condensation" from one of these forks, *owing solely to the fact of traveling "half a wave-length," reaches the other fork exactly in time to coalesce with its "rarefaction," without regard to whether the latter fork is at that instant sending off a rarefaction or a condensation!* Was there ever seen such a limping and imbecile hypothesis as this? Not a word, remember, as to whether the two forks swing in such relation to each other as to generate condensations simultaneously, or whether one fork shall generate a *condensation* at the same instant the other generates a *rarefaction!* The Professor ignores such a vital circumstance in this brilliantly defective explanation, for reasons perhaps known to himself; but it can not be ignored nor glossed over here. The simple and homogeneous idea of "half wave-lengths" seemed to be all this "highest living authority" was capable of grasping at one time. To have mixed up with such a profound problem the troublesome question of the possible alternate vibration of the two forks, which he must have known was just as liable to be the case as for them to vibrate simultaneously in the same direction, was evidently too much for him to undertake till such time as he should come to the *double siren*, thirty pages further on, when *alternation alone* should be the subject treated on, without any reference to that opposite kind of "interference" caused by "half wave-lengths"!

To prepare the reader for a just appreciation of this difficult task of mixing together two such incongruous *phases of opposition* and attempting to make them har-

monize, let us first note the concise teaching of Professor Tyndall as to the manner in which a tuning-fork generates these so-called "condensations and rarefactions." This preliminary instruction is essential to a correct understanding of the problem of how two forks generate interference and consequent silence when separated "half a wave-length."

It is entirely evident that this lecturer had lost sight of his recent extraordinary teaching in regard to the prong of a tuning-fork "swiftly *advancing*," *compressing* the air "immediately *in front of it*," and *thereby* producing "a *condensation* of the air," and then "retreating" and "leaving a partial vacuum behind," by means of which "a *rarefaction* of the air" is produced, and that in this way the sound-waves, consisting each of a *condensation* and a *rarefaction*, are *carved* and *moulded* and *sent* off at a velocity of 1120 feet a second! (See page 264.) His uniform teaching, throughout his *Lectures on Sound*, is that a prong of a tuning-fork moving *outward* in either direction makes the "condensation" of the air, while the same prong moving *inward* makes the "rarefaction" of the air. Hence, the absolute indispensability of taking into consideration this circumstance, in connection with the half wave-length separation, in order to arrive at any rational or consistent hypothesis in regard to the law of "interference" between such "condensations and rarefactions," as exemplified by the action of two forks thus stationed. Had the manner, here described, of generating the "condensations and rarefactions" of sound-waves, which he had so carefully elaborated in a previous lecture, flashed across his mind while laboring to explain to his audience how two unison forks produce "interference" by simply being made to sound half a wave-length apart, he must, I am persuaded, have hopelessly broken down in the midst of his argument, unless he is a man of extraordinary nerve. The writer of this would have dematerialized under such a shock.

Let us now suppose that the two forks, half a wave-length apart, happen to oscillate *alternately*,—that is, suppose the prongs of one fork should swing outward, "rapidly advancing" and producing "a *condensation* of the air," at the same moment the prongs of the other fork "retreat" or swing inward, producing "a *rarefaction* of the air, which, as remarked a moment ago, they are just as liable to do as to both swing in the same direction, as Professor Tyndall well knows,—it is perfectly manifest that the *condensed* half of the wave from one fork would then reach the other fork (half a wave-length distant) just in time to coincide with *its* condensation instead of its *rarefaction*, thus producing complete *coincidence*, or the exact opposite of *interference*, which Professor Tyndall was trying to make out! Fully one half of the number of times, therefore, when tested, according to the law of chances, there would be absolute *coincidence*, and consequently a loud sound in the line of the two forks, while the other half of the time there would be *interference*, and no sound at all!

Clearly, then, "interference" by separation half a wave-length, depends entirely upon the accident of "coincidence" between the vibrations of the two forks. Discard this, and the law is a nullity. But as there is nothing in this pretended law of "interference" in the first place, as I contend, and no difference in the sound of two unison forks, whether they vibrate a half or a whole wave-length apart, as Professor Tyndall might have easily tested, it follows that we will never notice the least difference in the effects of two such sounding instruments, under the circumstances named, should we test them a million times.

From the foregoing analysis does it not clearly follow, if there is any foundation for Professor Tyndall's solution of the *double siren* and its peculiar mode of producing interference by *alternate vibration*, that such action completely *neutralizes* the *neutralization* caused by the supposed half wave-lengths, thus converting *interference* into *coincidence*, and *vice versa*, just as the two forks might chance to oscillate either in synchronism or in alternation?

It is also plain to see that the same self-neutralization follows us into the supposed "interference" of the *double siren*, claimed to be caused alone by the alternate vibrations or puffs of its two disks, but which has already been shown to be no interference at all, being simply the proper and legitimate mode of *jumping up an octave* by doubling the number of its vibrations, as any sensible *siren* would do if attempting to raise its pitch an octave higher. We have only now to bring to bear upon this phase of opposition the principle of interference involved in the idea of "half wave-lengths" to also neutralize its neutralization! Let us just see how scientifically and logically one destroys the other, the same as in grammar two negatives neutralize each other and become equivalent to an affirmative.

Suppose the two disks of the double siren (instead of being placed on the same spindle one above the other) stationed side by side 51 inches apart, or just half the wave-length of the note C, which requires 132 vibrations to the second, making a whole wave-length 102 inches, and suppose the two disks so geared together and their supply-pipes so adjusted as to puff alternately. Of course, according to the explanation given by Professors Tyndall and Helmholtz the two disks are thus in a "phase of opposition," at whatever rate of speed they may revolve, and hence their puffs must neutralize each other alone by the operation of one disk producing a "condensation" at the exact time the other produces a "rarefaction," or, in Professor Tyndall's own words, "In fact, the *condensations* of the one coincide with the *rarefactions* of the other, and *the absolute extinction of the sounds of both sirens is the consequence*"; and that, too, remember, without the least intimation as to what distance the two sirens are to be separated, or whether there is to be any distance at all between them. In fact, no amount of distance whatever separating the two disks could by any possibility enter into the calculation of this mode of "interference," since these physicists teach that the same phase of opposition continues as the speed of rotation increases and the pitch rises, which would cause a constantly varying "half wave-length" to be necessary between them, if any such thing were taken into account. Hence, with the two disks of the *double siren*, the "interference," the "phase of opposition," and the "absolute extinction," are effected exclusively by puffing *alternately*, whatever distance they may be apart. But here steps in the other phase of this suicidal "law" of interference growing out of the "half wave-length" theory, and vetoes all this nonsense about "alternation"; for the moment the two disks are made to revolve fast enough to generate the note C, it is manifest that the *condensation* from one disk, by traveling half a wave-length, or 51 inches, will reach the other disk in time to exactly catch or coalesce with its *condensation* just starting, thus producing "*coincidence*" instead of "*interference*," and thus again *neutralizing* Professor Tyndall's *neutralization* or "absolute extinction" by producing the precise *opposite* of his supposed "phase of *opposition*"! Was ever the self-stultification of a theory more beautifully elucidated?

We thus see that this pivotal "law" of the wave-theory, as explained by Professor Tyndall, and as made to bear upon two separate phases of his hypothesis, completely neutralizes itself; and, instead of favoring the idea that sound has anything to do with wave-motion, the assumption, by this strained effort to frame some kind of interference between imaginary systems of air-waves, simply results in the overthrow of the current sound-theory, by proving that air-waves, with *condensations* and *rarefactions* as the basis of sound-propagation, have no existence in Nature, unless it be a purely fanciful existence in the imaginations of physicists. This demonstrative and all-pervading "law" which a moment ago seemed so efficiently active in favor of wave-motion,—producing "interference" between systems of undulations which had no practical existence,—and which was so flexibly accommodating as to create a "phase of opposition" in almost any direction, to order, has, under cross-examination, literally broken down the whole wave-theory by hopelessly arraying the most conclusive arguments of these physicists against themselves.

If Professor Tyndall could succeed half as well in establishing "mutual destruction" between two systems of sound-waves under the action of this so-called law of interference as he has done in producing a "phase of opposition" and "neutralization" between his most powerful arguments, he would have succeeded at least a score of times in rendering the wave-hypothesis invincible, as the foregoing pages amply illustrate.

But I have another and still more startling proof of the self-neutralizing effects of this supposed law of "interference" between the *condensations* of one system of waves and the *rarefactions* of another. To demonstrate the complete self-destruction of the principle involved, we need go no further than to Professor Tyndall's own reiterated description of the manner in which these "condensations" and "rarefactions" are generated and sent off from a tuning-fork or harp-string, and then look at the legitimate result of such generation and propagation.

Each fork or string, according to these explanations, produces *two distinct systems of sound-waves*, one system being sent off from one side of the fork or string, and another system being at the same time sent off from the other side, *the same motion producing a rarefaction on one side and a condensation on the other*, and each system being constituted of the same kind of "condensations and rarefactions." Observe the conciseness and unmistakable character of his language:—

> "Imagine *one* of the prongs of the vibrating fork swiftly advancing; it *compresses the air immediately in front* of it, and when it *retreats* it leaves a *partial vacuum behind*."—*Lectures on Sound*, p. 62.

Of course, on the opposite side of the fork the same thing takes place precisely, the other prong sending off the same kind of condensations and rarefactions in the opposite direction. This no one will pretend to dispute. Now, would it not be a surprise to Professor Tyndall, and to physicists generally, if it could be shown from this language that these two systems of waves, sent off from the two opposite sides of the fork, must necessarily *interfere* and *neutralize* each other, thus producing "absolute silence" according to the wave-theory? I will here undertake to demonstrate, to the satisfaction of any one who will attentively read this short argument, that two such systems of waves must necessarily *interfere*, and hence should result in "absolute silence," if there is the least foundation for the theory of wave-motion in the propagation of sound. But

first notice the equally explicit teaching of this same high authority in regard to the vibration of a single *harp-string*, which is much less difficult to comprehend than the somewhat complex operation of the two prongs of a tuning-fork:—

"Figure clearly to your minds a *harp-string vibrating to and fro;* it *advances*, and causes the particles of air *in front of it to crowd together*, thus causing a *condensation of the air*. It *retreats*, and the air-particles *behind it separate more widely*, thus producing a *rarefaction* of the air."—*Heat as a Mode of Motion*, p. 372.

It is plain to see from this language that both the "condensation" and the "rarefaction" here named are generated and propagated by this "to and fro" motion *on one side the string only*, and we have then only to "figure" another system of the same kind of condensations and rarefactions, generated in the same way, and sent off from *the other side of the string*, and then ask, *What takes place directly above the string?* Ah, that's the rub! Professor Tyndall never thought to explain this missing link in his favorite theory of condensations and rarefactions. He could think far enough ahead to elucidate, as he did with the row of glass balls, the *carving* and *moulding* of waves on one side of the string, and their propagation in a straight line, but, as was the case with the glass balls, he makes no provision for the air-particles slipping up or down, to the right hand or to the left. There being no motion of the harp-string "to and fro" in a *vertical* direction, of course there can be no *crowding of the air-particles together* as it advances, nor *separating more widely* as it retreats; hence, no condensations nor rarefactions *up* and *down*, and consequently no sound-waves, since sound can only exist and be heard as such condensed and rarefied waves.

Hence, it follows that no sound should be heard above the string at all, according to the wave-theory, since there is no advancing nor retreating in that direction to *carve* and *mould* the required condensations and rarefactions. Is it not, therefore, the legitimate teaching of Professor Tyndall, and also of the wave-theory, of which he is the most popular exponent, that the sound of a harp-string should not and can not be heard above the string at all, since there is no motion to and fro in that direction? This must be clearly the doctrine of the theory, since without motion there can be no "*condensation of the air*," and without condensation there can be no *air-wave*, and without air-waves there can be no *sound!*

But here *Nature* steps in, as usual, and contradicts the unavoidable logic of the wave-theory, since it is well known to every observer that sound is heard in a vertical direction, or directly above the string, just as intensely and at as great a distance as horizontally, or in the direction the string oscillates,—*which simply annihilates the assumption that sound is in any way connected with such supposed condensations and rarefactions*, or that they are necessary for its existence.

Now, the only possible answer to this difficulty is that the *lateral* or *horizontal* air-waves, as they are sent off from the string, *re-act* and *reflect upward*, thus conveying their condensations and rarefactions to the regions of air above the string as well as in a horizontal direction, the *row of glass balls* to the contrary notwithstanding. But here is exactly where "interference" and self-neutralization come in, as promised a moment ago, and which I will now make good.

It must be remembered that the *condensation* on one side of the string is generated and sent off by the very identical motion which generates and sends off the *rarefaction* on the other side of the string,

and at exactly the same instant of time; so that, according to the theory of "interference" by half wave-lengths, recently reviewed, the *rarefaction* on one side of the string would re-act and reflect upward a given distance, just in time to coalesce with the *condensation* from the other side, since they occur synchronously, and both travel with the same velocity, of course; and hence the two systems of waves from the two sides of the string must necessarily produce complete interference and cause "absolute silence" in a vertical direction, if there is the shadow of truth in the wave-theory! Thus, every way it can be presented, it is proved to be a monstrous self-contradiction, unworthy of a moment's serious attention by any well-informed physicist, except so far as to expose its superficiality and overthrow its claims as a scientific hypothesis.

I now invite the attention of the reader quite briefly to the question of musical "beats," with which most musicians are familiar, especially those accustomed to tuning instruments. They occur when two sounding bodies are slightly out of unison, and consist of a sensible increase of intensity, followed by a decrease almost to inaudibility. These swellings and sinkings of the tone occur once for each complete vibration difference in a given time between any two sounding bodies. In other words, if the vibrational numbers of two tuning-forks, for example, are respectively 256 and 257 per second, there would be but one beat per second. If the difference between them should be two complete vibrations in a second, there would be two beats. If there was a difference of only one vibration in five seconds, there would be, of course, but one beat or one sinking and swelling of the tone in five seconds, and so on. This is all the explanation needed, even by the unscientific reader, as to what beats are, and the cause of their number of recurrences in a given time.

The important question, however, which now concerns us, and which has puzzled physicists in all ages, from the time of Pythagoras to the present, is the true physical solution of these phenomena. We know, for example, that beats are produced by the difference in the vibrational rate of the two sounding bodies, and consequently by such sounding bodies being brought alternately into a relation of coincidence and opposition. But in what manner, or on what acoustical principle, does this change from coincidence to opposition between such instruments generate this successive increase and diminution in the intensity of the tone? On general principles, and as a matter of course, it is attributed by advocates of the current sound-theory to the *interference* of the two systems of *air-waves* sent off by the two beating instruments, though in what manner it is possible for two systems of hypothetic air-waves to interfere so as to produce this alternate sinking and swelling can not be made intelligible to an unscientific mind, or even to the advocates of the wave-theory, since, as just shown, the supposed coalescence of condensations and rarefactions amounts to nothing at all, by absolute trial, producing not the slightest effect when two instruments are placed half a wave-length apart; while the whole assumption is shown to be completely self-neutralizing whenever this supposed interference is combined with the same interference caused by the alternate puffing of the double siren.

That two systems of *air-waves*, if they exist at all as the means of sound-propagation, can not interfere so as to affect the intensity of sound in the slightest degree, Professor Tyndall tacitly admits in the

passage recently quoted. "When *several sounds*," he says, "traverse the *same air, each particular sound passes through the air as if it alone were present*"; whereas, if the current theory of "interference," or the mutual destruction of sound by opposing air-waves, was true, as taught by physicists, any two sounds of the same pitch and intensity traveling together would be just as apt to travel in interference and cause absolute silence as to coincide and be heard, the chances of course being equal. This has been repeatedly urged, and in various ways, as a self-evident fact which must alone be sufficient to break down all this reasoning about the interference of supposititious air-waves, and of itself proves that beats are in no way connected with any such "phase of opposition." If such interference between air-waves were possible, then, clearly, the language quoted above, from Professor Tyndall, could not be true. Whatever, therefore, may be the true cause of beats, it is clear that the interference of air-waves has nothing to do with them.

Besides, it must be clearly manifest to the reader who has attentively perused the preceding arguments, that air-waves as the means of sound-propagation have no existence in fact, but are purely chimerical, being based on a complete misapprehension of the physical laws. This has been shown in so many ways that it is unnecessary to specify any particular class of arguments bearing against the hypothesis, since almost any one of the preceding two hundred or more pages, if opened to at random, will show facts and reasons against such a supposition which must convince an unbiassed scientist that air-waves are utterly inadequate to account for the phenomena of sound.

If, then, the scope and logical bearing of the arguments advanced in this monograph unanswerably disprove air-waves as the cause of sonorous propagation, it is folly to claim that these alternate sinkings and swellings of sound, as observed in beats, come from the interference of that which has no existence in fact.

It is the explicit teaching of every writer on sound, as all well-informed students of acoustics are aware, that the loudness or intensity of tone results alone from the swinging to and fro of the air-particles, with greater or less amplitude, as they strike the tympanic membrane, hitting it with a harder or a lighter blow; and hence that the sinking or swelling of a sound, as in beats, *takes place at the ear of the listener by this motion of the air-particles.* According to this universal teaching, it is not produced directly in the action or condition of the two instruments themselves, except so far as they act to mould and send off the waves of air, but is caused by the interference or coincidence of the air-waves themselves, after they leave the sound-producing bodies. I will refer to a few brief passages to refresh the memory of the reader. Professor Helmholtz says:—

"A periodically oscillating sonorous body produces a *similar periodical motion, first in the mass of air, and then in the drum of our ear.*"—*Sensations of Tone*, p. 16.

Professor Mayer teaches the same thing:—

"It is evident that the ultimate effect of the passage of sonorous waves through the atmosphere *will be to cause the molecules of the air to swing to and fro with the motions of pendulums.* It is also apparent that all the characteristics of the periodic motion at the source of the sound *will be impressed on the surrounding air, and transmitted through it to a distance.*"—*Am. Ency., Art. on "Sound."*

Professor Tyndall is even more explicit, if anything, on this subject. He says:—

"The *greater volume* of sound heard everywhere throughout the room *can only be due to the greater amount of motion communicated to the air of the room.*"

"We have already learned that what is *loudness* in our sensations, is, outside of us, *nothing more than width of swing or amplitude of the vibrating air-particles.*" ["*Nothing more*" excludes the sounding body itself as having any direct connection with this increase or diminution of sound, except as the mechanical means of sending off the air-waves!]

"The pitch of a note depends *solely* on the number of *aerial waves which strike the ear* in a second. The *loudness* or *intensity* of a note *depends on the distance* within which *the separate atoms of the air vibrate.* This *distance* is called the *amplitude of the vibration.*"—*Lectures on Sound*, pp. 48, 73.—*Heat as a Mode of Motion*, pp. 225, 372.

In another place Professor Tyndall distinctly says that if we hear one sound *louder than another* it is because the ear is "hit harder" in the one case than in the other by the vibrating air-particles (*Lectures on Sound*, p. 11). It is therefore easy to see that the sinking and swelling of the sounds of two beating instruments result "alone," according to the wave-theory, from the alternate *coincidence* or *interference* of the air-waves themselves sent off from such sounding bodies. I deny that this is any explanation at all of musical beats, as it has been clearly shown a few pages back that no such interference between two supposed systems of air-waves can take place, since not the slightest weakening of two unison tones occurs when two vibrating bodies are sounded half a wave-length apart,—the position which, above all others, admittedly meets this condition, and causes the *condensations* of the one system to exactly coalesce with the *rarefactions* of the other, if any such systems exist. Hence, this so-called "amplitude" or "width of swing" of the air-particles in the propagation of sound, in which they are said to oscillate "to and fro with the motions of pendulums," and to "shake the drum of the distant ear," is demonstrated to have no actual existence in Nature.

To show that "beats" are directly caused, according to the current theory of sound, by this alternate *interference* and *coincidence* of supposed *condensations* and *rarefactions* sent off in the form of waves, as the two beating forks *oppose* or *re-enforce* each other, I will quote Professor Tyndall's very clear and concise explanation of these phenomena, according to the received view of sonorous propagation. I will, however, first let him explain to the reader how these "condensations" and "rarefactions" from two unison forks, by *interfering*, may "abolish the sounds of both":—

"I draw my bow across a tuning-fork, which for distinction's sake I will call A, and cause it to send a series of *sonorous waves through the air.* I now place a second fork, B, behind the first, and throw it also into vibration. From B waves issue which pass through the air already traversed by the waves from A. It is easy to see that *the forks may so vibrate* that the *condensations* of the one shall *coincide with the condensations of the other*, and the *rarefactions* of the one *with the rarefactions of the other.* If this be the case, the two forks will *assist each other.* The *condensations* will, in fact, *become more condensed*, the *rarefactions more rarefied*, and as it is upon the *difference of density* between the *condensations* and *rarefactions* that *loudness* depends, the two vibrating forks thus supporting each other will produce a sound of *greater intensity than that of either of them vibrating alone.* It is, however, also easy to see that the two forks may be so related to each other that one of them shall require a *condensation* at the place where the other requires a *rarefaction;* that one fork, for example, shall urge the *air-particles forward* ["*swiftly advancing*"] while the other *urges them backward* [retreating and "leaving a *partial vacuum*"]. If the opposing forces be equal, particles so solicited will move neither backwards nor forwards, and the *aerial rest which corresponds to silence is the result.* Thus it is possible by adding the sound of one fork to that of another *to abolish the sounds of both.*"—*Lectures on Sound*, p. 258.

Here, then, as before stated, the cause of silence is the "interference" of the two systems of air-waves sent off from the two unison forks traveling in such relation to each other that the *condensations* of one system coalesce with the *rarefactions* of the other, thus tending to "abolish the

sounds of both." Silence, in this case, has nothing to do with the *alternate* vibration of the two forks, as was the case with the so-called interference produced by the *double siren!* We will now let this lecturer tell us how to manipulate the two unison forks so as to make one vibrate a trifle slower than the other, and thus generate the "beats" of which we are seeking an explanation. The reader will carefully note that the alternate *swellings* and *weakenings* of the tones of the beating forks, as here described, are explicitly attributed, all the way through, to the alternate *coincidence* and *interference* of the *condensations* and *rarefactions* of the *air-waves*:—

"Each of the two forks now before you executes exactly 256 vibrations in a second, and when they are sounded together you have the perfect flow of unison. I now load one of them with a bit of wax, thus causing it to vibrate a little more slowly than its neighbor. Supposing, for the sake of simplicity, that the wax reduces the number of vibrations to 255 in a second, what must occur when the two forks are sounded together? *If they start at the same moment, condensation coinciding with condensation* and *rarefaction with rarefaction*, it is quite manifest that this state of things can not continue. The two forks soon begin to exert *opposite actions on the surrounding air.* At the 128th vibration *their phases are in complete opposition, one of them having gained half a vibration on the other.* Here the one fork *generates a condensation* where the other *generates a rarefaction;* and the consequence is that the two forks, at this particular point, *completely neutralize each other, and we have no sound.* From this point onward, however, the forks support each other more and more, until, at the end of a second, when the one has completed its 255th and the other its 256th vibration, the state of things is what it was at the commencement. *Condensation then coincides with condensation* and *rarefaction with rarefaction*, the full effects of both sounds being produced upon the ear. . . . It is quite manifest, that under these circumstances we can not have the *continuous flow of perfect unison.* We have, on the contrary, *alternate re-enforcements* and *diminutions* of the sound. We obtain, in fact, the effect known to musicians by the name of '*beats*,' *which, as here explained, are a result of interference.*"—*Lectures on Sound*, p. 262.

Thus, consistently, all the way through the wave-theory, these authorities explain *beats* as the alternate *interference* and *coincidence* of the *condensations* and *rarefactions* of air-waves after they have been generated and sent off from the fork, and that when the weakening of the tone occurs it takes place alone because the tympanic membrane is not "hit" so hard by the oscillating air as when the tone is louder.

To make sure that the reader shall comprehend this pivotal fact of my argument, namely, that "beats" occur alone by the alternate motion and quiescence of the air-particles, I will make one other reference to Professor Tyndall's explanation. He says:—

"In the case of *beats* the *amplitude of the oscillating air reaches a maximum and a minimum periodically. . . . Its particles alternately vibrate and come to rest.*"—*Lectures on Sound*, pp. 266, 268.

Now, in opposition to this explanation of beats, I maintain that the operation which alternately augments and diminishes the intensity of tone, as the oscillations of the two forks cross each other's path in changing from synchronous to alternate vibration, has nothing to do with air-waves or any motion of the air-particles whatever, but *takes place in the instruments themselves, or in their potential and practical sympathetic attraction for each other*, without regard to the *coincidence* or *interference* of such useless nonentities as these so-called atmospheric *condensations* and *rarefactions*. I claim that the simple laws of acoustics, as applied by the consistent principles of the corpuscular hypothesis, which have thrown light on so many mysterious phenomena and elucidated so many difficult questions during the preceding discussion, will be found amply sufficient, when properly investigated and analyzed, to clear up this occult problem of "beats" on the general law of *sympathetic vibration.*

At pages 79, 80, &c., I endeavored to show that the *sympathetic vibration* of a fork or string, when its unison was sounded near it, could not, by any rational possibility, be accounted for on the supposition of the synchronous dashing of air-waves against it, as the wave-theory necessarily assumes, and gave what I consider good and sufficient reasons for rejecting such an hypothesis, even if no arguments had since been advanced showing that such atmospheric sound-waves have no real existence in Nature. I assumed, as the only consistent view, that there exists potentially, in all bodies capable of producing a musical sound, an affinity or sympathetic attraction for all other bodies capable of such sonorous effects, the same as there exists potentially in a piece of steel a magnetic sympathy for all other bodies of steel, and that it only requires that mysterious electric condition which we designate as *magnetic*, to cause such unison steel bodies to either attract or repel each other, according to the manner in which their magnetic currents of substantial but intangible corpuscles synchronize or cross each other's path. In an analogous manner, a sounding body only needs to be tensioned to that rigidity which develops a *unison* relation to other bodies of like sonorous rigidity, to raise its potential affinity into a practical sympathetic attraction, and by which means its potential or dormant sonorous pulses are taken hold of by the corresponding pulses of its unison neighbor, which gradually cause it to awaken into a similar sonorous action. And in a manner very analogous to this principle of magnetic repulsion, when the relation of polarity is reversed so that the substantial magnetic currents oppose each other, two forks or other sounding bodies, if made to vibrate in such a manner as to be thrown periodically *into* and *out of* unison, by oscillating first together and then in opposite directions, may alternately attract and repel, sympathize and conflict, re-enforce and oppose, each other, by the coalescence or interference of their substantial corpuscles acting upon each other's sonorous potentiality, quite similar to such magnetic action.

I will not pretend here to enter into the minutia of this hypothesis, which, it seems to me, will, when properly elaborated, fully explain the phenomena of beats on the principles of the alternate re-enforcement of, or interference with, this sonorous affinity or sympathetic attraction between two musical instruments, and which will, as I believe, prove to physicists much more satisfactory than the superficial and illy considered supposition of air-waves. I simply throw out the general suggestion of this law of sympathetic attraction as the rational basis of a solution, to show the reader that this problem of beats, as one of the most relied-on arguments of physicists in favor of some kind of interference between air-waves, is no exception to the general rule that such assumed "phase of opposition" is as useless as it is impracticable, and as foundationless as the air-waves on which it depends.

I will only present a single argument to show, as I believe, conclusively, that the action and force which produce beats are to be traced to the instruments themselves, and their influence upon each other, and need not be carried a single inch away to accommodate this superficial hypothesis of interfering air-waves. Suppose, for example, two forks mounted upon their resonant cases and tuned sufficiently out of unison to produce, say, one beat to the second. If sounded in close proximity to each other, or, as my hypothesis teaches, in a position of strong sympathetic attraction, a listener stationed a hundred feet

away from them will distinctly hear their *beats*,—will, in fact, hear them as far away as the sounds of the forks are audible. But let the two forks, while sounding, be gently separated only a few feet toward the right and left of the listener, and though he will continue to hear their united sounds in full force, yet the beats will entirely cease, showing that they result from the sympathetic influence of the two forks upon each other, owing to their affinity, and not to the alternate *interference* and *coincidence* of the two systems of supposed air-waves a hundred feet away, or at the ear of the distant observer, as the wave-theory teaches.

It is perfectly plain that the two systems of air-waves from two beating forks, if such waves exist at all as the cause of sound, must travel to the distant observer exactly in the same relation to each other (as to coincidence or interference) when the forks are slightly separated to the right and left, remaining equidistant from him, as when their resonant cases are in such close juxtaposition as to actually touch each other. Yet, in the former case, when not in close sympathetic proximity, the sounds are as perfectly smooth and mellow as if they flowed from two forks in absolute unison; while in the latter case, when in close sympathetic union, the beats can be distinctly heard, as before remarked, to the extreme limit of audibility. Need there be any stronger argument required to show that the alternate coincidence and interference of hypothetic air-waves are in no way whatever connected with the cause of sonorous beats? And need there be another argument adduced to show that the true cause of these phenomena lies, as here postulated, in the influence of the two instruments upon each other through this law of sympathetic attraction, as required by the corpuscular hypothesis?

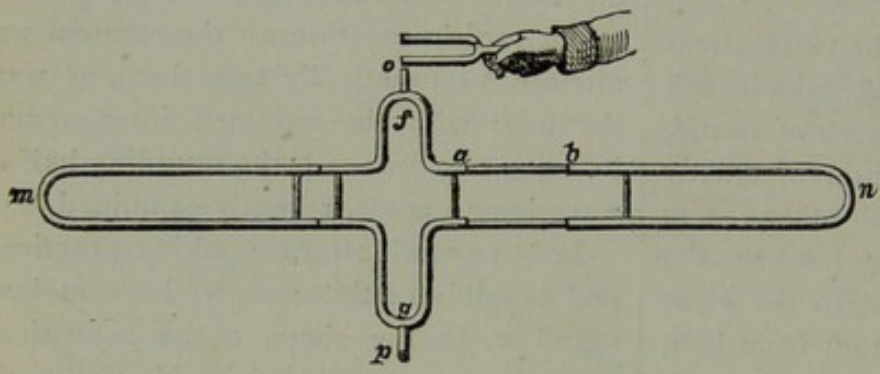
Following the lead of this assumed "interference," we would naturally expect it to finally culminate in something like direct evidence of its existence, if it really has any such foundation in fact or science. It would be very strange, indeed, if an important "law" in physics, lying at the very basis of a scientific theory, and involving such an unmistakable condition of things as the occurrence of "*absolute silence*" between two loudly sounding instruments by the *interference* of their air-waves, should not be susceptible of some sort of demonstrative proof which appealed directly to the auditory sense, instead of depending on mere theoretical inferences, which might vanish into thin air the moment we attempt to practically test them, as was the case with the assumed interference between two unison forks sounding half a wave-length apart, recently examined.

In our search after something practical and tangible of this sort, we have at last found it, in the shape of an acoustical apparatus manufactured by M. Konig, of Paris. This ingeniously constructed instrument is intended to squarely meet the difficulty by dividing a stream of sound into two unequal branches, one being half a wave-length longer than the other, and then re-uniting them in a common outlet, where they must naturally be expected to interfere by the *condensations* of one of the systems of waves coalescing with the *rarefactions* of the other, thus producing the long sought for "absolute silence" so essential to this "law," and so indispensable to the wave-theory of sound as a scientific hypothesis.

It is needless to say that such a conclusive proof of the current hypothesis of wave-motion as this would be, if founded on fact, would naturally receive considerable prominence in Professor Tyndall's book, as it certainly does. Before making

any further remarks in regard to the apparatus or its acoustical effects, I will take the liberty of transferring bodily to these pages the engraving and explanation, as given by this author, and earnestly request the reader to carefully examine the same:—

"Sir John Herschel first proposed to divide a stream of sound into two branches, of different lengths, causing the branches afterwards to re-unite, and to *interfere* with each other. This idea has been recently followed out *with success* by M. Quincke; and it has been still further *improved upon by M. Konig*. The principle of these experiments will be at once evident from Fig. 141. The tube *o f* divides into two branches at *f*, the one branch being carried round *n*, and the other round



m. The two branches are caused to re-unite at *g*, and to end in a common canal, *g p*. The portion, *b n*, of the tube which slides over *a b* can be drawn out as shown in the figure, and thus the sound-waves can be caused to pass over different distances in the two branches. Placing a vibrating tuning-fork at *o*, and the ear at *p*, when the two branches are of the same length, the waves through both reach the ear together, *and the sound of the fork is heard*. Drawing *a b* out, *a point is at length attained where the sound of the fork is extinguished*. This occurs when the distance *a b* is one fourth of a wave-length; or, in other words, *when the whole right-hand branch is half a wave-length longer than the left-hand one*. Drawing *b n* still further out, the sound is again heard; and when twice the distance *a b* amounts to a whole wave-length, it reaches a maximum. Thus, according as the difference of both branches amounts to half a wave-length or to a whole wave-length, we have *interference* or *coincidence* of the two series of sonorous waves. In practice, the tube *o f* ought to be prolonged till the direct sound of the fork is unheard, the attention of the ear being then wholly concentrated on the sounds that reach it through the tube."—*Lect. Sound*, p. 261.

After it had fallen to my lot to discover so many inaccuracies, and, it may be justly said, inexcusable mistakes, in the scientific observations and experiments of this physicist, it was quite natural that I should be inclined to discount in advance this entire statement in regard to the Konig instrument. It was plainly evident to my mind, if the apparatus and its acoustical effects were correctly described they would strongly favor the wave-theory, and would present an almost conclusive evidence in favor of this law of interference between sound-waves, as claimed by advocates of the hypothesis. I therefore, on general principles, could not believe that the representation, as quoted, was truthful to any degree which would tend to favor the theory of wave-motion, for the reason that I had already found so many considerations bearing directly against it which were absolutely unanswerable; and because, as all science and reason plainly teach, *a true theory can not contradict itself*. I was therefore compelled to assume, in advance, on the same general principles of logic, that, should any sonorous change be observed, on drawing out one branch of this instrument half a supposed wave-length longer than the other, it would be susceptible of a satisfactory explication on some other hypothesis than that of wave-motion.

In view of these considerations I resolved to test the matter carefully, and now have the satisfaction of announcing that I have done so with the following conclusive results.

To make entirely sure of my data, I first obtained from a friend the use of a complete Konig instrument (the one represented in the engraving), and tested it with forks of different vibrational numbers,

carefully drawing out, while each fork was sounding, the sliding branch (*b n*) of the device in order to detect the exact point of *silence*, as recorded by this high authority on sound, if any such point existed. But I here declare to the reader and to the scientific world that no such thing as *silence* occurs, nor even a respectable approach toward it. By the most careful act of attention, while moving the sliding branch of the instrument backward and forward, a point was discovered which produced a slight though sensible weakening of the tone, but it required care to detect it. This, however, is very far from justifying the extravagant language of Professor Tyndall, just quoted, namely, "Drawing *a b* out, *a point is at length attained where the sound of the fork is extinguished.*" This is not true, in any pardonable sense of the word "extinguished," since the sound of the fork is not diminished in intensity more than about one quarter, as any sound-expert would readily admit. So much, then, for the reliability of Professor Tyndall's scientific statements when recording simple matters of fact, on which no one need be or can be mistaken, if he has ever tried the experiment.

But here comes the important question, What causes this sensible weakening of the tone as the sliding branch of the instrument is drawn out to a certain point, if there is no truth in the wave-theory or in this law of interference between sound-waves? This is an inquiry which must naturally suggest itself to the mind of the reader, and, in arriving at a correct answer, it will be found, as I now propose to show, that physicists have wholly misapprehended this instrument and its acoustical effects, as was so clearly proved to be the case with the "phase of opposition" in the *double siren*, and that this change of tone has nothing to do with air-waves or their supposed interference. The attention of sound-investigators is especially invited to the solution about to be given, which will no doubt be new to acoustical science.

By means of one specific test (with which all others agreed), I found that a fork with 256 vibrations in a second, and a consequent wave-length of 52 inches, sounded at *o* (see engraving), required the sliding branch *b n* to be drawn out *not* sufficiently to make *half a wave-length difference* in the two branches (26 inches), but exactly 24 inches, in order to produce the maximum change or diminution of intensity. This would make the whole wave-length from such a fork but 48 inches, instead of 52 as it should be; that is, if this enfeebling effect was actually due to the interference of two systems of air-waves, as Professor Tyndall teaches. Besides, if this weakening of tone was the effect of a genuine *interference* between the *condensations* of one stream of sound and the *rarefactions* of another, there should be "absolute silence," as all physicists teach, since the two wave-systems are *exactly equal.* But as there is a reduction only of a scarcely noticeable fraction of the normal intensity of the tone of the fork, which reduction takes place at a point differing materially from the half wave-length hypothesis, it follows that the phenomenon, whatever it may be, must be explained on some other principle than that of so-called "interference" between two systems of atmospheric sound-waves. Is not this mechanically, acoustically, and mathematically, incontrovertible?

I will now undertake to give a solution of this phenomenon, without resorting to any such incongruous laws and facts as those involved in the explanation based on the assumption of wave-motion, and will endeavor to explain how this solution was arrived at.

I became satisfied, on finding that the difference between the two branches, at the point of greatest diminution of sound, was 24 instead of 26 inches, that the effect must be the result of *resonance*, and therefore must be due to either the re-enforcement or opposition of the two vibrating air-columns of the two tubes, the same as just explained in regard to the cause of beats. To strengthen this surmise, I found that the same fork (256 vibrations) held over the mouth of a tube open at both ends, required 24 inches as its maximum resonant depth, or a depth corresponding exactly to the difference between the two branches *m* and *n*, thus proving, incidentally, that a tube open at both ends is somewhat more than double the resonant depth of a similar tube having one end closed; and thus again showing the habitual inaccuracy of Professor Tyndall's observations, who teaches that the length of one tube is exactly double that of the other.

The fact thus discovered, that the maximum resonant depth of a single open tube agreed precisely with the difference in the length of these *two* open tubes forming the Konig instrument, my next effort was to invent some means of verifying my conclusion, and thus demonstrating that it was not the "interference" of two *streams* of sound-waves, but an effect of resonance which caused this perceptible weakening of sound. Fortunately the invention came to me, and accordingly I constructed the Konig instrument, with the important difference of elastic branches (*m* and *n*) formed of rubber tubing, which could be attached and detached of any required length, and stopped off at any desired portion of either branch.* I ascertained by the first test that precisely the same effect was produced with the elastic tubes as with those of the Konig instrument, and that the greatest diminution was reached, as before, when the difference in length was 24 inches instead of 26 inches, or a half wave-length.

Retaining this proportion of length between the two branches, my next experiment was to take advantage of the elastic tube by pinching it together, between my thumb and finger, at various places, while the fork was sounding at *o*, and observing the result with one branch open and the other closed; and, to my surprise and gratification, I found that my suspicions were correct, and that I could obtain exactly the same result of weakening the tone by stopping off the short branch between 11 and 12 inches from *f*, thus having but one stream of sound instead of two! I thus demonstrated the fact that at this particular point there was not the slightest difference in the intensity or quality of the tone when the sound passed through both branches and "interfered," as supposed, and when it passed through the long branch alone, and resounded back in opposition from the short tube closed at one end. I made this conclusive test by pinching and relieving the tube in rapid succession, thus suddenly changing from two streams to one; but not the least difference could be observed, as just remarked, in the quantity or quality of the sound, the same effect being produced by the opposing resonance of one open and one closed tube as was produced by the opposing resonance of two open tubes with a resonant difference of 24 inches in length.

To complete the demonstration that there was nothing in this supposition of "interference" between the two streams of sound or their supposed air-waves, I adjusted the two branch tubes to exactly equal lengths, which, of course, produced the full resonant effect of both tubes.

* The improved Konig instrument, with elastic branches, here referred to, can be seen at the office of HALL & Co., publishers of this book.

Then, by simply pinching one of the tubes, as before, at about 12 inches from *f*, I obtained the same weakening of tone precisely as was observed when the branches differed by 24 inches, or when the two streams were in supposed "interference"! I thus clearly proved that dividing the stream of sound into two branches of unequal lengths, and again causing their air-waves to unite and "interfere," was a pure misapprehension of physicists, and amounted to nothing at all in favor of wave-motion, since a single continuous stream gave exactly the same result when opposed by a closed tube of a different resonant depth.

This weakening of tone caused by the two branches of the tube differing half a supposed wave-length, as well as the effects of the test last given, will no doubt be found, when fully understood, to be only the result of coalescence or opposition between two resonant columns of air of different vibrational numbers, which reenforce or oppose each other by the law of sympathetic attraction, in a somewhat analogous manner to the attraction and repulsion of two magnets, as recently intimated, and as illustrated in musical beats. At all events, the hypothesis of two streams of sound "interfering" by the *condensations* of the one system of waves coalescing with the *rarefactions* of the other, is completely exploded by these experiments with the elastic tube improvement on Konig's instrument, which show that any resonant effect produced by dividing the sound into two streams can be equally obtained by a single stream, as just described, in connection with a closed resonant tube of certain depth.

Aside from this solution of the problem, it remains an unassailable fact that no such thing as *silence* or any approximate approach toward it takes place when one branch is half a wave-length longer than the other. I emphasize this fact, in opposition to the authority I am quoting. What, then, must be thought of the statement of Professor Tyndall, in which he distinctly says that when drawn out to the difference of half a wave-length, "*the sound of the fork is extinguished*"? He either deliberately and knowingly misrepresented the facts of the case, or else he taught and published to the world on mere inference or hearsay, as science, that of which he had no personal knowledge, because it seemed to favor the hypothesis of wave-motion! It is the safest and altogether the most charitable view to assume that he never tested an apparatus of the kind, and possibly never *saw* one; for it is altogether probable, if he had ever seen one of these Konig instruments, his curiosity would have induced him to test it, and thus correctly inform himself as to its sonorous effects. How he dared venture to make such baseless explanations of an apparatus he had never tested, and which was so easily obtainable, baffles human ingenuity to conceive.

In addition to this altogether probable supposition, I now venture the assertion, without knowing the facts, that the Royal Institution of London, under whose auspices these lectures on Sound were delivered, does not own one of these Konig instruments, or at least did not at the time of their occurrence, since it is more than probable that if such a device had been among the scientific apparatus of that institution some one of the members would at some time or other have had the curiosity to test it, and would thus have been enabled to enlighten Professor Tyndall, who evidently stood in such pressing need of it.

It is a singularly incongruous fact that this eminent author takes especial pains to commend scientific investigators who

shirk no pains or labor in arriving at the exact truth, wherever it may lead them, or whether it favors a pre-adopted theory or not, and who never take anything for granted in science on mere *theory* or *inference* when an *experiment* is possible to verify or contravene it! His eulogistic commendations of physicists who thus labor are so praiseworthy that I must quote one or two sentences:—

"Those who are unacquainted with the details of scientific investigation have no idea of the amount of labor expended in the determination of those numbers on which important calculations or inferences depend. . . . There is a *morality* brought to bear on such matters, which, in point of severity, is probably without a parallel in any other domain of intellectual action. *The desire for anything but the truth must be absolutely annihilated; and, to attain perfect accuracy, no labor must be shirked, no difficulty ignored.*"—*Lectures on Sound*, p. 26.

Why did Professor Tyndall, after employing such beautiful language as this in commendation of faithful workers in science, *shirk the labor* of testing the Konig instrument, which he might have readily obtained, before publishing to the world a scientific description of its effects having not a shadow of foundation in truth, thus practicing a breach of that "morality" which he commends in others, and deceiving the young scientific students of the land, who look to him as a guide? Why did he *shirk the labor* and *ignore the difficulty* of testing two unison forks or other sounding bodies placed half a wave-length apart, by which he could have convinced himself that not the slightest difference occurs in their sounds from such inferential or theoretic "interference," when it would not have taken him half an hour to make the experiment, and completely overthrow the wave-theory? Instead of acting on this principle of fidelity to scientific truth, which he had so highly eulogized in others,—that "the desire for anything but the *truth* must be absolutely *annihilated;* and, to attain *perfect accuracy, no labor must be shirked, no difficulty ignored,*"—he found it altogether more available and convenient to deal in scintillating theoretics, for which he is so noted, about the "interference" of hypothetic *air-waves*, which have no real existence in Nature, and thus "shirked" the trifling labor of sounding two forks at different distances apart, while his assistant observed in line their acoustical effects! The truth is, he could not help knowing that his theory of "interference" would have appeared to much better advantage had he been able to demonstrate it before his audience by producing "absolute silence" between two unison instruments sounding half a wave-length apart. But for some reason, which I leave the reader to find out, he did not attempt any such a fatal experiment. In connection with this manifest *shirking of labor*, I beg the reader to note his pen-painting of a "true physical philosopher":

"The *true physical philosopher* never rests content with an *inference* when an *experiment to verify or contravene it is possible.*"—*Lectures on Sound*, p. 36.

Yet he was "content" to assume, on mere theoretic "inference," the most important and pivotal facts of the current sound-theory, when an "experiment," costing but a few minutes of his time, would have not only *contravened* such assumptions, but, in doing so, would have annihilated the whole theory, since the assumed facts named constituted the very key to the main arch of the superstructure.

He not only rested "content" to shirk the labor of an "experiment" to test the truth of many of his most fundamental hypotheses, but in some cases he even spent more time in *fixing* an experiment to favor his theory than it would have taken to make an honest experiment, and

thus "contravene it"! As a proof, look at his effort to put the "smoke of brown paper" into "one end" of his tin tube, so that no "puff" should be ejected from the other end on clapping the books, when it would have cost less care, at least, to fill the whole tube by elevating its small end, and thus to have shattered his experiment! (See page 270, and onward.) The absolute annihilation of a "*desire for anything but the truth*" did not seem to apply to this case, and clearly demonstrates that the experimenter was not a "*true* physical philosopher," according to his own definition, or he would not have "shirked the labor" of filling the whole tube, and thus have rested "content with an *inference*" when an "experiment" was at hand to "contravene" the hypothesis!

These animadversions may seem unkindly severe; but, as a "true physical philosopher," I dare not "ignore" nor "shirk" the responsibility of exposing such unreliability in the discussion of scientific phenomena. I am forced, in truth, to assert that no careful and competent observer can fail to be astonished, on reading Professor Tyndall's various scientific works, at the continual recurrence of the most glaring inaccuracies everywhere visible. I open accidentally, as an illustration, to page 49 of his *Lectures on Sound*, and see this prominent "law" announced:—

"To produce a *musical sound* we must have a body which *vibrates with the unerring regularity of the pendulum.*"

Yet a more erroneous proposition was never penned in a scientific work, since it can be shown that a highly "musical sound" may be produced, in which no two of its vibrations are of the same periodicity! To make sure that the above statement was not a slip of the pen, he repeats it on the next page in even stronger and more explicit language. He seems to do this to impress it upon the reader, that, under no circumstances, can there be an exception to the rule:—

"The *only condition* necessary to the production of a *musical sound* is that the pulses should succeed each other in the *same interval of time*," or, as before expressed, "*with the unerring regularity of the pendulum.*"

The fallacy of this carefully reiterated law can be shown in a single sentence. The motion of a pendulum, as every one knows, is perfectly *isochronous;* that is, it oscillates with exactly the same periodic intervals, when once started, from its longest to its shortest swings, or until it settles entirely to rest; whereas, the most "musical" of all the sounds produced in an orchestra, as every musician is aware, are the *sliding* tones of the *violin* or *violoncello*, in which no two vibrations are of the same periodicity, and hence are the very opposite of isochronous or pendulous, as to intervals of time!

But why spend time in pointing out and criticising the philosophical views of a writer who tacitly admits himself not to be a "true physical philosopher," by not conforming to the requisites he has himself prescribed?

While thousands of scientific students are to-day ready to accept almost any proposition relating to the advanced theories of the time, if they only know it to have the indorsement of Professor Tyndall, I declare to the reader, upon my conscientious conviction, that, from the evidence of the quotations in these pages alone, it would be a safe general rule to reject, as probably fallacious, any scientific theory of which he might have become a prominent champion. Of course there are exceptions to most general rules, and it would be strange if even a uniform tendency to inaccuracy should not occasionally diverge into the truth.

I might continue these direct and dam-

aging quotations *ad libitum*, had I space, as *there is not an instance in this whole course of lectures on Sound, where the truth of the wave-theory is directly involved in the explanation*, which could not be equally turned against the lecturer and made to militate against the current hypothesis of sound. But the fatal instances already given are a sufficient illustration of the blinding influence of a false theory in leading the greatest intellects into error, even on the simplest questions of fact.

And here I feel compelled to say that it has been extremely unpleasant, and even embarrassing, though a moral and scientific necessity in my case, as explained in the preface, to be forced to take issue with such unqualified antagonism with so eminent a scientist, especially on simple questions of veracity and fact,—such as those concerning two unison forks sounding half a wave-length apart, and the acoustical effects of the Konig instrument,—questions in regard to which the possibility of being in error is so utterly unnecessary that it is difficult to conceive of anything short of an unpardonable want of information, which could have superinduced such reckless assumptions and such erroneous statements. Yet this very explanation of the engraving just reproduced from his book, and this action of two unison forks in abolishing each other's sound when placed half a wave-length apart, are but the legitimate fruits of the wave-theory, being no more foundationless than any other part of the hypothesis, and no less conspicuously and distinctly inculcated by every other writer on Sound, in proportion to his ability, than by this physicist.

However, it must be regarded as a matter of congratulation to the scientific world, as well as to the general public, that this great authority has narrowed down the whole question as to the truth or falsity of the wave-theory of sound to a few simple and representative questions of fact, which need not depend for a single day on any man's veracity or scientific standing. For example, this single representative question of "interference" between air-waves, in which the whole wave-hypothesis is intrinsically involved, namely, whether two unison forks, or other instruments, if sounded half a wave-length apart, with the ear stationed in line, can be heard the same as in any other position, must absolutely settle the whole undulatory problem, now and forever. *If they can be heard the same in that as in any other position, which the whole world knows to be a fact, then the wave-theory falls to pieces, and with it falls Professor Tyndall as a scientist!*

It may seem unduly severe thus to select out for a target the scientific reputation of one physicist, who is but equally involved with others who have written on the subject of sound. But, in determining the basis of my arguments against the undulatory theory, I was compelled to choose for my principal antagonist a strictly representative English authority to quote from, that my review, after being completed, might not fall flat from not having touched the bottom facts of the hypothesis, or from having failed to grapple with the "highest living authority." I therefore selected Professor Tyndall (in connection with Professor Helmholtz, the representative German, and Professor Mayer, the highest American authority), recognized by the civilized world as the most eminently popular exponent of these various scientific theories,—particularly that of sound,—and whose lectures on the subject, from which my citations are made, have been translated into all the leading languages of Europe. If, therefore, he has fallen the fated victim upon the altar of progressive truth, to appease the wrath

of the scientific gods, he may attribute the catastrophe to his having become a more conspicuous target than any of his coadjutors, by the greater triumphs of his genius in popularizing a theory having no foundation in Nature or true science, and no merit as a philosophical hypothesis save that imparted to it by the ingenuity of its advocates.

I will now briefly fulfill a promise intimated in the early part of this monograph, and that is to again call attention, at the close of the work, to the conspicuous and incongruous fact, that, while a fork or string in vibrating moves through the *air* at a velocity of only a few inches in a second, it actually "sends" off air-waves, as we are taught by physicists, at the enormous velocity of 1120 feet in the same time.

I have repeatedly urged, and given reasons for believing, as the reader doubtless recollects, that there can be no measurable spring-force to free air, while it contains no appreciable elasticity when unconfined by which a body moving through it can transmit a pulse to a distance, or stir the atmosphere even a short space in advance by causing one particle to push another, it another, and so on, as was illustrated by Professor Tyndall with his row of glass balls.

I also stated that this principle of *mobility*, one of the most prominent characteristics of our atmosphere, was of necessity ignored by physicists in their discussions of atmospheric wave-motion, since to recognize such a law, when assuming the transmission of an air-wave to a distance and at great velocity by a slowly moving fork or string, would be a fatal self-contradiction, as any kind of an impulse or atmospheric disturbance whatever must be counteracted and almost instantly neutralized by a persistent tendency to equilibrium.

Whatever displacement of the air-particles, therefore, may be effected by a vibrating string, such disturbed air can only travel, till it settles finally to rest, at a velocity equal to that of the displacing body. The aggregate distance traveled in a second, in one direction, by a vibrating prong or string, can not, as elsewhere shown, be more than seven or eight inches in a second.

It is true that some portion of the travel of a string in its oscillation to and fro is swifter than its mean velocity, owing to its tensile force added to its momentum; but how much swifter at its point of highest speed I have not been able to calculate to a certainty, nor have I been able to find any one who could aid me in determining this question to a nicety. If we even suppose its highest speed, at any one point of its travel, to be four times that of its mean velocity, which unquestionably exceeds the fact, and estimating but one half of the second occupied by its forward motion and the other half by its return motion, it would make its rate of velocity at the swiftest part of its travel but 64 inches in a second, or *not more than the one two hundredth part the velocity of sound.* This, manifestly, as the most ordinary mind must comprehend, is the utmost velocity an air-wave could attain, which receives its impetus from an object moving through the air at a speed no greater than that postulated above, as the highest point of velocity in a vibrating string.

Thus, while a string, estimating the swiftest portion of its travel, moves only at the rate of sixty-four inches in a second, it sends off its air-waves, as the current theory necessarily teaches, at a velocity of *thirteen thousand four hundred and forty inches in the same time;* or, in other words, it projects these aerial undulations through the air more than *two hundred times* swifter

than the very motion which gives them their impetus! Was there ever anything taught as science more transcendently or transparently impossible than this? Yet, incredible as it may seem, this is the exact and unavoidable teaching of the wave-theory, which my friends have thought me almost if not quite insane for attempting to assail; while the most ordinary student must see that by no law of philosophy, and by no rules of mensuration known in heathen or Christian lands, could such a string "send" off corporeal waves of any kind of mobile substance *a distance of more than sixty-four inches in a second*, even if the friction and inertia of such substance were wholly abolished!

These facts more than bear out all I formerly said when presenting the fatal illustration of the locust. I then asserted that it must be evident to any thoughtful mind that the stridulation, so far from churning the entire atmosphere throughout four square miles into condensations and rarefactions, did not stir the air a *foot* around the insect, while what atmospheric disturbances did occur would not probably travel at a velocity greater than about *four feet* in a second. Had I placed it at *four inches* in a second I would have been much nearer the proper limit, that being the aggregate movement of the insect's legs in producing the tone. Yet it remains an unanswerable fact against the wave-hypothesis, that, while rasping its legs across the nervures of its wings, at this very slow rate of speed, the shrill tones which it produces are radiated over four square miles of atmosphere at a velocity at least *one thousand times greater* than that of the movement which generates the sound!

Should I, as a scientific teacher, publicly declare and impress it upon my hearers that a *bullet*, after leaving the muzzle of the gun, could travel with a velocity even two hundred times greater than that of the gases passing through the gun-barrel which gave it the impetus, as does Professor Tyndall virtually, and as he does *actually* in regard to air-waves, it could but reasonably be inferred either that I must assume my audience a convocation of idiots, incapable of distinguishing sound from light, whom I wished to test by stating a practical absurdity, or else that I had successfully demonstrated my own incompetency to handle any scientific question. If, however, after so teaching it, I should persist in maintaining it as true, and publish to the world as a settled fact of science that a bullet would travel thus *over two hundred times faster* than the gases giving it the impetus, which common sense would brand as a transparent absurdity, is there any language in which to frame a rebuke too severe for such a crime against science and human intelligence?

This mechanical law, which is applicable to all *physical* bodies,—*air-waves* the same as *bullets*,—does not apply to the incorporeal and almost infinitely attenuated emanations which my hypothesis assumes, and which constitute sound, light, heat, electricity, magnetism, &c.; for, though the vibrations of the fork generate these corpuscles of sound, they do not "send" them a hair's breadth from its prongs, any more than the effervescing of the acid or the decomposition of the zinc, which generates the electric currents, actually imparts to them their enormous velocity by the physical tremors of the battery!

I have carefully explained, in another portion of this review, that all such incorporeal emanations—as of sound, light, and heat,—acquire their velocity manifestly and alone from an unknown, and, as yet, inexplicable law of radiation, conduction, and diffusion, which is entirely independent of any vibratory or tremulous motion at

their source, though to such motion their origin or generation is mostly if not entirely to be attributed.

No one knows, or can know, why electricity travels at such an inconceivable velocity through a wire, while no one would even for a moment suspect that it was caused by any corresponding physical movement at its source, any more than the vegetable tremors among the petals of the rose or honeysuckle were the means of imparting the velocity to their imponderable granules of fragrance, causing them to diffuse themselves through the surrounding atmosphere at considerable speed. It is equally irrational to suppose that the slight movement of a tuning-fork or string, but a distance of a few *inches* in a second, can project, as we have seen, sound-pulses two hundred times swifter than such vibratory motion through a substance absolutely devoid of appreciable spring-power when free to circulate, as is the case with air, which is the clearest possible demonstration that such pulses can not be constituted of air-waves, since the physical laws of mechanics hold with invariable uniformity as to the movements of all tangible and corporeal substances, such as air-waves or water-waves, where an equal and adequate mechanical motion and force are necessary for displacement and velocity.

A steamboat-wheel, for example, can not by any possibility "send" the waves of water from it, even if there were no inertia or friction to be overcome, at a velocity exceeding that of its revolving paddles. What would be thought of a scientist, of world-wide fame as a public lecturer, who should teach and then publish in a book that such a steamboat-wheel would actually "send" the waves of water away from its revolving paddles two hundred times swifter than their own movement? This is exactly what Professor Tyndall and all advocates of the current sound-theory teach in regard to vibrating strings, tuning-forks, &c., and the physical air-waves which they are supposed to "send" off! The bare fact that water-waves are admitted by Professor Helmholtz to be "essentially identical" with air-waves, ought to alone overthrow the wave-theory of sound, since water-waves can not travel faster than the displacing body which gives them their impetus.

To argue the point further than to thus clearly and distinctly state it in its proper bearing on this undulatory question, would be to assume the reader grossly ignorant of the simplest physical and mechanical effects. I will therefore close this argument by saying,—as Professor Tyndall will at once admit that the aggregate oscillatory movement of the fork referred to does not exceed sixty-four inches in a second, even counting its point of greatest speed, while the velocity of sound is 13,440 inches in the same time, or more than two hundred times faster than the motion of the fork,—that the demonstration becomes absolutely unassailable, namely, that these sound-pulses radiated from a vibrating instrument *are not constituted of air-waves at all*, and hence that the popular atmospheric wave-theory of sound has utterly and hopelessly broken down.

Lastly, in bringing to a close this somewhat extended review, I have the pleasure of presenting an argument which has been purposely reserved as a suitable culmination of this monograph. I trust it will not be considered unduly egotistical if I should declare as my deliberately formed conviction that the argument to which reference is here had is not only entirely original, but that, singly and alone, it is sufficient to break down the wave-theory of sound, even if the preceding portion of this treatise were blotted out; and I have no hesi-

tation in further adding my belief that an unbiassed physicist can not help at once admitting the truth of this statement, after carefully reading the argument to which I refer.

This investigation of the nature of sound has already been extended to nearly double the number of pages originally contemplated, without exhausting the subject or presenting more than a tithe of the objections which might pertinently be urged against the current hypothesis. But a limit must be unavoidably reached at some point in the discussion, and I see no better way to fix upon it than with the single consideration here to be presented; though I have every reason to feel assured that sufficient has been already adduced to convince the candid and intelligent student of science that the wave-theory was originally founded on a clearly mistaken view of Nature's laws and forces. However that may be, I now invite the reader to the argument intimated, as follows:—

I have already had occasion, in discussing the cardinal laws and principles underlying the wave-theory of sound, to refer to the fact that there exists, according to the admissions of all writers on the subject, an absolute *analogy*, amounting to a clearly defined *parallel*, between so-called *sound-waves* and water-waves (see page 237, and onward). As the reader no doubt recollects, I quoted extended passages from Professor Helmholtz, the highest living authority on Sound, showing, in the most explicit language, that, according to the accepted view, *sound-waves* and *water-waves* are "of a *precisely similar* nature," are "*essentially identical*," and move "*exactly in the same way*." A single condensed extract will be here reproduced to facilitate the reader's examination:—

"Suppose a stone to be thrown into a piece of calm water. Round the spot struck there forms a little *ring of wave*, which, advancing equally in all directions, expands to a constantly increasing circle. *Corresponding to this ring of wave, sound also proceeds in the air* from the excited point, and advances in all directions as far as the limits of the mass of air extend. The process in the air is *essentially identical with that on the surface of water*. . . . The process which goes on in the atmospheric ocean about us is of a *precisely similar nature*. . . . The *waves of air* proceeding from a sounding body transport the tremor to the human ear *exactly in the same way as the water transports the tremor produced by the stone* to the floating chip."—*Sensations of Tone*, pp. 14, 15.

In view of the universal inculcation of physicists as to the nature of sound-propagation, of which this quotation from Professor Helmholtz but concisely expresses the substance, I need hardly say, that if, on a careful examination of the subject, it shall be found that *the essential elements of wave-motion are diametrically in conflict with the most prominently observed phenomena of sound*, does it need any further reasoning to show that the wave-theory itself is an unmistakable fallacy of science?

In the preceding argument, to which reference was just made, the reader will remember that the *amplitude* and *wave-length* of water-waves were proved to invariably sustain a relative proportion to each other, in feet and inches, of about 1 to 10, from the smallest ripples, having a wave-length of only an inch from crest to crest, to the largest ocean billows, having two and even three hundred feet of wave-length. This relative proportion was shown to belong to the very nature and necessity of wave-motion, involving principles and laws, which were pointed out, inseparable from such phenomena, whether in air, water, or any other fluid substance. Hence, when it was ascertained, by the clearest analysis of facts, that there was no *amplitude* at all, or oscillation of particles to and fro, in substances through which sound freely passes, such as the

various metals,—not even enough to be observed with the aid of the most powerful microscope,—while the so-called *wave-lengths* of one of the low notes of the piano (E, with 40 vibrations to the second), according to the wave-theory, were absolutely 28 feet in air and 476 feet in iron, "from *condensation* to *condensation*," did it really require another argument to show to a critical scientific mind that no analogy whatever, or even an approach toward analogy, could exist between water-waves and so-called sound-waves? And was it not, therefore, a conclusive proof, that, instead of *undulatory motion* being the law governing sonorous propagation, sound travels in *direct lines* through all substances,—whether wood, water, air, or iron,—exactly as the corpuscular hypothesis requires, thus making it every way probable *that substantial sonorous pulses constitute the true and only solution of sound-phenomena?*

But now we come to that particular characteristic of water-waves to which I have been alluding,—one which is so inseparable from their very nature and existence, and so marked and easily determined, that it becomes conclusive on its face against the hypothesis of atmospheric sound-waves, by destroying the very idea of any analogy between the phenomena of sound and of true wave-motion; thus completing the destruction of the undulatory theory so effectually that even a child may, by means of this single argument, overwhelm the profoundest physicist. This peculiar characteristic of water-waves, and hence of all wave-motion, is the easily demonstrated fact, hitherto unobserved by any writer on sound, so far as I am aware, *that wave-velocity is always and exactly in proportion to wave-length, or distance from crest to crest!*

I assert, unhesitatingly, and am prepared to demonstrate it, that this is a characteristic of every conceivable system of waves within reach of our observation, and is so essentially interblended as a part and parcel of the nature and form of wave-motion, however generated, that water-waves can not exist at all outside of this concisely expressed law of Nature.

Thus, if the position I have here assumed be susceptible of unquestionable proof,—namely, that water-waves necessarily travel with a velocity proportioned exactly to their wave-length or distance from crest to crest, the large waves traveling many times swifter than the small ones,—it inevitably breaks down the wave-theory, as the unscientific reader can at once see, by shattering its very foundation of *analogy to wave-motion*, since it is a well-known fact, and universally admitted by physicists, *that there is no difference in sound-velocity between the highest notes, such as D of the piccolo flute, with a theoretic wave-length of less than three inches, and the low E, for example, of the double bass, with a theoretic wave-length, in air, of twenty-eight feet!*

In fact, the most casual observation of any one who has ever listened to a band of music playing at a distance of a quarter of a mile away, assures him full well that *the lowest and highest sounds produced must travel with the same velocity, since they reach the ear of the listener in perfect time*, the same as if he were stationed within a dozen feet of the players! Were this not the fact, or, in other words, were there any analogy between sound and true wave-motion, the music of a band would be utterly unintelligible if heard a single furlong away, as the *low* notes, with *long* wave-lengths, would outstrip the *high* ones, with *short* wave-lengths, destroying their rhythmical relation to each other, and consequently converting the most harmonious chords into a medley of discordant sounds. No one, with the least music in

his soul, will doubt this, especially if he pretends to reason at all on questions of science.

Hence, it only needs to be shown, by positive observation and measurement, that large water-waves, having long wave-lengths, as with ocean billows, invariably travel with many times greater velocity than small waves, such as ripples caused by throwing a pebble into a still pond, in order to annihilate, by an infallible law of Nature, the very principle of wave-motion in sonorous propagation, because, according to the teaching of Professor Helmholtz and all writers on the subject, if sound-waves have any existence in fact, they should, as a matter of course, be "of a *precisely similar nature*" with water-waves, should be "*essentially identical*," and be propagated "*exactly in the same way*"! Clearly, then, if the *velocity* of water-waves is proportioned exactly according to their *wave-lengths*, while all sounds, as is universally known, travel with the same uniform velocity, without the least regard to their supposed wave-lengths, it must follow that instead of the two classes of phenomena being analogous, it makes them "*essentially*" *opposite*, "*precisely*" *dissimilar*, while they move "*exactly*" in a *different way!* It only, therefore, requires the literal *facts* in regard to wave-velocity to be settled in order to solve this whole problem of the nature of sound.

To determine the question involved in this final argument, and to leave no possible room for doubt as to these pivotal facts, I instituted a series of searching and careful tests, so that the matter could be presented to the scientific reader as the result of actual observation and measurement, and not as the result of a merely theoretic hypothesis, which, as we have so often found, may turn out to be fallacious and deceptive.

Accordingly, I began my investigations by testing the velocity of the smallest well-defined waves I could conveniently measure. To secure perfect stillness, I procured the use of a bath-room facing the south, so that the sun might shine through the glass upon the surface of the water. I then filled the tub (five feet long) with clear water, and arranged above it a pendulum of a suitable length to beat seconds; and, by so turning the faucet as to let the water drop about once in a minute, I had time to observe and measure one system of waves before another had commenced.

There was no trouble in accurately observing the movement of these tiny ripples passing off as a drop struck the surface of my miniature pond. I found, by repeated observations, that such wavelets were about one inch long from crest to crest, each drop producing about half a dozen well-defined undulations. Timing these waves by the motions of the pendulum, there was not the least difficulty in ascertaining that their velocity from one end of the bath-tub to the other was at the rate of *two feet in a second.* This was the inauguration of what turns out to be an important scientific discovery,—so important that it completely shatters an established scientific theory which had stood unshaken for centuries, and which no physicist has ever dreamed of calling in question.

My next observation was made on the surface of a still pond surrounded with high banks, so that no action of the wind might interfere with the accuracy of my measurements. A distance of 30 feet was carefully measured off, and while my assistant dropped stones into the water at given signals I timed the velocity of the waves sent off by noting the second-hand of my watch. The result was, after repeated experiments and much careful observation, that the wave-velocity, as well

as wave-length, was proved to be in the exact ratio of the size of the stones dropped into the water,—those weighing about a pound driving off the waves the full distance of 30 feet in 10 seconds, or at a velocity of 3 feet a second. These waves I found to have a length of nearly a foot from crest to crest, and an amplitude of about *one inch*, measuring from the bottom of the trough to the top of the crest, as I judged, from the fact that such waves, 15 feet from my assistant, lifted the water around a stake half an inch above the normal level of the pond.

Incidentally, while experimenting in this way, I discovered another distinct error into which Professor Helmholtz had evidently been led by the misguiding tendency of a pre-adopted theory. In his anxiety to show that sound-waves and water-waves were "essentially identical" and "precisely similar," he was innocently (I will assume) led to misstate entirely the actual effect of dropping a stone "into a piece of calm water." In order to make this effect correspond to that of a single vibratory motion to and fro of a tuning-fork or harp-string upon the air, such stone, of course, must be made to produce but a *single wave*, with *a single crest and sinus*, since a single complete vibration of a sounding instrument, as all writers on sound tell us, generates but a single sound-wave, having one *condensation* and one *rarefaction*, both of which cease the moment the vibration ceases! Hence, it was absolutely necessary for Professor Helmholtz, in order to sustain the wave-theory, to leave the scientific impression on the minds of his readers that a single impulse thus produced on the surface of water by the impact of the falling stone would produce but a solitary wave! Accordingly, his language is very explicit, as just quoted: "Suppose a stone to be thrown into a piece of calm water. Around the spot struck there forms a little *ring* of wave, which, advancing equally in all directions, expands to a constantly increasing *circle*."

Now, it is evident that it would not have answered the purposes of the wave-theory, which this eminent physicist was trying to illustrate, to have spoken of *rings* of waves being thus produced, or of their expansion to constantly increasing *circles*, as this would not have been "precisely similar" to so-called sound-waves! But what is the fact? It is this, as any schoolboy knows who has ever thrown a stone into a pond, namely, that a stone, on striking the surface of water, *produces more than a dozen perfectly defined waves, which pass off in all directions, forming that many constantly increasing circles*,—thus, in a way wholly unexpected, showing an absolute dissimilarity and want of analogy between true wave-motion and these hypothetic sound-waves, even allowing physicists to fabricate them in their own way! It is entirely impossible to believe that Professor Helmholtz did not know that a stone thrown "into a piece of calm water" will actually produce a dozen or more well-defined waves. Why, then, did he speak of a single "*ring* of wave" and a single "*circle*"? I leave the reader to answer.

I next entered into a series of careful experiments, testing and measuring waves sent ashore from passing steamboats of different sizes, and traveling at various rates of speed. These waves were of correspondingly different amplitudes and wave-lengths, ranging from 8 to 20 feet from crest to crest, and from 10 to 24 inches from crest to sinus, thus keeping up a uniform proportion of about 1 to 10, in feet and inches, between amplitude and wave-length, as heretofore urged. To determine the matter carefully, my assistant took a position in a small boat 300 feet

from shore, measured by a line which he kept taut; and, as the first wave from a passing steamboat would reach him, he would give me the signal, so I could note the time elapsing till it had reached the shore. By many such observations it was definitely established that exactly as the amplitude and wave-length increased did the velocity also increase, waves of a length of 12 feet from crest to crest traveling the distance of 300 feet in 40 seconds, or a trifle more than 7 feet in a second,—being more than double the velocity of the waves generated by dropping stones of a pound weight into still water, and more than three times the velocity of waves caused by drops of water falling into a bath-tub, as in my first experiment.

These facts were entirely conclusive to my mind that I had struck the lead which alone must overthrow and destroy the wave-theory of sound, since it was self-evidently impossible for that theory to be true, according to these tests and observations, unless it was a fact that tones of a low pitch, and having long wave-lengths, could be proved to travel with many times greater velocity than those of a high pitch and consequent short wave-lengths, which the observation of the whole world declares to be impossible, no difference whatever, as already shown, being observable between them.

It now only remained to test the velocity of ocean billows, or waves having a length from crest to crest corresponding to and representing tones of great depth of pitch, according to the wave-theory, such as the lower notes of the pianoforte and church organ. Accordingly, I took up my residence, for a period of time, at Rockaway Beach,—

"On old Long Island's sea-girt shore,"

so famous for its picturesque ocean billows and incessant surf. Wind and weather seemed to conspire to aid the cause of scientific investigation, as they gave me not only waves of all desirable dimensions, but the loveliest temperature conceivable in which to make my experimental observations and measurements.

By anchoring a couple of buoys, 200 feet apart, a short distance from the shore, and in line with the direction of the approaching waves, it was an easy matter to observe and follow the progress of any particular billow on which the attention was fixed, after it had lifted the farthest buoy, and thus note the exact number of seconds which would elapse before it would strike the other. It was a source of the deepest interest and congratulation, on the part of the writer, to watch from day to day, as the intensity of the wind varied, the absolute verification of this important discovery, as previously determined; for, as already observed, the velocity of these billows invariably increased with the exact ratio of increase in their size and wave-length!

For example, billows of about 4 feet amplitude and from 30 to 35 feet wave-length were 20 *seconds* in traveling the 200 feet, thus making their velocity 10 feet in a second; while rollers 8 or 10 feet high, and with a wave-length of 80 or 90 feet from crest to crest, actually increased their velocity to 15 or 16 feet in a second, or nearly *eight times the velocity of the small wavelets measured in my first experiment!* This was enough, though it was evident that, had I been able to witness and measure billows 20 to 30 feet high, and with a wave-length of over 200 feet, such as often occur in mid-ocean, their velocity would, by maintaining this ratio of increase, no doubt reach fully 30 feet in a second, or a speed of more than 20 miles an hour!

Now, with all these facts just as here presented, and which any student of science

can easily verify by a little observation and at no expense, what has the advocate of wave-motion, as the scientific basis of sound-propagation, to say? There really seems to be but one single conclusion to which any logical mind can come, with these indisputable facts before it, and that is: As this fundamental principle of wave-motion demonstrates that the velocity of a system of waves is always in exact proportion to their wave-length, while the velocity of all sounds is the same whether their hypothetic wave-lengths are long or short, it follows, as a demonstrative scientific conclusion, against which no rebuttal can be made, that sound does not travel at all by wave-motion, and hence that air-waves, or the supposed undulatory motions of any other kinds of substance (through which sound is known to travel with great facility, such as iron, glass, wood, water, &c.), have nothing whatever to do with the generation or propagation of sound! Does it not, therefore, follow, as the inevitable result of these experimental observations, here for the first time placed on record so far as the writer knows, that the wave-theory of sound, in its fundamental principle and most vital element, is a scientific mistake based on a complete misunderstanding of the physical laws?

In addition to the foregoing decidedly conclusive results, I had the satisfaction of making and recording another observation while noting the progress and velocity of waves sent off from passing steamboats, which, though only collateral, is beautifully confirmatory of the general bearing of this law against the wave-theory of sound, to the consideration of which the reader's attention is especially invited.

I ascertained, by close calculation and measurement, that waves, while near the passing boat, or before they had traveled a sufficient distance to expend much of their force, *moved with considerably higher velocity than after they had reached to a greater distance.* But this proved to be entirely consistent with the principle evolved by the discovery of this fundamental law, as just explained, because the velocity of waves must necessarily decrease and their wave-lengths *contract* or shorten in the exact ratio as their amplitude becomes less!

There is no escape from this rule, as the reader no doubt already sees; for this *contraction of wave-length* and this *diminution of velocity* according to the ratio of *decrease in amplitude* is strictly and philosophically interdependent, and coincides with the laws of wave-motion, as here evolved. To elucidate the principle, it is plain to see if large waves travel faster than small ones, as my observations prove, then it follows that the front waves, as they spend themselves and diminish in amplitude, must necessarily lose in velocity, and, in so doing, will allow the waves in the rear, of larger amplitude, to constantly gain on those in front, thus shortening their distance from each other. In this manner the diminution in velocity naturally keeps pace with the diminution in amplitude, while the two combined mechanically result in this proportionate contraction or shortening of wave-length, exactly as my observations have shown to be the case.

If, therefore, there is the least analogy existing between actual wave-motion, as thus exemplified, and sonorous propagation, it must be perfectly clear to a logical mind that *a sound should travel slower and slower the farther it gets away from the generating instrument, while it should also become higher and higher in pitch by the contraction of its wave-lengths, as this is exactly the manner in which water-waves are propagated!* But since it is well known that

sound retains the same *pitch* precisely, as well as the same *velocity*, however far its range may have extended from its source, as all observation proves, it becomes another and collateral demonstration that wave-motion is in no manner whatever connected with sonorous propagation, and that physicists are consequently laboring under a grievous philosophical misapprehension in their advocacy of the current theory of sound.

The law thus discovered—that all waves travel with a velocity exactly in proportion to their size and wave-length—not only serves the purpose of destroying the wave-theory of sound, but, while doing so, it beautifully accounts for certain phenomena which have been often observed but never explained, and which are, in fact, entirely inexplicable except by the key thus brought to light.

Take the well-known fact that every system of normal water-waves is accompanied by an occasional billow of very much larger proportions, which can be easily seen, at a considerable distance, looming up above its fellows. No doubt the reader has often observed this remarkable occurrence, and possibly wondered at the philosophical cause. I will now endeavor to explain the mystery, I hope satisfactorily, by applying this fundamental law of wave-motion just laid down.

As it is practically impossible for any two waves to be exactly of the same size,—as it is for any other two objects, large or small,—it is equally impossible for any two waves to travel with exactly the same velocity, since this law proves that their velocity must depend entirely upon their size. Hence, in the very nature of things, any wave which happens to be a small fraction larger than the one preceding it must necessarily gain slowly on the one in advance, till at last, overtaking it, the two blend into a single wave of about double the normal size of waves constituting that system.

The same thing then continues, after the two are united, with increased acceleration, requiring less time for this reenforced billow to overtake the next wave in advance, owing to its increased velocity by such increase of size, till at last the accumulation results in these tremendous *king-waves*, as I shall call them, alone by the action of this elementary law of wave-motion, which thus again in another and unexpected way completely contravenes the wave-theory of sound, since no such disproportioned *sound-waves* are even claimed to occur in sonorous propagation by any writer on the subject! If sound consisted of wave-motion at all, or if air-waves were possible as the cause of sound-phenomena, we should certainly hear in every sustained musical tone an occasional outburst, or sonorous explosion, whenever one of these atmospheric *king-waves* should happen to accumulate and dash against the tympanic membrane! As no such sonorous effects are ever observed, it becomes clearly manifest that sound does not travel by means of air-waves at all, or by any principle analogous to undulatory motion.

Thus, aside from the philosophical value of a scientific explanation, never before attempted, of these natural phenomena of *king-waves*, it strengthens my general argument, based on this elementary law, by showing that every phase of true wave-motion is essentially subversive of the current theory of sound, since it is diametrically opposed to all observed sonorous phenomena. No rational man can doubt that, had Professor Helmholtz been aware of this law of wave-motion here demonstrated, namely, that wave-length and wave-velocity go hand in hand, he must

have unconditionally abandoned the wave-theory of sound as a fallacy of science, and at once have sought some other hypothesis for solving the problems involved in sonorous propagation. As an honest physicist he could not have continued his adherence to a merely theoretical inference, after its very foundation had been swept away. In such an emergency, what could he have grasped as a basis of solution save the beautiful and consistent hypothesis of substantial sonorous pulses, which has been assumed and somewhat elaborated in the pages of this monograph, and which has never failed in rendering satisfactory explanations of all difficulties encountered.

In view of this law of wave-motion, which so completely destroys even the semblance of analogy between sonorous pulses and water-waves, Professor Helmholtz surely can not help seeing that fully one half of his great work on sound is thereby reduced absolutely to waste paper. One really can not help sympathizing with a writer under such circumstances. At least one half of this wonderful book, *The Sensations of Tone*,—a work which cost the author so many years of brain-struggle, and evincing a profundity of thought and mathematical formularization without a parallel in modern scientific research,—is based alone on the fundamental assumption, already quoted, that there is a complete similarity—an absolute parallel—between the action of sound-waves and water-waves, which, by the law thus demonstrated, is mercilessly scattered to the four winds. No reader can suppose, for a moment, that had this great investigator of science been aware of this law of wave-velocity, as so fully shown, that he could have repeatedly declared, as the fundamental principle of the wave-theory, that water-waves and atmospheric sound-waves are "essentially identical," "precisely similar," and travel "exactly in the same way." Evidently such language as this never could have found a place in his book, because it would have been devoid of the slightest foundation in truth, and hence so eminent and candid a savant as Professor Helmholtz could not have knowingly made these statements; and if the statements thus quoted could not be truthfully made, it is plain to see that the wave-theory, based upon them, can have no foundation in science or in the physical laws.

Starting out, however, with an honest mistake, originating in a pure fallacy of science, as the foundation of all his future reasoning on sound-propagation, he consistently built his elaborate castle in and upon the air, to be admired for a time by the physicists of the world as a beautiful and marvelous structure, but at last to fall into utter ruin at his feet by the fatal touch of a single philosophical fact! *

If there was, therefore, but this *one* conclusive argument against the wave-theory,—an argument, by the way, which the combined ingenuity of the world can neither jostle nor weaken,—Professor Huxley would say to physicists that their case was hopeless, and that they might as well abandon the wave-hypothesis at once. His words are big with meaning:—

"Every hypothesis *is bound to explain*, or at any rate *not to be inconsistent with, the whole of the facts it professes to account for;* and if there is *a single one of these facts* which can be shown to be inconsistent with (I do not merely mean inexplicable by,

* Since this argument was written, and mostly in type, Professor Robert Spice, to whom I have so often been indebted for valuable suggestions, has called my attention to the fact that the law here announced is admitted as correct in a recently published English work, though no details or measurements, as to the various proportions of wave length and velocity, are given.

but contrary to) the hypothesis, *such hypothesis falls to the ground—it is worth nothing. One fact* with which it is *positively inconsistent* is worth as much, and is as powerful in negativing the hypothesis, *as five hundred.*"—HUXLEY, *Lectures on the Origin of Species*, p. 140.

A truer and more concise rule of logic never was written. But if a *single* fact inconsistent with an hypothesis is sufficient to break it down, how irretrievably must the wave-theory have fallen to the ground when not a single fact or phenomenon in connection with the whole subject is found to be in its favor? On the contrary, every fact examined, and scores of others not touched upon in this monograph, point exactly in the opposite direction. It seems wholly inconceivable that such an array of pertinent considerations should conspire to break down the wave-theory, and yet that it, with all its absurdities and self-contradictions, should be the true solution of the sound-problem!

If these facts have really driven the wave-theory of sound to the wall, and demonstrated it to be a scientific fallacy, there is not a scientist who would not be willing to admit that the undulatory theories of *light* and *heat* are involved in the same catastrophe, and must share the same demolition, without striking them a blow, since it was only the sound-theory, as universally held, which led to the invention of *ether*, by which light as well as heat could be construed into some kind of undulatory mode of motion. As the wave-theory of sound—the very foundation of *ether* and *ethereal undulations*—has been shattered, it is clear to see that the superstructures reared upon it must necessarily fall to the ground.

In conclusion, I am well aware that to proclaim the overthrow of a universally accepted hypothesis, such as this of the undulatory theory of sound, which has stood the test of scientific investigation for hundreds of years, and which has never, so far as the writer knows, been called in question by a single physicist, or even for a moment doubted, has a presumptuous look on its very face,—amounting, it must be confessed, almost if not quite to audacity. But the facts, figures, and arguments, are here spread out, somewhat hurriedly, before the reader, while the appeal is now distinctly made to scientific thinkers and investigators either to show to the world that the considerations presented against the theory are erroneous or else to acknowledge their correctness, which I doubt not they will cheerfully do.

NOTE ON THE ANTENNÆ OF THE MOSQUITO.

COMMENTS ON THE HYPOTHESIS OF PROFESSOR MAYER, AS PUBLISHED IN THE "AMERICAN JOURNAL OF SCIENCE."

At pages 195, 196, &c., as the reader will recollect, I had occasion to examine the question of the unisonant vibration of the antennæ or so-called "auditory hairs" of certain invertebrates, such as those of the *mysis* or *opossum-shrimp;* and assumed, in opposition to Professor Helmholtz and other physicists, that any vibratory motion observed in such organs as the effect of sound must be regarded as simply *reactive* instead of *unisonant*, being first heard by the animal through the proper auditory organs, without any motion whatever of such parts, and then reflected back upon these antennæ or fibrillæ through the nervous system of the creature, thus causing

the tremor which is noticed by experimenters as the supposed direct result of unisonant action.

This principle was illustrated by the reaction of sense-impressions causing subjective effects on different parts of the human organism, just as certain sounds, after being heard,—the *filing of a saw*, or some peculiar *scraping movement of a slate-pencil*, for instance,—will often react through the nervous system unpleasantly upon the *teeth*, and, with some temperaments, so set them on edge as to be almost unendurable. No one, of course, would suppose that such impression on the teeth could occur from the direct or objective action of sound-pulses, since a deaf person would perceive no such effect. This peculiar sensation can only be felt when the tone producing it has first passed to the brain through the proper auditory apparatus, and then reacted through another system of sense-nerves back upon the teeth. Such reactive connection between the teeth and the organs of audition is abundantly confirmed by the well-known experiment among dentists by which a violent toothache can be entirely checked for a number of seconds by pricking or pinching certain portions of the ear.

The truth is, no one, after a moment's reflection, will deny the correctness of the *reactive principle* here assumed as the most probable explanation of these tremulous movements of so-called "auditory hairs." To ignore the fact that certain external organs can be thrown into violent agitation as the effect of sound reacting through the nervous system, after it has been heard, would be to shut our eyes to the commonest experiences of human life. What reader has not seen nervous persons so startled by a sharp and unexpected sound that their hands would quiver and the whole frame tremble for some seconds after the shock? To attribute this *vibratory motion* of the hands and fingers to the direct or *unisonant* action of sound, as the reasoning of physicists would necessarily imply, instead of its *reactive* effect through the nerves after the auditory organs had performed their part of the work, would be to trifle with reason and stultify common sense, since, as before remarked, a deaf person, however nervous, would, of course, experience no such tremor of the fingers from sonorous shocks, however sharp.

While discussing this subject, in the fifth chapter, I gave what I still consider good and sufficient reasons for rejecting the possibility of such a thing as *microscopical fibrils* vibrating in *unison* to different sounds of the musical scale, since to be susceptible of such vibration (unless *forced* by very close contact), a string, rod, or fibril must itself be capable of producing that vibrational number, if plucked, which its length, weight, and rigidity, absolutely forbid.

Since those suggestions were in print I have read a carefully prepared article by Professor Mayer, in the *American Journal of Science*, for August, 1874, which had escaped my notice, in which he labors to show that the male *culex* or common *mosquito* hears sounds in the same way as described in the case of the *mysis*, by means of the variously tuned fibrils of his antennæ vibrating sympathetically to tones of various degrees of pitch, and that by this means he is enabled to hear the *female mosquito*, and thus direct his course toward her in the dark!

As this exposition of the auditory apparatus of the *culex*, given by Professor Mayer, involves the truth or falsity of the whole philosophy of audition and aural anatomy formulated by Professor Helmholtz as the basis of the wave-theory of sound, I propose to give a few moments

to the considerations adduced in favor of such microscopical unisonant vibration.

I could entertain the reader with numerous interesting quotations from this ably written article, but will only make one or two brief extracts, to convey an idea of the general drift of the positions assumed. After experimenting with the antennæ of several mosquitoes, under the microscope, and observing the action of their fibrillæ while sounding a number of differently tuned forks, Professor Mayer remarks:—

"Experiments similar to those already given revealed a *fibril tuned to such perfect unison* with Ut_3 [one of Konig's tuning-forks] that it vibrated through 18 divisions of the micrometer, or ·15 mm., while its amplitude of vibration was only 3 divisions when Ut_4 was sounded. Other fibrils responded to other notes, so that I infer from my experiments on about a dozen mosquitoes, *that their fibrils are tuned to sounds extending through the middle and next higher octave of the piano.*"

"*The song of the female* vibrates the fibrillæ of one of the antennæ more forcibly than those of the other. . . . The mosquito now turns his body in the direction of that antenna whose fibrils are most affected, and thus gives greater intensity to the vibrations of the fibrils of the other antenna. When he has thus brought the vibrations of the antennæ to equality of intensity, he has placed his body in the direction of the radiation of the sound, and he directs his flight accordingly; and, from my experiments, it would appear *that he can thus guide himself to within* 5° *of the direction of the female.*"

It seems exceedingly strange, not to use a stronger word, that it never should have occurred to so careful an investigator of science to first *kill* the *mosquito* before making observations upon this supposed sympathetic vibration of its fibrillæ, as was suggested in the case of the shrimp, which could have been so easily done while the insect was secured under the microscope, by a little carbonic acid gas or by some other means, without marring the form of a single fibril! Instead of such a practical and fundamental thought occurring to this eminent physicist, he is particularly careful, in every instance, to inform the reader that he employed a "live" mosquito on which to experiment!

If his hypothesis of the *unisonant vibration* of a certain fibril through 18 divisions of the micrometer to the tone of Ut_3 is based on science, surely that particular fibril would have responded exactly the same after life was extinct, if not disturbed structurally, or else it did not vibrate unisonantly in the "live" insect! *Any organ vibrating by sympathy to a* Ut_3 *fork does so because such unison body has a vibrational number corresponding to that of the exciting tone*, which, of course, depends entirely upon its size, weight, and rigidity, and not upon the fact of the animal possessing such organ being either *alive* or *dead!* If Professor Mayer should find, on trying "about a dozen" of such lifeless mosquitoes with tuning-forks ranging through the entire register of the two octaves of the pianoforte, that not a single fibril could be made to stir,—as I predict, on general scientific principles, must be the case,—he would at once see that all this reasoning about the sympathetic vibration of microscopical organs was a fundamental philosophical mistake; and hence, that the supposed acoustical structure of the ear, including Corti's rods, as supporting the wave-theory of sound, must be simply visionary, having no correct basis in true science.

In such a contingency, there would be no conceivable explanation possible, as I doubt not Professor Mayer would admit, save the one given in Chapter V., already referred to, that all such tremors of the antennæ and fibrillæ of invertebrated animals, as the result of tone, is a reactive or subjective effect,—the tone reflecting, as it were, through the nerves of such animal organism back upon its external organs.

I thus venture the hypothesis, without trying a single experiment or knowing a thing about it except from my own reasoning, that the antennæ or fibrillæ of no *dead insect* or *crustacean* will ever respond sympathetically in the slightest degree to a tone when the vibrating body is a sufficient distance away *to prevent the incidental disturbance of the air from blowing them*, say, a distance of four or five feet.

Although the position here assumed is not necessarily vital to my argument against the wave-theory of sound,—that depending upon numerous direct considerations heretofore advanced,—I nevertheless give it a prominent place in the investigation of the collateral reasoning of physicists upon questions which are essential to the general correctness of their hypothesis; and I earnestly trust that these writers on sound will fairly test this question of the unisonant vibration of antennæ on dead insects, and if I am mistaken in my hypothetic reasoning on the subject, they are at full liberty, of course, to show me no mercy, as I surely do not deserve *quarter* when I refuse to give it.

It is a matter of astonishment, beyond words to express, as intimated when discussing Corti's arches, that physicists universally ignore this simple but fundamental acoustical law—that a rod secured at one end, in order to be capable of vibrating sympathetically in response to a tone of any determinate pitch, must, on being plucked, have the same vibrational number, or swing with the same normal periodicity, as the body producing the exciting tone; and that in order to thus correspond in vibrational number, its length, weight, and rigidity must at least approximately agree with those of the exciting instrument. Instead of taking this essential and elementary acoustical condition into the account, which, it would seem, ought to be the first thing a physicist would think of, Professor Mayer, following the example of Professor Helmholtz, assumes that a microscopical fibril on one of the antennæ of a mosquito may be "*tuned to such perfect unison*" as to respond to the middle A of the pianoforte, which, under the experience and skill of the best musical instrument makers, requires for its tone a string or rod at least *several hundred times longer than the fibril in question!*

This amazing absence of what I am compelled to call scientific perspicacity, in thus ignoring one of the most vital and fundamental principles of acoustics, seems to be but another illustration of what I have before referred to as the misguiding tendency of a false theory, even upon the greatest of intellects, when it once comes to be generally adopted as science.

If Professor Mayer really desires the world to place the least faith in his scientific "discoveries" that the microscopical fibrils of a mosquito's antennæ are actually "tuned to such perfect unison" with certain tones of the musical scale as to vibrate sympathetically when the corresponding tuning-forks are sounded, I insist that he shall experiment upon dead mosquitoes instead of "live" ones; and if he shall then fail to make a single "auditory hair" fall into unisonant vibration, I shall claim that *my* "discoveries" in regard to *nervous reaction*, "which I imagine are entirely new," have laid the true physiological and acoustical foundation for scientifically explaining the phenomena in question.

As a proof that the *tremulous action* of that particular fibril observed by Professor Mayer, under the microscope, and to which he specifically refers, was not *unisonant* but *reactive*, we have the fact, stated in his own words, as just quoted, that with one fork, Ut_3, it vibrated through 18, and with Ut_4 through 3 divisions of the micrometer;

whereas I now assert that a sounding body of any kind which would sympathetically vibrate in full unison to Ut_3, as did this fibril, would not respond at all to another fork as much out of unison as Ut_4 would be! This alone shows that the observed motion of this fibril was not the effect of unisonant or sympathetic vibration at all, but must be accounted for on some other hypothesis!

Of course, all this reasoning about the sympathetic vibration of these microscopical organs of insects, or the same kind of reasoning by Professor Helmholtz in regard to Corti's rods in his analytical investigation of the human ear, is simply intended to re-enforce the wave-theory of sound, and logically grows out of that general assumption. These far-fetched attempts, however, to show the periodic effects of air-waves on such microscopical organs are entirely unnecessary in order to account for the auditory powers of animals, either large or small.

It seems singular, to say the least, that a male mosquito in the dark is obliged to follow the direction indicated by the sympathetically vibrating fibrils of its antennæ in order to reach within *five degrees* of the singing female, when other animals, large and small, are capable of reaching their mates in a bee-line, in the darkest night, alone from listening to their cries, without the sympathetic vibration of any system of antennæ having fibrils tuned to two octaves of the pianoforte!

It is true Professor Mayer anticipates this objection, and attempts to meet it by assuming that other animals can turn their heads and shift their external ears so as to catch the direction of the sound by its varying intensity, as first one ear and then the other is employed; just as if a mosquito could not turn its head or its whole body, or shift its antennæ for that matter, in various directions, for the same purpose, —that is, supposing these antennæ to be really auditory organs which take the place of ordinary ears, which they may be, but which I neither affirm nor deny. Professor Helmholtz, in maintaining the unisonant vibration of such auditory hairs, claims their office to be the same in these lower animals as the Corti rods are in the higher species. But all this reasoning is forced, and falls vastly short of meeting this mosquito problem, since a hawk, by the sense of hearing alone, without external ears to shift, by simply turning its head or body to determine the proper line, can direct its course to within a good deal less than *five degrees* of the singing bobolink, as it often does this when its prey is completely hidden from sight by dense foliage. Yet C. Hasse, the eminent histologist and microscopist, assures us, as already quoted, *that the ears of birds are entirely destitute of Corti's rods!*

Thus, the "discoveries" of Professor Mayer, which he says "I imagine are entirely new," are proved to be "entirely" worthless, since a male mosquito ought to be able to hear the female and find his way to her in the dark without the unisonant vibration of its fibrils, if a hawk can perform as difficult a task without either antennæ or Corti's rods to vibrate sympathetically!

Instead of allowing the male mosquito to hear sound, in a common-sense way, by the direct action of the sonorous pulses falling upon his auditory organs, whatever they may be, and thus directly communicating the sensation, as to the direction of the sounding body, to the nerve-center, Professor Mayer complicates the whole process immensely, and more than triples the amount of geometrical calculation which this insect is obliged to make over ordinary animals before it can determine,

after a sound-pulse strikes it, which way to steer! As proof of the correctness of this statement, see the last citation, in which this eminent authority assures us that the sound of the female first shakes, by sympathetic vibration, a properly tuned fibril on one of the male's antennæ which happens to be turned in the direction of such sound. The male culex, perceiving this sensation of the vibratory motion of that particular fibril, first locates it properly on this antenna, and then commences a course of geometrical calculation to ascertain which way to turn his body in order to allow the properly tuned fibril on the other antenna to receive a like sympathetic impulse. After this has been telegraphed to and from the nerve-center of the insect, the turning process commences, the mosquito in the mean time noting the gradual bringing into equal sympathetic play the properly tuned fibrils of both of the antennæ, and, by a difficult mechanical and mathematical course of reasoning, finally determines the exact point in the circle, "when he has brought the vibrations of the antennæ to *equality of intensity*"! When the two unison fibrillæ are thus made to vibrate with "equality of intensity," the fact is again communicated through this system of nerves to the seat of intelligence, where the operation is analyzed, and the decision then transmitted through another set of nerves to the muscles and ligaments of the wings, which finally put into execution the complete result of the routine of ganglionic processes, by which the insect is enabled to guide "*himself to within* 5° *of the direction of the female*"!

Now, if all this mechanical and geometrical ratiocination and acoustical analysis, and all this repeated telegraphing back and forth through different systems of nerves, must be gone through with by a male mosquito before he can determine within five degrees "the direction of the female," when a hawk can instantly fix the direction of an object it seeks by simply hearing its sound, without any unisonant vibration whatever, either of antennæ or Corti's rods, I am at a loss to see any practical or rational purpose in this almost infinitely more complex and ingeniously constructed organism of the culex, unless it be the work of an intelligent Creator, designed especially to convince physicists and naturalists of His existence!

Would it not be a much more reasonable assumption than this supposed sympathetic action of fibrillæ, though perhaps not so "entirely new," that one mosquito finds another in the dark by the sense of *smell*, on the same general principles by which it directs its course within the hundredth part of a degree toward the tip of a sleeping man's nose? If it could be shown by Professor Mayer that mosquitoes only annoy sleepers who *snore*, it might tend to corroborate his *unisonant* hypothesis! But the strict impartiality of such nocturnal visits, and the known capacity of the culex genus for finding almost any exposed square inch of a man's body, however dark the night, independently of any such directing unisonant capillary apparatus as sympathetically vibrating fibrillæ tuned to two octaves of the pianoforte, go strongly to demonstrate the inutility, to say the least, of any such a harp of a thousand strings in aiding this dipterous proboscidian to find his musical mate!

But if a mosquito determines the direction of a sound by the sympathetic vibration of certain fibrils on one or both of its antennæ, as Professor Mayer supposes, I would like to inquire of this high authority *how the insect knows when a particular fibril has been put into motion?* It surely does not *hear* it vibrate, for that would imply that it had an auditory apparatus inde-

pendent of these fibrillæ sufficient for all practical purposes. It can not *see* such vibratory motion, for this is supposed to take place in the dark. Besides, if the male culex could see the motion of one of his own microscopical fibrils, he ought to be able to see the female! He must, therefore, depend alone upon the sense of *feeling* for a knowledge of this vibratory motion, whenever it occurs, as Professor Mayer would no doubt admit.

Now, to *hear* by *feeling* is about as anomalous an operation, and about as much a perversion of Nature's laws, as to *see* by *smelling*, or to *taste moonshine!* Aside, however, from this novel and absurd transformation and metamorphosis of the five senses, it is evident, if the motion of any particular fibril is *felt* by the mosquito, that such fibril must have a *tactile nerve* passing through it; and as there are several hundreds of these fibrils projecting from the antennæ of a single mosquito, it involves the enormous and extravagant waste of Nature's most precious materials in thus distributing hundreds of nerves belonging to one sense for the sole purpose of accomplishing the work of another! Why should Nature arrange four hundred tactile nerve-branches, extending through these fibrillæ, for the purpose of communicating to the ganglionic center of this insect the sensation of tone by feeling, when a single *auditory nerve*, properly brought to the surface of some part of the male mosquito's body, would have been amply sufficient to receive the substantial sonorous pulses of the female's music, as the corpuscular hypothesis so rationally supposes?

Such an operation as this is surely no more wonderful nor inconceivable than the analogous fact, which Professor Mayer can not ignore, that this same mosquito has evidently located on some part of its head or body an *olfactory nerve-membrane* which is capable of receiving the almost infinitely attenuated corpuscles of odor emanating from some other living animal, by which the sensation of *smell* is instantly transmitted to the seat of intelligence, and there translated not only into the knowledge of the proper *direction* of the odorous body, but is also resolved into such information as enables the insect to decide the *character* of the object smelt, whether it is favorable or unfavorable to its sanguiniverous appetite, *without any vibratory motion whatever!*

These two senses of *smell* and *hearing* are thus more than ordinarily analogous. I insist that, to a logical philosophical mind, the bare fact of imponderable and infinitesimal granules of odor, by simple contact with an olfactory nerve-membrane, being capable of conveying definite and complex intelligence to the brain of a living creature, *without any oscillatory motion of the air or of such nerve-membrane*, ought to be regarded as proof positive that acoustical impressions are made upon their appropriate nerve, and conveyed through it to the seat of intelligence in a similar way,—by the absolute contact of substantial sonorous corpuscles, without the aid of vibratory motion!

How it is possible for a thoughtful scientific investigator, after the subject has been brought to his attention, to believe, as he is obliged to do, in this manifest and acknowledged action of *odor*, and grasp the beautiful and consistent manner in which its impressions are received and analyzed, alone by *corpuscular contact*, and then instantly trample down all analogy and uniformity in Nature's laws by abandoning corpuscular action and resorting to *wave-motion*, requires more than human ingenuity to divine! It seems to the writer that this analogical consideration, when prop-

erly investigated and understood, ought to be alone sufficient to overthrow the wave-theory of sound, and at once to establish in its stead the *corpuscular hypothesis* as the only consistent solution of sound-phenomena, unless we admit that logic and reason have been banished from the earth.

Professor Tyndall refers approvingly to the course of reasoning by which an able physicist, in the time of Sir Isaac Newton, logically met and overthrew his emission hypothesis of light, and by which, as a strong analogical argument, the undulatory theory of light was aided if not finally established, till Newton himself was compelled to accept and advocate it. It was in this way: Let it be first understood that there was not a single scientist at that time who questioned the truth of the *wave-theory of sound*. Such a thought had never occurred to Newton or to any one else, so far as history records. Hence, the wave-theory of sonorous propagation was accepted, as a matter of course, as true science and as common ground upon which no dispute or even doubt existed. The argument, then, against the emission-theory of light was like this: Is it reasonable that *sound*, the first sensation above *odor*, should depart from the law of corpuscular contact and be produced by wave-motion, as all admit, and then that *light*, the next sensation above sound, should abruptly return to this same law of corpuscular contact which governs smell, rather than continue on as an undulatory motion of some sort of attenuated substance such as *ether* was assumed to be? On the basis of the wave-theory of sound being admitted as science, this logical mode of reasoning was simply irresistible. Newton and his coadjutors could not withstand it, and hence the *emission theory* of light fell to the ground, as it ought to have done with such scientific data as a foundation.

But think of the disaster which would have befallen his antagonists, had Newton been able to grasp the beautiful and harmonious consistency of Nature's laws, and to have hurled back upon their heads their own inevitable logic, re-enforced by the corpuscular hypothesis of sound? By simply appropriating their own argument, strengthened by a single modern improvement, he could have not only prevented the destruction of his emission-theory of light, but could have at once established the corpuscular theory of sound, thereby framing a consistent and uniform continuity in the nature and mode of operation of all the senses, from the lowest to the highest, as so fully illustrated at the close of the fifth chapter.

The time, however, had not yet come, and the age was not yet sufficiently ripe, for so radical and revolutionary a move as the overthrow of the universally accepted wave-theory of sound, and the establishment of the corpuscular hypothesis upon its ruins. I can not believe, from the arguments and considerations massed in this review, that it would be manifesting unjustifiable confidence in their unanswerable character, to assert that the time for such a scientific revolution has at last come; and that, could the great Newton be permitted to look down from his higher sphere upon the progressive strides scientific investigations are making, and behold the tables turned upon the logic which trailed the banner of his emission-theory in the dust, he would now have his revenge.

NOTE ON THE TELEPHONE AND PHONOGRAPH.

Since the publication of the first edition of this treatise on Sound, in 1877, inquiries have been made as to whether the Telephone and Phonograph do not conflict with the new departure and favor the wave-theory? I answer no; but they rather tend to confirm the view here taken, that sound must be a substance of some kind, and consequently that it cannot be accounted for as the undulatory movement of the air or other conducting medium.

In the first place, in undertaking an explanation of these remarkable instruments, it is necessary to call attention to the obvious distinction, so frequently referred to in the preceding pages, between the incidental *air waves* sent off by a sound-producing body, such as the vocal organs and the *sound-pulses* themselves. These sound-pulses, as I have tried to show, are generated by the molecular action, which occurs in the rapid vibratory motion of the sounding instrument (see page 93), and are then propagated through the air, by *a law of conduction peculiar to sound*, as electricity (another substantial emanation,—not wave-motion—) is conveyed through a wire by an analogous law of conduction—not *driven* through it by the motion of the battery or dynamo machine, as sound-waves are supposed to be *driven* through the air by the to-and-fro motions of the tuning-fork's prongs!

Synchronously, however, with each vibration of the sounding body and each sound-pulse thus generated, there is also generated and sent off an air-wave which is driven to a limited distance proportioned to the force of the vibrating instrument. These air-waves, however, as I show, have nothing to do with the accompanying sound-pulses, being only incidental to the production of sound as the generation of *heat* in a dynamo machine *is incidental to the generation of electricity*, but no part of the electricity generated. Such air-waves, therefore, must necessarily correspond in force and rapidity to the strength and rapidity of the vibrations, and consequently to the intensity and pitch of the sound. Hence, in talking in close proximity to the diaphragm of a phonograph, it is readily understood that these air-waves, impinging upon the diaphragm, cause it to vibrate with a rapidity and force corresponding to the rapidity and force of the accompanying sound-pulses, thus producing a record of indentations in the tin foil; and when the needle of the phonograph is again passed over the line of indentations it causes the diaphragm to reproduce vibrations similar to those of the sounding body which originally produced the record. Thus the very tones of the voice, as well as the words spoken, are reproduced. This explanation entirely accounts for the action and effect of the phonograph without involving any such scientific fallacy as air-waves themselves constituting the sound-pulses. As well might an electrician assert that the *tremor* of the electro-dynamic machine and its consequent *disturbance of the air* constitute the electric current which produces the light! The one is but incidental to the other.

But the phenomena of the *Telephone* are entirely different. It is true its diaphragm may vibrate when spoken to with force, as does that of the phonograph; but such vibratory motion is not necessary to the conveyance of a message through the electric wire. It has been proved by Dr. R. M. Ferguson, Ph.D., F. R. S., the eminent Scotch physicist, as published in the *Scientific American Supplement*, No. 120, and also by Count Du Moncel, the renowned French electrician, as published in his work on the Telephone, that the action which is conveyed from the Telephone through the electric conductor, and which is heard at the receiving instrument, must be regarded as "*molecular*," since the most refined observation shows no vibratory motion whatever in the receiving diaphragm. In fact both these high authorities have shown that no diaphragm is necessary, either at the receiving or transmitting end of the line, since *messages have been sent by speaking against the naked poles of the magnet*, and heard at the receiver without any diaphragm or other body capable of vibration. Hence, they have recently announced to the scientific world that the theory of sound will have to be reconstructed, since *molecular action* of some kind is forced to take the place of the supposed vibratory motion in the Telephone. This is no doubt correct, as far as it goes, but we may reasonably expect that these eminent scientists will go still further, and in due time make another announcement, that the entire *wave-theory* will have to give way to the molecular and corpuscular hypothesis.

As sound-pulses are thus shown, by the highest authorities on the subject in Europe, to pass through the electric conductor without wave or vibratory motion, I may safely claim one-half of my new departure as accepted, and for the remaining half it will only be necessary to arrive at a better understanding of the correlation and interconvertibility of these incorporeal substances, such as sound, electricity, light, heat, etc., and we will readily comprehend how substantial sound-pulses, spoken against the magnetized transmitter, may combine with the substantial electric fluid, and thus be conveyed in its embrace, so to speak, to the distant receiver without the assistance of any corporeal movement whatever of the wire, magnet, or diaphragm. This view of course involves *molecular* motion, not of the material substance of the magnet or wire, as these physicists have hastily supposed, but rather the molecular and corpuscular motion of the two blending and correlated substances—*sound and electricity*—the only active substances involved in this operation. The explanation thus given is not only consistent with the phenomena in question, but it fully corroborates the view of sound taken in this monograph, as any one can see who will take the trouble to read it.

ADDENDA TO CHAPTER VI.

EVOLUTION OF SOUND ASSAILED.

This work on sound has been published more than two years, and no attempt at reply has been made, with the single exception of the following Review by Prof. R. L. Brockett, A. M., Professor of Physical Science in Western Maryland College. The criticisms of this scientist were called out at the request of Rev. Dr. L. W. Bates, of Lynchburg, Va., who sent a copy of the work to him requesting his examination and opinion. The following extracts from that opinion were sent to us by Dr. Bates, and at our request the author wrote a reply, all of which are given herewith.

In connection with this review and rejoinder, we take the liberty to print also the critical observations of a very careful investigator, Prof. I. L. Kephart, A. M., for five years Professor of Physical Science in Western College, at Western, Iowa, with the author's answers and the Professor's final acquiescence, which, it is believed, will throw some light on the subjects discussed in Evolution of Sound.

It is readily comprehensible that even an able scientific investigator, like Prof. Brockett, might be mistakenly led to reject such a radical departure, opposing, as it does, a theory of science never before called in question, and one which his long habit of teaching had made almost a part of himself. But it is insupposable that an equally competent critic, and with equal experience, facilities and prejudices, like Prof. Kephart, for example, after studying the treatise for months, should *mistakenly* give it his unqualified indorsement. This distinction in the weight of testimony, between the rejection and approval of a new hypothesis in science, would seem to be self-evident.

Among the many professors of physics, whose testimony is unequivocal in favor of the new hypothesis, we take the liberty of naming Professor L. M. Osborn, LL.D., Professor of the Physical Sciences in Madison University, at Hamilton, N. Y., who closes a recent letter to us in the following words:

"The part on sound I prize very highly—a new departure that must be *permanent*, and lead to many modifications of old notions.

L. M. Osborn."

Such decisions as this are not negative, but positive. Hence they carry with them the weight of unquestionable reliability.

We will only add that, although this treatise has been for nearly two years in the hands of the three eminent authorities on sound (Tyndall, Helmholtz and Mayer) reviewed by the author, yet no attempt at reply on their part has thus far been made. This silence cannot be construed to imply that the arguments are regarded by them as too trivial to be considered worthy of notice, particularly in view of their unconditional *approval* by so many college professors whose ability to judge correctly upon this subject surely entitles them to some respect. It can only imply, in the opinion of one professor who has abandoned the wave-theory of sound, that these authorities on acoustics, realizing the unpleasant predicament of accepting the new hypothesis and thereby admitting their own exhaustive treatises on the subject without foundation, have adopted the policy of silence, hoping that by ignoring the whole matter as if it had no existence, the author's obscurity would allow the work to fall still-born, and in this manner prevent a sensation in the scientific world, such as the total destruction of a universally-accepted theory must necessarily produce. Whether or not this view of the animus of these eminent scientists is correct, it will not be an easy matter to convince thoughtful investigators that such a revolutionary departure in science, as this monograph, is unworthy of reply, especially arguments which can command the approval of experienced professional acousticians. We ask students of science to read and weigh these arguments, and then judge for themselves if the wave-theory of sound has not seen its day?

Publishers.

Professor Brockett's Review.

"I have carefully read it [*Evolution of Sound*], —given it much and close examination,—and my conclusions are that the book, as an argument against the undulatory theory of sound, is an utter failure. It is ingeniously written, is certainly the work of a man who has a thorough knowledge of the subject, but who covers up his weak points with a great flow of language, and makes so many bold utterances about overwhelming his opponents, that readers who are not *au fait* in the science of acoustics are apt to be misled. His hypothesis of corpuscular emissions is exceedingly defective, and requires so many modifications to meet particular cases, that it needs only to be stated to enable one to find insurmountable objections. 'Wilford' himself admits that there are difficulties, but consoles himself that it is the only refuge, the current theory being overthrown.

"The greatest objection I have to the book is, that the author uses the accurate knowledge he possesses, (for what reason I can not tell) to teach error. This is a charge no one should make without proof. Let me produce it. In the first part of the 'Review,' where he labors to show that the pulsations of a sonorous body do not and can not disturb the air as acousticians claim, and illustrates by showing that he could not, in a closed room, with a fan, cause a gas light to flare twenty-five feet off, under five seconds of time, and with all the effort of 'one-man power'; and, in a triumphant way, asks how the prong of a tuning-fork could throw off air-waves, when it only moves eight inches a second, and set in motion another tuning-fork 180 feet off tuned synchronously, while his fan moved over an arc of seven feet and could not cause air-waves to be felt only twenty-five feet [away], and then only after a lapse of at least five seconds.

"Now there is no analogy whatever between the motion of a tuning-fork and that of the fan, and he must have known it. The fan moves seven feet and the fork eight inches, he says, in a second; and his argument is that as the air, by its mobility, moved around and closed up so easily after the fan as not to disturb the rest of the air, that it is impossible to believe that the tuning-fork, that moves only eight inches in a second, could disturb the air at all. Let us consider this. All air-waves are not sound-waves. When we wave our hand, or move a fan, or in any other way move the air, we produce air disturbances or waves; but *sound waves* are only produced by the motion of *elastic bodies giving instantaneous pulses*. It is true that the prong of the fork moves only eight inches in the *aggregate*, in a second; but in that time it makes 384 *pulses*, *every one* of which *produces a sound wave*. His fan, with the 'one-man power,' can only disturb the air, and can not produce a sound-wave, *because it* (the fan) *is not elastic;* and, if it were, even his 'one-man power,' without the aid of machinery, would not be able to give the *requisite velocity* to produce a *sound*-wave. His fan makes one vibration or pulse while the fork-prongs make 384; the one disturbs the air by moving *slowly* through it, which disturbances are easily adjusted by the mobility of the particles; while the other, by its *instantaneous* pulses, sets in motion *sound*-waves. that pass from the elastic
all directions. Hen
when they say the prongs of the fork advance *rapidly;* and he tells us that this rapid advance is only eight inches in a second, falls short of the mark. Is not 384 pulses or vibrations rapid motion?—and is not one pulse of seven feet per second slow motion in comparison? If Wilford wished to state the case fairly, he would not have put it as he has. He knew better. * * * * If every movement of the air produced a sound-wave, we would live in a bedlam, and your congregation would not be able to hear you preach while the ladies were using their fans; nor does this motion of the fans interfere with the sound-waves from your voice, and their rapid motion is but slightly affected even by a strong wind.

"Wilford does not seek to tell us what a sound-wave is. He makes extracts from acousticians, and calls on his readers to observe that he is very fair; but, if you will examine the quotations, you will see that his purpose is to pick out a sentence here and there, and interpolate occasionally some qualifying remark; * * * * not to present the matter fairly, but to overthrow the current theory at whatever expense. * * * * *

"A sound-wave is produced by an instantaneous vibration or pulse of an elastic body, as a music-box, when playing under a receiver and pump out the air, *the music will cease*, or rather we will not hear it, but will be *heard again* when *the air is let in*. In like manner, by observation, we know that the air-wave is a sphere—like a soap-bubble,—because we hear the sound in every direction from the sonorous body. Having, then, these two points as data, and connect with them the known fact that only instantaneous pulses will compress the air suddenly and constitute a sound-wave, we find, then, that at every pulse of an elastic body a spherical globe of air is made at the body, that vibrates to and fro, but does not advance; but, owing to the structure and properties of the air, not necessary to enumerate here, this sound-wave sets in motion—forms—another sound-wave, and it another, and so on, sometimes to the distance of many miles. When, then, we hear the sound of a bell miles away, or the whistle of a locomotive, it is not the sound-wave, that was made at the place where the bell or the locomotive is, but it is the sound-wave made of the air where the listener is. * * * It is not the air that has traveled over the intervening space that strikes the tympanum of the listener, but the air around the listener that has been set in motion hy the advance of the series of sound-waves, which stops only when their force has been expended. This rapid advance of the *form* of the wave is the reason that winds affect so little their progress; besides, elastic fluids, as air and gases, pass in currents through each other without creating but little disturbance.

"Now, any one can see that if these waves are made as claimed, the air all around the circumference of the sphere must be compressed, and the air of the interior must be rarefied. Sudden compression of the air causes heat, and rarefaction causes low temperature. This I can show you with a piece of apparatus belonging to the college, by means of which I can compress the air, and ignite tinder, causing it to burn freely; and yet Wilford has the hardihood to use ridiculous phrases in alluding to these condensations and rarefactions, as if they had no existence in fact.

"All of our experience goes to show that the

distance sound travels, and the distinctness with which we hear it, depends entirely upon the condition of the air. The more homogeneous the air is, the better medium is offered to the progress of the sound-wave. As we ascend through the air, the sound grows feebler; and at the tops of very high mountains, pistol-shots are no louder than pop-guns make at the base.

"But, besides all this, and a plenty more that might be written, the undulatory theory of sound is established mathematically. All the phenomena of sound have been examined in connection with the current theory and mathematical formulas have been applied in the most rigid manner; and, in every instance (sometimes correcting error, however), the theory has proved sufficiently able to meet every case.

"His cheapest game would have been to apply his hypothesis to the phenomena of light, because it will give, in some instances, a plausible explanation; though many of the phenomena—notably that of refraction—it does not and can not explain; and even Sir Isaac Newton, the originator of the corpuscular theory of light, admitted his theory did not satisfactorily account for the phenomena. * * *

"I find Dr. Drinkhouse [editor of the *Methodist Protestant*, Baltimore, Md.] has commented favorably upon the part entitled *The Problem of Human Life*. I do not know anything about that part of the book; but if he expects any help in his Problem, by showing that sound is made of corpuscles of matter, I fear his solution of the Problem is not a correct one."

Wilford's Rejoinder.

OFFICE OF HALL & CO., }
NEW YORK, Jan. 23. }

REV. DR. BATES.

Dear Sir: Your letter to Hall & Co., inclosing copious and verbatim extracts from Prof. Brockett's review of *Evolution of Sound*, was handed to me for my examination and reply. Allow me to thank you for the interest you have taken in securing so competent a scientist to review the work, and one, too, who has proved himself not afraid to risk his reputation as a physicist and acoustician on the venture he has made; and I here place it to his credit that he is the first scientific investigator who has shown a willingness to attack these arguments against the current sound-theory, though the monograph has been in the hands of hundreds of professors of physical science and scientific journalists for months.

I must say, however, in all frankness, that I am surprised, no less than gratified, to know that this is the best that can be done in favor of the wave-theory, and the worst than can be said against *Evolution of Sound*, by a skillful professor of physics. That he has done his best to convince you "that the book, as an argument against the undulatory theory of sound, is an *utter failure*," there can be no doubt; and the very fact that he has "*carefully read it*,—given it *much* and *close examination*,"—is conclusive on its face that had there been weaker or more vulnerable points to assail, he would have selected them in preference to the line of argument chosen. Hence, in meeting this assault, I shall feel that I am not wasting my time on matters of trivial importance.

But first, let me say, I forgive the Professor for his personal and unkind thrusts, virtually charging the author, though admitting his "thorough knowledge of the subject," with positive dishonesty in using "the accurate knowledge he possesses * * * *to teach error*," and who "covers up his weak points with a great flow of language," in order to mislead the readers of his book, "who are not *au fait* in the science of acoustics," even accusing him with misrepresenting the authorities he quotes by a purpose to "pick out a sentence here and there, and interpolate occasionally some qualifying remark: * * * *not to present the matter fairly*," etc.

Although I forgive, I will not forget; and will only say here that I defy any man to place his finger on a single quotation in the hundreds made in *The Problem of Human Life*, including *Evolution of Sound*, which does not fairly represent the meaning of the author cited. An educated man ought to know that explanatory interpolations, thrown into a passage quoted, are entirely allowable, to save quoting the context or to avoid much longer explanations afterward, provided such interpolated remarks are duly *bracketed*. But enough of this.

I now come to the subject-matter of the review, and I am only stating what you, no doubt, have already observed, when I say that the entire argument is devoted to a single phase of the sound-question; and, though variously elaborated, involves but one assumed principle or law of science, namely, *that there are two kinds of air-waves*, differing from each other in the most essential characteristics,—one kind, such as those produced by a *fan*, traveling only about five feet in a second and only capable of reaching to a distance of twenty-five or thirty feet in a still room; and another kind, called "sound waves," produced by the motions of a tuning-fork's prong or other vibrating sonorous body; and of such an entirely different nature that they are capable of making headway through the atmosphere at a velocity of 1120 feet a second, and to a distance, often, of many miles.

The reason for Professor Brockett's selecting this phase of the discussion, and devoting his entire review to it, is apparent. This law of *two kinds of air-waves*, with the essentially different characteristics just pointed out, lies at the very foundation of the wave-theory of sound, and without which it would have no existence, as every tyro in science knows; and this law being seriously assailed in *Evolution of Sound*, he saw that unless it was rescued from the attack, the whole undulatory hypothesis must fall to the ground. Hence, he chose to direct all his force to this single aspect of the question.

I make no objection to the way he states my argument based on the *fan* experiment; and I only wish to impress the fact upon your mind that he *admits*, as he is necessarily obliged to do, the result of that experiment as I have given it, namely, that the waves thus produced travel only at a very slow speed, say about five feet in a second, and to a distance of only about twenty-five or thirty feet in a still room; while he attempts to account for it by saying: "His *fan* makes one vibration or *pulse* while the fork-prongs make 384; the one disturbs the air by moving *slowly* through it, *which disturbances are easily adjusted by the mobility of the particles*, while the other, by its *instantaneous pulses*, sets in motion *sound-waves*."

As he has thus admitted the correctness of my explanation of the fan experiment, I now propose to show that it is the *fatal* though *unavoidable* admission of his review, and that by it alone he has annihilated the wave-theory of sound, as well as his entire argument, for, by this admitted fact of the fan sending off air-waves at a very low velocity, it will be conclusively proved that the so-called "instantaneous pulses," or motions of the tuning-fork's prong, to which he so repeatedly calls your attention, can not by any possibility send off air-waves any swifter in proportion to their own rate of velocity than can the motions of the fan. He has selected the battle-field after "much and close examination," and upon it shall the battle be fought.

My first appeal shall be to logic and reason, without any special reference to this review, but only as relates to the improbability of the existence in Nature of any such essentially different varieties of air-waves as the theory requires; after which I will give the positive proof, in various ways, that such different varieties of air-waves can have no existence in fact.

It is well known to every student of physical science that sound travels through all solid and liquid bodies with even greater velocity than through air. Professor Tyndall says:—

"The velocity of sound in *water* is more than *four times* its velocity in air. The velocity of sound in *iron* is *seventeen* times its velocity in air. The velocity of sound along the *fiber of pine wood* is *ten times* its velocity in air."—*Lectures on Sound*, p. 47.

Let us now see how this *law* of two different kinds of air-waves, upon which the very life of the wave-theory depends, will behave, when we try to harmonize it with the propagation of sound through *water* and *iron*. But before testing it thus, I wish barely to call your attention to this most suggestive fact, that in all the published works on sound not one single writer has ventured to discuss the nature of this indispensable wave-motion in water, iron, and other solid and liquid bodies. They cautiously steer entirely clear of these ugly questions of "condensations," "rarefactions," "wave-lengths," oscillations "to and fro" of the wave particles, and "superpositions" of a number of systems of waves at one time passing through iron, although they talk and write learnedly and confidently enough of all these things taking place in the passage of sound through air. Why this apparently studied silence in relation to sound-waves in water and iron, when these writers know very well and admit that sound travels with greater facility and with many times greater velocity through them than through air? I will tell you the reason, whether they think of it or not. Air is *invisible;* and it becomes entirely convenient to fabricate and formulate all this scientific nonsense about atmospheric "condensations," "rarefactions," "oscillation of the particles to and fro," "superpositions," etc., as the absurdity of the thing can not be detected, since the atmosphere can not be seen. But should they attempt to apply their philosophy of amplitude, or "to and fro" motions of the particles to iron, or even water, where the particles are visible under the microscope, they must know, if they reflect at all, that the shallow deception would be exploded, and that all this pretended wave-motion as the principle of sound-propagation would be at once demonstrated to have no existence in fact. But as long as they can keep us away from *iron*, or anything we can examine with the microscope while sound is passing through it, and confine our attention to a substance like the air that can not be seen, there is no end to their rhetoric about this "*spherical globe of air*" "like a soap-bubble," as Professor Brockett expresses it, which forms in a circle all around the tuning-fork!

What a pity that some one of his students should not request him to give an ocular demonstration of his theory of air-waves by generating a "spherical globe" of *iron* or *water* "like a *soap-bubble*," and let them look at it under the microscope! These *bubbles* ought surely to form in *water* and *iron*, if they do in *air!* But there is not the least danger that advocates of the wave-theory of sound will ever perpetrate such a folly as even to allude to these little *globes* and *spheres* caused by sound in connection with any substance that can be seen, knowing, as they must, that such a legitimate application of their philosophy to visible bodies would instantly explode the "soap-bubble" fraud, and turn the whole wave-theory into ridicule!

But now let us try to test the truth of this theory in *air*, by applying it to *water*. First, then, I state the logical and incontrovertible principle, which no one will question, that if *air-waves* constitute *sound-waves* in *air*, then *water-waves* constitute *sound-waves* in *water*, and *iron-waves* constitute *sound-waves* in *iron*. One has no need of a scientific education to comprehend or see the force of this logical truism. Then, as *sound-waves* in water must be *water-waves*, just as sound-waves in air must be air-waves, it involves the unavoidable necessity of two kinds of water-waves, the same as Prof. Brockett's two kinds of *air-waves*,—one kind slow (from two to thirty feet a second), and the other kind fast (4,500 feet a second),—one kind *visible* and the other kind *invisible*, even under the most powerful microscope,—one kind with an *amplitude* or depth of furrow equal always to *one foot* for every *ten feet of wave-length*, while the other kind is devoid of all amplitude, not even enough to be observed under the microscope, since no motion of the water-particles "to and fro" takes place by the passage of sound, and hence there are no waves, because such a thing as a system of waves without amplitude is as absurd as to talk of a *rainbow* without a *curve*.

But here the wave-theory of sound runs against an inexplicable difficulty, and one that hopelessly crushes it. In *Evolution of Sound*, at page 318, and elsewhere, I quote from the highest living authorities numerous passages declaring that *sound-waves* are "essentially identical" with *water-waves*, are "precisely similar" to them, and travel "exactly in the same way." These are the very words of an authority no less than Professor Helmholtz himself, the greatest living exponent of the wave-theory of sound. But, mark you, he said this with reference to *atmospheric* sound-waves, the thought never entering his mind at that instant, that sound passes through *water* with much greater facility than through air, and consequently should have much more distinctly marked waves! Had this idea flashed across his mind that sound passes through water,—and that, too, in the form of waves,—he would instantly have seen the ridiculous plight in which he had, unwittingly, involved the entire wave-theory; for if sound-waves in air are "essentially identical" with water-waves, and if they are "pre-

cisely similar" to them, and if they travel "exactly in the same way," then sound-waves in water must also be "precisely similar" to water-waves, must be "essentially identical" with them, and must travel "exactly in the same way;" and hence it follows, monstrously absurd as it is, *that sound-waves in water are nothing more nor less than water-waves!* This is inevitable, if there is any meaning in words. And thus we not only annihilate the wave-theory of sound both in air and water, but we upset all science in regard to the velocity of sound in different substances. Observation assures us that all sounds travel through water at the uniform velocity of about 4,500 feet a second, whether such sounds are of the highest pitch, having a theoretic wave-length of only *one foot*, or are the low notes of the piano, with theoretic wave lengths in water of over one hundred feet. But here comes Prof. Helmholtz, who authoritatively denies this feature of science, and declares that sound-waves travel "exactly in the same way" as water-waves!

What, then, is the result? Why, simply that all observation in regard to the velocity of sound, whether in air or in water, is wrong from beginning to end; for, as sound-waves travel "exactly in the same way" as water-waves, there ought to be no uniformity at all in the velocity of sounds of different pitch, and consequently of different theoretic wave-lengths, because it is overwhelmingly established in *Evolution of Sound*, for the first time in any scientific work, that the *velocity* of all water-waves must vary, by the necessity of wave-motion, in exact proportion to the *wave-lengths* of any given system,—the small waves of one inch wave-length, caused by the falling of drops of water, traveling only two feet in a second; those caused by a passing steamboat, with ten feet wave-length, traveling seven feet in a second; while ocean billows, with thirty to one hundred feet wave-lengths, travel from fifteen to thirty feet a second. (See pages 317 to 326.)

This single consideration, therefore, without the aid of another proof, overthrows the wave-theory of sound in air as well as in water, because in the only wave-motion we can see and measure, we find that an immutable law prevails, namely, that the velocity of all waves is variable and in proportion to wave-length, while sounds, whether high or low in pitch, have but one uniform velocity in any one substance, thus demonstrating that sound does not travel by wave-motion at all.

I will here venture the assertion that Professor Brockett never read this argument at all, notwithstanding his "much and close examination;" for, if he had, he would have been totally confounded by the fact that the very nature of wave-motion flatly contradicts the wave-theory of sound.

But I have not yet reached the culmination of these logical and common-sense reasons for rejecting air-waves as the principle of sonorous propagation, nor have I touched upon the greatest absurdities which such an assumption necessarily involves. I have already stated the logical fact, that, if *sound-waves in air* constitute *air-waves*, as Prof. Brockett teaches, and as admitted by all writers on the subject, then *sound-waves in iron* constitute *iron-waves*. It is impossible to evade this. Further, as atmospheric sound-waves are formed by "*a small excursion to and fro*" *of the air-particles*, thus constituting their "amplitude," without which air-waves could not exist (see many quotations to this effect, *Evolution of Sound*, p. 78), it follows that *iron sound-waves* must also be formed by "a small excursion to and fro" of the *iron particles*, thus constituting the necessary "amplitude" of *iron-waves*, and without which a "wave" is a nonentity! But as no such "excursion to and fro" of the iron particles occurs in a solid mass of iron when conducting sound, even when examined under the most powerful lenses, and consequently no "amplitude" exists in such supposed iron undulations, it demonstrates that there is no *wave-motion* in iron as the result of sound, and hence that sound must pass through iron by some other law; and if through iron then through air, as there evidently can be no two different modes or principles of sound-propagation through different substances,—one *wave*-motion, and another something else! Hence, the undulatory theory of sound, even in air, breaks down of its own inherent weakness.

Should it be said, here, that in the propagation of sound through iron the particles may move "to and fro," producing the necessary "amplitude" as required in all wave-motion, but not sufficiently to be visible under a microscope, then I answer that such *invisible* and *infinitesimal* motion, even if it occurs, would not constitute sound capable of addressing the human *ear*, because the *eye* is admittedly one of the most refined and sensitive of the avenues to perception; and this being so, these supposed motions of the iron particles, which can be so easily heard by the unassisted ear, should, if they take place at all, be plainly visible to the naked eye! But as this assumed "amplitude" or motion of the particles can not be seen when the sight is magnified a million fold, it is conclusive evidence, on its face, that such motion, if it takes place at all, is a million times too trifling to be heard! Thus, again, does wave-motion in *iron* break down; and with it, as a necessary corollary, wave-motion in *air*. Let Prof. Brockett try his hand on this problem, instead of skipping "here and there" and dealing in glittering generalities.

But it is maintained by Professors Tyndall, Mayer, Spice, and in fact all writers and lecturers on acoustics, that sound-waves can be actually observed to run along an iron bar, if a vibrating sonorous body be held against it. This, however, is only another evidence of a want of thoroughness and critical examination on the part of physical investigators, as will at once appear. There is no question but that a molecular tremor may be detected running along a bar of iron, when a powerfully vibrating tuning-fork is held against it, because this tremor can be felt at a distance of many feet from the fork. But, strange as it may seem, these tremors which are but incidental to the fork's vibration, having nothing whatever to do with the accompanying sound-pulses, are mistaken by physicists for the sound itself, though it is easily demonstrable that such tremor does not travel along the bar at a velocity of one hundred feet in a second, while it is well known that sound itself passes through iron at a velocity of more than 19,000 feet in the same time, or more than twenty-five times swifter than a rifle-bullet. To demonstrate the truth of this distinction, an acoustician needs only to place his ear and hand against one end of a long strip of pine wood, whilst his assistant draws a saw, or other rough instrument, across the other end, and he will find *that each movement of the saw will be heard very distinctly some time before the incidental tremor will*

reach the hand, thus showing that the sound pulses and the accompanying tremor of the wood are two very distinct and separate classes of phenomena. How plain would all this be to acousticians, without an argument, if they could but once recognize this fundamental distinction between sound-pulses themselves, and the incidental air-waves, water-waves, iron-waves, or wood-waves occasioned by the vibrations of the sounding body which occur at the same time! Self-evident as this distinction must be to the mind of every careful investigator, after the thought has been once suggested, yet it is a fact that no writer on acoustics has ever intimated such a thing, till it was first published in *Evolution of Sound.*

Now, to make this matter so plain that a child can grasp it, we have only to modify the experiment of the pine strip, by holding the stem of a large tuning-fork, while vibrating, in a jar of water, and then observe that, while the sound-pulses pass through the water and ring out by the resonance of the table on which the jar rests, without displacing the molecules of the water, the tiny, incidental water-waves, generated at the surface by the tremor of the fork's stem, can be seen passing off in circles all around it. These are the identical incidental waves or tremors mistaken by Professors Tyndall, Spice, and others in the iron bar or strip of wood, which occur nearly simultaneously with the sound-pulses. Acousticians are therefore compelled to look upon these tiny water-waves, which pass off in concentric circles round the stem of the fork, *as the veritable sound pulses generated by the fork, notwithstanding such little waves are plainly observed to travel only about one foot in a second, while sound is known to travel in water* 4,500 *feet in the same time!* There is no escape from this. I assert here, and call upon the reader to witness, that any distinction between these tiny water-waves, caused by the tremor of the fork, and the sound-pulses generated at the same time is entirely impossible according to the wave-theory, *since precisely the same incidental waves in air,* produced by the to-and-fro movements of the tuning-fork's prongs, *are claimed by all acousticians, without one single exception, to constitute atmospheric sound-waves with their "condensations and rarefactions"!* As these incidental water-waves, made by the vibrations of the fork, are the same phenomena, precisely, as the air-wave produced by the same vibrations, and since the former are plainly seen to have nothing to do with the ac companying sound-pulses, it is clear that the latter must be regarded in the same light, merely incidental to the production of sound. Yet simple and manifest as this distinction is, and lying as it does at the very foundation of acoustical science, it remains an astounding fact that it has been wholly hidden from the minds of the physical investigators of the world up to the present time. I claim no credit for having made and first given to the world this superficial discovery, but I do discredit the intelligence of a professional acoustician, or even a tyro in science, who can not grasp such a self-evident distinction the moment it is presented to him. Prof. Brockett fails entirely to recognize it, though it is stated in various places in *Evolution of Sound,* which he had so "carefully read", and notwithstanding his entire argument involved that very distinction.

This same class of phenomena occurs in the sounding board of a piano, against which the vibrating strings have their bearing, thus producing that augmentation of the tones of the strings which we call *resonance.* The board, however, does not vibrate as a whole or bodily, as the wave-theory teaches, in order to send off air-waves. If it did, it could only be at a rate corresponding to its own vibrational number, which, as shown at page 84, would change the pitch of all the strings to the normal pitch corresponding to the board's vibrational swing. The production of sound being *molecular* in the strings (see page 93), its augmentation, by the resonance of the board, *must also result from the molecular tremor of the wood.* Hence, any solid body, such as metal, pressed against the board, checks its molecular tremor and diminishes the resonance. This keeps the distinction clear between the true cause of sound (molecular action) and the erroneous view of air-waves, which would necessarily require the bodily vibration of the sounding board, a thing impossible to take place for all the different strings at the same time, as shown. I may not have been clear on the subject of resonance in the body of this monograph, but the above is what I wish to be understood as teaching.

But I now come to the most startling absurdity, bearing upon this phase of the wave-theory, ever taught as science, though it is an inseparable part of the current hypothesis. I will point it out with some care, and particularly invite to it the attention of Prof. Brockett.

The wave-theory teaches that if the great organ-pipe, which produces the lowest note, (sixteen vibrations in a second, as stated in Prof. Blacerna's recent work), should be sounded in contact with a mass of iron, the tone thus produced would travel through the mass in veritable *waves* or *undulations,* consisting of actual *condensations, rarefactions,* and *wave-lengths.* But what would be the length of such undulations, from condensation to condensation, according to this highly scientific and mathematically formulated theory? I answer—*eleven hundred and ninety feet!* What should be the *amplitude* or depth of *sinus* in undulations having such prodigious *wave-lengths,* according to the proportion which prevails in all systems of water-waves? I answer—*more than one hundred feet,* giving them about three times the magnitude of the largest ocean billows ever seen! Does Professor Brockett believe in these enormous iron billows, with a dimension in wave-lengths of nearly a quarter of a mile from crest to crest, as the result of an organ tone? He certainly does and must, if he believes in the wave-theory of sound, since this is a legitimate deduction from that theory as every candid acoustician will admit; and no wonder Prof. Robert Spice was forced to declare, when the writer laid before him this consequence of the wave-theory, that the idea of such enormous iron-waves, caused by sound, was a manifest absurdity, and hence that the wave-theory itself could not be true.*

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* Since the first edition of this reply to Prof. Brockett was published, I have learned, through a friend who had occasion to interview Prof. Spice, that he now denies having any doubt as to the correctness of the wave-theory, and even denies ever having admitted anything of the kind to me. I regret that I am called upon to say, over my signature, that in more than one conversation with me on this subject, he distinctly admitted that he did not believe in the correctness of the wave-theory of sound, nor the undulatory theory of light, though not prepared to

To a physicist I would not need to waste a single line in proving that, in accordance with the current theory, the organ-tone named must pass through iron by means of these stupendous undulations more than a thousand feet long, as measured from the center of one condensation or crest to the center of another. A professor of physical science knows that it is so, unless he has shut his eyes to the unavoidable absurdities which are the legitimate consequences of this theory. But to students who are "not *au fait* in the science of acoustics" or who are not read up in the mysteries of this *mathematically formulated* hypothesis, it may not be so plain. It shall therefore be proved in a single paragraph.

If we divide the distance sound travels in a second by the number of vibrations any sounding body makes in a second, we of course determine the wave-lengths of that or of any other sound of a given pitch, since the pitch of any tone is caused by the number of vibrtiaons of the sounding body in a second which produces it,—while, according to the theory, each vibration sends off a wave, whether in air, water, iron, or whatever other conducting medium. Now, as sound travels in air, at 60 degrees Fahrenheit, 1120 feet in a second, and seventeen times swifter in iron, it must therefore have a velocity in iron of 19,040 feet in a second, which, divided by 16, the number of vibrations of this low organ-tone in a second, shows the wave-lengths, of a sound of that pitch in iron to be *eleven hundred and ninety feet from crest to crest*, as just stated, and as any one can verify. This is a fair specimen of the beautiful theory I have the honor of opposing!

But the most startling feature of this "scientific" hypothesis remains to be stated. It presents us with the anomaly of iron *undulations*—actual *waves*—nearly twelve hundred feet long from crest to crest, but without an *amplitude* or depth of *furrow* of *even the one millionth of a hair's breadth!* One would really think that a professor of physical science, competent to retain a chair in a respectable college, would be ashamed to have the students know that he was capable of believing in a theory which involves and necessarily teaches such a monstrous impossibility as that a certain sound passes through iron in actual *waves* or *undulations* eleven hundred and ninety feet from crest to crest, and then stultify himself and the theory by admitting, as he is forced to do, that such stupendous undulations—four times the size of the largest ocean billows—are devoid of all *amplitude*, the only thing that constitutes an *undulation!* Surely such absurd nonentities as these can not be called "waves," for, in the name of Webster's Dictionary, what is a *wave* with the *amplitude* left out?

In concluding this part of the inquiry, I now ask intelligent, common sense, thinking men, to tell me if such hypothetic philosophical monstrosities as these iron undulations without amplitude, can be scientifically or rationally called "*waves*"? If not, then sound manifestly travels through *iron* by some other law than *wave-motion;* and if through *iron* then through *air*, since, as just remarked, even Prof. Brockett, with all his "hardihood," would not venture to claim two distinct principles of sonorous propagation through different substances, lest he might thereby involve his "mathematically" formulated theory in the necessity of accounting for a separate mode of travel for every known substance.

I now come directly to the consideration of Prof. Brockett's criticisms, in the course of which I have promised to produce *positive proof* that air-waves sent off by the motion of a tuning-fork's prong can not, in the nature of things, travel any faster than can the air-waves sent off from a *fan*, or even from a *stick* of the same size as the prong, and moving through the air with the same velocity; and, in doing so, I will of course shatter the wave-theory of sound, since there can, in that event, be no air-waves corresponding in velocity to sound-pulses. I ask you to carefully note the following considerations.

In *Evolution of Sound* I make the assertion, and claim to have established its truth by many illustrations, that it is not possible for even the most skillful advocate of the current theory of sound to touch the hypothesis with his pen and write a single page in explanation of its details without being forced into self-contradictions, not from any fault of his intellect or education, but alone from the inherent absurdity of the theory, based, as it is, upon laws and principles in conflict with Nature and with one another.

I will give an illustration of the truthfulness of this charge by proving that Prof. Brockett, even in this short review, has been compelled not only to contradict himself several times and in several different ways, but to flatly contradict Tyndall, Helmholtz, and every acoustician who has written on sound. This seems like a serious charge, but I will make every word of it good by quoting his own language.

Here is a self-contradiction which is entirely fatal to his theory. He admits that the aggregate rate of travel of the prong of a tuning-fork is only eight inches in a second. These are his words: "It is true that the prong of the fork moves only eight inches in the aggregate in a second." Then put this statement along with another, as follows: "Only *instantaneous pulses* will compress the air suddenly, and *constitute a sound-wave*," and it will take but a moment to point out the flattest possible self-contradiction. First, we must know, from his own use of the word, what meaning he attaches to "pulse." He evidently does not mean the repeated *starts* and *stops* of the prong while vibrating, but its *actual motion while traveling*, after starting and before stopping. We have positive proof that this is his meaning, because he calls the movement of a fan through a single sweep of seven feet a "pulse." Note his words: "Is not *one pulse* of *seven feet per second* slow motion?" Then, as the "pulse" of the fan is its actual travel "seven feet," and has nothing

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accept the corpuscular hypothesis, believing it possible that some middle ground might be discovered. I say this much in vindication of myself, and will add, that if Prof. Spice now claims to believe in the scientific correctness of the wave-theory of sound, and that my arguments against it are fallacious, he has an excellent opportunity of setting the public right by meeting the author of *The Evolution of Sound*, face to face, before a New York or Brooklyn audience, in a friendly discussion of the whole question. As he is a professional and public lecturer on acoustics, of considerable celebrity, he must be competent to sustain the theory if it is defensible at all, and hence the public invitation thus given is entirely legitimate, whether he is disposed to accept it or not. Should he decline to join me in an open ventilation of this subject as here intimated, teachers, as well as students of science, will be able to appreciate the force and value of his denials, or even of his public expositions of the wave-theory.

A. WILFORD HALL.

to do with its start and stop, it follows that the "pulse" of a prong is its actual travel *a sixteenth of an inch*, or through one of its sweeps, and has nothing to do with its start or stop! Now comes the contradiction. He admits that the actual travel of a prong during a second, leaving out its starts and stops, is but "eight inches," or only *one tenth* as fast as the fan travels. And as the fan's travel is "slow motion," the prong's travel is *ten times slower*, and therefore can not be an "*instantaneous pulse!*" Now take his other statement that "Only *instantaneous pulses will compress the air suddenly*," and the bottom falls out of his whole criticism, showing that the motion of the prong, not being "instantaneous" but "slow motion" — much slower than the fan's movement—can not compress "the air" or send off waves, even as swiftly as can the motion of the fan! This I call *positive proof*, and obtained directly from the highest living authority, so far, at least, as this discussion is concerned,—namely, Prof. R. L. Brockett, A. M.

But look at the thing philosophically for one moment. What a shallow idea to advance as part of a "mathematically" formulated theory of science, that this slow motion of a prong, if it only stops after traveling a sixteenth of an inch, will send off an air-wave at a velocity of 1120 feet in a second; but if it goes on at the same rate of travel seven feet before stopping, it will only drive the atmospheric disturbance with a velocity of *five feet* in a second! Yet this is exactly what this "established" theory teaches. If the prong advances a sixteenth of an inch at the slow rate of "eight inches" in a second and stops, then off shoots an air-wave at a velocity of more than a thousand feet in a second; but if the same prong should travel on seven feet *at ten times this velocity*, and stop, as does the fan, then, presto! it sends a wave only *five feet* in a second, "which disturbances are easily adjusted by the mobility of the particles!" Yet just such mechanical puerility as this is taught in all our colleges as a part of physical science.

Does not reason teach any man, who pretends to think at all on questions of philosophy, if the motions of a prong, or a stick, or anything else, to a distance of a sixteenth of an inch at a given velocity shall produce a certain mechanical effect upon the air, that the same motion continued an *inch*, or a *foot*, or *ten feet*, must, for each sixteenth traveled, produce at least an equal mechanical effect? Yet this insane theory, that has been "*established mathematically*," as Prof. Brockett declares, teaches that if the prong moves a sixteenth of an inch at a velocity of eight inches in a second, and stops, it will send off an air-wave two hundred times swifter than if it moves seven feet before stopping, and *even at ten times that velocity!* No difference, according to this theory, how slow a body advances, if only at the rate of eight inches in a second, *so it only stops often enough*, it produces an enormous effect at *each motion* in the velocity at which it sends off air-waves; but if it stops but *once*, and, after moving seven feet at ten times higher velocity, its effect on the air is *two hundred times less!* Common senses would tell us that the result ought to be exactly the reverse,—the long continuous sweep producing vastly the greater effect on the air.

The unvarnished truth is that Prof. Brockett does not know the meaning of the words he employs, though he uses them in strict accordance with the wave-theory. To quote him: "This is a charge no one should make without proof. *Let me produce it.*"

Take for example, his incorrect use of the word "motion," which, above all other words in this discussion, needs to be employed correctly. Now, every tyro knows, or can easily know, that *motion* signifies the act of a body *passing* from one position to another. This is its primary and universal meaning, as all vocabularies teach. It does not signify the number of *starts* and *stops* a body makes in a given time, but the actual *travel* of the body *while moving*, after starting and before stopping. But Prof. Brockett, either unaware of this true meaning of the word or else to *cover up* the "weak points" in his theory, asks you, "Is not 384 pulses or vibrations *rapid motion?*—and is not *one pulse* of seven feet per second *slow motion* in comparison?" And, this, too, mark you, notwithstanding he had just admitted that the actual travel of the prong in either direction was but eight inches in a second or *one tenth* the distance of the fan's travel. He thus erroneously supposes that the succession of numerous starts and stops of the prong constituted its "rapid *motion*" without any regard to whether the prong traveled an inch or seven feet in a second, while the *one start and stop* of the fan in a second constituted "*slow motion*," even if it its travel had been a hundred feet in the same time! Thus a meteor, shooting athwart the heavens, would be *slow* motion according to this critic, because it did not stop and start a good many times in its course!

There is no mistake about this meaning of the word "motion," as he employs it. If a prong starts and stops often enough it is "rapid *motion*" if it only advances *an inch* in a second; but if it advances seven feet in a second, or eighty-four times as fast, it is "*slow motion* in comparison," because it did not start and stop a good many times on the way! Yet, if this confident critic were traveling by a train of cars, he would hardly write you that the train made "rapid motion" through the country because he happened to be drawn by a ricketty locomotive which was compelled to stop and start every half minute! He would, no doubt, be able to catch the true meaning of the word "motion" in such a case, and see that the stops and starts, instead of constituting the train's "motion," were directly opposed to it; and had his common sense only come to the aid of his uncommon science in like manner, while trying to analyze the motions of a prong and their mechanical effects on the air, he would never have been led into the use of such "ridiculous phrases" as calling eight inches a second "rapid motion," and "seven feet a second *slow motion* in comparison!" There is one of his personal remarks I am sorry I can not quote in return: "He *knew better!*"

Now, whether the prong of a tuning-fork really moves, while traveling through one of its swings, at a rate of velocity of only "eight inches" in a second, as Prof. Brockett admits, or many times faster, it matters nothing in this argument against the wave-theory. Should it even travel at ten times this rate of speed, it would only equal the fan's velocity, which the Professor truly declares to be "slow motion." The absurdity of the thing of which I complain, is in teaching, as does Professor Brockett, and as do all writers on sound, that this prong, in moving *one sixteenth of an inch only*, produces *two hundred times more mechanical effect*

on the air than if it moved seven feet at the same rate of velocity!

I believe I am fully justified in the assertion that Prof. Brockett has not read the book at all "carefully," or more than merely glanced at it "here and there;" for, if he had read it, why does he go into an explanation to convince you that I deny the possibility of compressing the air, and thereby generating heat? He assures you that "with a piece of apparatus belonging to the college" he can compress the air so as to ignite tinder. Yet he must have been aware, had he read the book, that you knew all about this matter, which was fully explained and admitted in *Evolution of Sound*, in which I showed that amadou could be ignited by heat thus generated. Then he adds: "Yet Wilford has the hardihood to use ridiculous phrases in alluding to *these condensations and rarefactions as if they had no existence in fact.*"

Now, I protest that if this critic really read the book and was honest in making this statement, he is entirely incapable of understanding what he reads. I carefully explained the principle, and showed how the air could be condensed and rarefied, thus producing heat and cold, by the action of a piston in a tube, and made an elaborate estimate of the mechanical force it would take to condense a given quantity of air sufficiently to generate the heat required by the wave-theory, according to the estimate of Laplace. My "ridiculous phrases," therefore, were employed in exposing the "ridiculous" idea that a locust by stridulating, or moving its legs across the nervures of its wings, could exert enough mechanical force or pneumatic pressure to condense the four cubic miles of air throughout which its sound was heard, and thereby generate heat sufficient to add "one-sixth" to the velocity of its sound, as the wave-theory imperatively requires! Why did not Prof. Brockett find it convenient to see this argument if he had really read the book "carefully?" It seems to have been more in accordance with the object he evidently had in view to utterly ignore a dozen just such unanswerable arguments as this; and, in lieu of it, to accuse me of using "ridiculous phrases" about the philosophical experiment of compressing and heating the air, so well understood by all scientific students. Is this a specimen of that fairness and that paramount desire for nothing but the truth, of which professors of physical science so constantly boast? And in contrast with this manifest skulking of the main difficulties, I ask any reader of my treatise on sound to point to a single consideration referred to by writers to favor the idea of wave-motion, that is not fairly and squarely attacked, without showing the slighest disposition to evade or dodge the force of the arguments used.

Had Prof. Brockett done nothing else in his entire review but take up that one argument based on the stridulation of the locust, and had he tried to show how it was possible for an insect by moving its legs to compress and heat four cubic miles of air, and thus add "one-sixth" to the velocity of its sound, while actually exerting a mechanical force sufficient to shake 2,000,000,000 tons of tympanic membranes, as so clearly shown to be taught by the wave-theory of sound, it would have been vastly more creditable to him as a candid scientific investigator than deliberately to ignore it by misrepresenting the author he reviews.

I now come to another positive proof, growing directly out of Prof. Brockett's admissions, that the air-waves sent off by a vibrating tuning-fork do not constitute its sound pulses,—an argument, by the way, against the undulatory theory, which admits of no kind of reply; and if Prof. Brockett thinks differently he is at perfect liberty to try his hand at it. To prepare for this evidence, I will first quote his exact language:—

"His fan, with the 'one-man power,' can only disturb the air, and can not produce a sound-wave, because it (the fan) *is not elastic;* and, if it were, even his 'one-man power,' *without the aid of machinery, would not be able to give the requisite velocity to produce a sound-wave.*"

Before framing my argument, however, on this fatal admission, I wish again to refer to his incorrect use of words. Throughout this review he uses the phrase "*elastic* body" for *sonorous* body; and in the most absurd manner denies that a fan is "elastic," when any one knows that a fan may be even many times more elastic than the stiff prong of a tuning-fork, or a bell. He evidently meant that a fan was not *sonorous*. A piece of *caoutchouc* or soft rubber is one of the most *elastic* bodies in existence; but I never heard of it being remarkably *sonorous*. This outlandish employment of a common and familiar word, and in a way entirely foreign to its signification as given in any dictionary, is certainly refreshing, coming from one of the leading chairs of a first-class college.

But the admission to which I refer, in the quotation just made, and which contradicts all the Professor has tried to inculcate in this review is, that with the aid of "machinery" attached to the *fan* its air-waves might be driven off with *increased velocity*, and thus come nearer constituting sound-waves, than if the fan was propelled by "one-man power," as in my experiment. The principle thus admitted is evidently correct, as any one can soon determine, and as I ascertained in my experiment, namely, that the air-waves sent off by swinging the fan to and fro traveled with a velocity in proportion to the force applied in operating the fan. If the fan was moved with little force the air-disturbances would travel sluggishly; but if the fan was operated vigorously, with the full strength of my arm, the waves would naturally make headway through the air with increased velocity; and consequently Prof. Brockett is right in assuming that if the fan were operated by powerful "machinery" the waves generated would necessarily travel with much greater velocity. Since, therefore, he admits this principle to be correct, he thereby acknowledges the wave-theory of sound to be false from root to branch; for that theory teaches, as every one knows, that air-waves, sent off from a tuning-fork whose feeble motions a single hair will check, travel with exactly the same velocity as do the waves driven from a powerful steam siren, or fog-horn, operated by the "machinery" of a twenty horse-power engine! Thus, again, by one of the inevitable self-contradictions inseparable from the theory, the whole hypothesis is destroyed; for all know, that while air-waves will travel with greater velocity if greater force be applied in driving them off, every sound travels with one uniform velocity in air, whether it be the feeble sound produced by a musquito's wing, or the thundering report of a fifteen inch Krupp gun!

My learned reviewer, therefore, by the cleverest blunder imaginable, while attempting to criticise

my fan experiment, has unwittingly stumbled upon an important scientific principle which most signally lets the bottom drop out of his review by demonstrating that the sound-pulses from a vibrating tuning-fork must be *something* entirely different from the trifling air-waves thus put in motion, —*a something which radiates and travels, not by mechanical propulsion at all, but by its own peculiar law of conduction, and without any relation to the force which the sonorous body exerts on the surrounding air.*

How beautifully is this view of sound illustrated by the substantial current of electricity which travels through a wire by its own peculiar law of conduction at a uniform velocity of about 3,000 miles a second, without any relation whatever to the force of the battery or the rotary power of the dynamo-electric machine which generates the fluid! If physicists would pay the slightest attention to these wonderful analogies existing all around them in Nature, they would instantly cease to advocate these monstrous absurdities so inseparable from the undulatory theory.

What I understand by a sound-pulse, or sound-wave, in contradistinction to an air-wave is made very plain at the close of the fifth chapter. Had Prof. Brockett read the work as "carefully" as he claims to have done, he would have withheld his charge that "Wilford does not seek to tell us what a sound-wave is." I have explained this whole matter very carefully, so that he that runs may read.

Here is a very simple but conclusive argument against the wave-theory, which alone overthrows it. Let a large funnel-shaped tube be sunken half its diameter in a tank of water, and then let a system of water-waves be generated by a vibrating body at its small end, and it will be observed that such waves, so far from being augmented by passing through the tube, will entirely die out or become obliterated before reaching the large end. Whereas a sound of any kind, generated at the small end of the same funnel, will be increased in volume many fold in passing through it, as witness the effects of speaking into the small end of a fireman's trumpet; thus demonstrating that sound-pulses are something entirely different from waves of any kind. Any student, desiring to know the truth upon this subject, can easily try this simple but convincing experiment,

I will conclude my positive evidence, that the air-waves sent off from a vibrating prong can not travel as fast, even, as can those sent off from a fan, by presenting another simple *experiment* addressed to the observation of the senses,—a class of evidence universally admitted to be more reliable than any other, provided the experiment be honestly made. As already intimated, physicists who have experimented and written on sound appear to suppose that as the air is invisible this "soap bubble" cheat of the wave-theory can not be exposed. But I now propose to *look* right at Prof. Brockett's *spherical globes of air* with the naked eye, and find out by a single experimental test just how much reliance is to be placed in the mathematically established hypotheses of these vaunted authorities on physical science.

The experiment is easily made by any one possessing a large tuning-fork,—the larger the better, so its vibrations are sufficiently rapid to produce tone,—and consists in the following: Fill a glass jar (the larger the better), turned top downward with the dense smoke of brown paper; and when the motions of the smoke, caused by the heat of the burning paper, have subsided, gently reverse the jar in front of a light window, and hold the vibrating fork in it, and it will be found that every motion of the air, produced by the oscillations of the prongs, will be plainly visible in the undulations and convolutions of the smoke. Now, what takes place? I declare to you and to the scientific world that the air-waves thus visualized are the same precisely as those sent off by the fan's rapid oscillations, only on a very diminutive scale, the waves traveling at the rate of about one to two feet in a second, and only reaching to a distance of a few inches till their headway is entirely checked by the density of the surrounding air! But while this very circumscribed incidental effect on the air is taking place, the sound of the fork is heard throughout the room, thus demonstrating that the fork's action on the air is but *incidental* to its vibrations, and has nothing whatever to do with the *sound-pulses* generated by the molecular action brought into play in consequence of the sudden stops and starts of the sounding body itself. (See the law of sound-generation, for the first time given, in *Evolution of Sound*, p. 93.) Having thus, by a demonstrative scientific test, proved that the air-waves sent off by the so-called "instantaneous pulses" of a sounding body are not the sonorous pulses which we *hear* and call *sound*, I now return to take my final leave of Prof. Brockett, by showing from his review, and in the most unmistakable language, that he not only contradicts himself again, but that he flatly contradicts Professors Tyndall, Helmholtz, and Mayer, as well as every acoustician who has written on the subject of sound, thus deliberately renouncing the wave-theory. He contradicts himself by first teaching that atmospheric sound-waves do really *travel* at the observed velocity of sound, and immediately after by declaring that they *do not travel at all, but stand perfectly still!*—showing that the law of self-contradiction is an inherent principle of the wave-theory, by whomsoever advocated.

Look at the explicitness of his language. Speaking of a vibrating "elastic" body, he says that it "sets in motion sound-waves that *pass from the elastic body* as a center *outwards in all directions*," thus clearly teaching that these sound-waves actually *travel* or *advance* through the air. Again, to the same effect: "The more homogeneous the air is, the better medium is offered to the *progress of the sound-wave*," thus unmistakably teaching—as do Tyndall, Helmholtz, and all writers on sound—that these waves really *travel* from the "elastic body as a center *outwards in all directions.*" Then as just charged, he declares in the same positive manner that these air-waves do not *travel*,—do not "*pass* from the elastic body as a center *outwards in all directions*," but *stand perfectly still where they are made!* Be not amazed at this. Here is the proof, in his own words:—

"At every pulse of an *elastic* body a spherical globe of air is made at the body, that vibrates to and fro, *but does not advance.* * * * This sound-wave sets in motion—*forms—another sound-wave, and it another, and so on*, sometimes to the distance of many miles. When, then, we hear the sound of a bell, miles away, or the whistle of a locomotive, *it is not the sound-wave that was made at the place where the bell or the locomotive is*, but it is the

sound-wave made of the air where the listener is."

Thus we have not only one of the most clearly defined self-contradictions conceivable, but we have at the same time one of the most astounding absurdities ever announced in support of his monstrosity of physical science called the undulatory theory. Let us analyze it for a moment, and endeavor to comprehend its enormity.

In the first place, we are assured that a "sound-wave," constituted of a "spherical globe of air" and made by an "*elastic* body" like a "bell," remains stationary where "made," since it "*does not advance*;" but before this "spherical globe of air" gives up the ghost it "*forms* another sound-wave" (without any assistance from the "*elastic* body") which also "*does not advance*," but proceeds to *form* another wave, "it another, and so on, sometimes to the distance of many miles." Thus all these thousands of spherical globes of air, extending in a line for "many miles," are entirely independent of the "elastic body," except the one first made, "*at the place where the bell or the locomotive is*," since each one of the entire lot was *formed* by the "globe of air" next behind it! There is no mistake about this being the truthful representation of the idea conveyed in this lucid and inimitable eclaircissement, because the "sound-wave *made of the air where the listener is*," he positively assures us, is not "the sound-wave that was made at the place where the bell or the locomotive is," because that wave "*does not advance!*"

Well, now, I ought to give up my opposition to the wave-theory of sound, after encountering such a new and stunning philosophical revelation as this; for of what avail can "a great flow of language" be in checking the resistless sweep of such a logical avalanche, or in attempting to dam the concentrated torrents of such a catyclysm of natural philosophy? A new Pythagoras has burst upon the world! An apotheosized oracle has dropped into our midst, whose etiolated robes scintillate with the burnished spangles of physical science, and the corruscations of whose luminous genius have thrown into hopeless tenebrosity the achievements of Helmholtz and Tyndall, as the incandescent radiance of the electric light pales the ineffectual glow of a tallow dip!

But I will try to stand in the presence of this new beacon of science, and will first quote Prof. Tyndall, to ascertain what the wave-theory really teaches, and thus find out whether sound-waves do or do not "advance":—

"Imagine this tuning-fork vibrating in free air. *At the end of a second* from the time it commenced its vibrations, *the foremost wave would have reached a distance of* 1090 *feet* in air at *the freezing temperature*," etc.—*Lectures on Sound*, p. 69.

Prof. Brockett says, Pshaw! Tyndall, you are "not *au fait* in the science of acoustics;" if you were, you would know that sound-waves do not "advance" at all, but stand perfectly still where they are "made," and that "the foremost wave," instead of *reaching* to a distance of 1090 feet in a second, is engaged in the new scientific process of *forming* another wave, at the place where the bell or the locomotive is!"

Tyndall again says, in reply:—

"*Imagine* one of the prongs of this vibrating fork *swiftly* advancing. It compresses the air immediately in front of it. * * * The whole function of the tuning-fork is to carve the air into these *condensations* and *rarefactions*; and they, as they are formed, *propagate themselves in succession through the air*." — "Figure clearly to your minds a harpstring vibrating to and fro; it *advances*, and causes the particles of air in front of it to crowd together, thus producing a *condensation* of the air. It retreats, and the air-particles behind it separate more widely, thus producing a *rarefaction* of the air. * * * In this way the air through which the sound of the string is propagated is moulded into a regular sequence of *condensations* and *rarefactions*, which *travel with a velocity of about* 1100 *feet a second*." (See all these quotations, and many more to the same point, *Evolution of Sound*, pp. 78, 79.)

But Prof. Brockett, no doubt disgusted with Tyndall by this time, may entertain a higher estimate of Prof. Helmholtz as an acoustician. We will therefore briefly consult him:—

"Suppose a stone to be thrown into a piece of calm water. Round the spot struck there forms a little ring of wave, which *advancing* equally in all directions, *expands to a constantly increasing circle*. Corresponding to this ring of wave, *sound also proceeds in the air* from the excited point, and *advances* in all directions as far as the limits of the mass of air extend. *The process in the air is essentially identical with that on the surface of the water.* * * The *waves of air, proceeding from a sounding body, transport the tremor to the human ear exactly in the same way as the water transports the tremor produced by the stone to the floating chip.*"—*Sensations of Tone*, p. 14. (See this citation analyzed, p. 318 *Evolution of Sound*.)

Now, as Prof. Brockett would not pretend to say that *water*-waves do not "*travel*" or "*advance*," and as he would not dare to assert that these authorities do not correctly expound the current hypothesis, he has clearly abandoned the wave-theory of sound, since Prof. Helmholtz declares that air-waves "advance" "*exactly in the same way*" as do water-waves!

The truth is, although professors of physical science ought to be the first to evince a readiness to accept any new advance in scientific research, they are too often about the last men who may be expected to give in their adherence to a new truth which tends to force them out of the smoothly worn grooves of scholasticism which, for years, have guided the wheels of their mental machinery. I may, therefore, reasonably expect just such opposition as exhibited in this initial attack from a few professors of physical science, at least till such time as they shall be coerced out of their beaten ruts of thought by invincible argument, or possibly till a general change of scientific views occurs, as new investigators come upon the stage.

While this is a just explanation, so far as it goes, of the backwardness of certain physical investigators to fall in with new scientific discoveries, there is another cause even less creditable. A teacher of formulas laid down by standard authorities, and who has for years drilled and lectured his classes to believe in certain laws and principles of science as mathematically established, is not apt to show much alacrity in coming out before the same classes (unless he is more severely true to himself than my present critic appears to be), and confessing that he has been teaching them nonsense for philosophical truth. It is well, however, for the cause of scientific research and the advance-

ment of true knowledge, that there are noble and honorable exceptions to this rule, and plenty of them, who are not ashamed to become fools that they may be wise, and whose testimony in favor of the correctness of the new position on sound, though in direct opposition to their life-long convictions, must be received in preference to the interested and biassed opinions of a legion like the one I have the honor of answering.

The new hypothesis of astronomy, formulated by Copernicus, is an illustration exactly in point. Although self-evident on its face, it was at that time scouted as "a total failure" by the Professor Brocketts of the Ptolemaic school, because it came in conflict with a long-established theory of science; and if we will read those controversies we will see almost the precise language used in this review, namely, that the views of Copernicus could not be correct, because the old system of astronomy had been "established mathematically," and that "all the phenomena" of the motions of the heavenly bodies "have been examined in connection with the current theory, and mathematical formulas have been applied in the most rigid manner; and, in every instance (sometimes correcting errors, however,) the theory has proved sufficiently able to meet every case." Yet it is a matter of record that the ridiculed theory of Copernicus triumphed, and the "mathematically" established theory of the Ptolemys went down with a crash. I wonder if Professor Brockett ever read of that controversy.

One would really think that modern physicists, knowing the lesson taught by the disastrous overthrow of the Ptolemaic system of astronomy, would be a little cautious in jeering at any announcement in science, however apparently preposterous, without a careful examination of its claims.

But there were a few Galileos of those days, as there are now, who had the mental force to investigate new truth in science, and lift themselves out of the scholastic grooves of that venerable nonsense so long fastened upon the world by professors of mediæval philosophy. I solemnly declare, as my conviction, that there are to-day many professors of physical science (judging from letters I am receiving), installed in the chairs of our colleges and universities, who, for bigotry and fogyism, can discount the most opinionated religionists of the dark ages; though it is well for the cause of the world's intellectual progress that all or even a majority do not come within this category; for we can congratulate ourselves upon the fact that there are investigators of *truth*, both in science and religion, who are not afraid to acknowledge its claims in whatever new garb it may appear, or whatever new message it may have to deliver.

In conclusion, I wish to say that it is not claimed nor pretended that *Evolution of Sound* is free from minor errors. It must be borne in mind that it is the first work ever written on that side of the question, having no previous investigations to guide the writer's pen; and it would be more than a miracle if the author, who makes no pretentions to a regular scientific education,—only to a common-sense view of the subject discussed,—should not have written some things needing correction, even if his arguments in the main should prove to be correct. And it will no doubt prove a godsend to the advocates of the undulatory theory of sound if there should be found a few such inaccuracies, to be seized upon as straws by the drowning hypothesis before it sinks out of sight.

But the case is entirely different with the wave-theory of sound, which has been a subject of investigation for hundreds of years. It has been written upon and elaborately explained, in all its details, a thousand times, and by the ablest scientists the world has ever produced; and there is, therefore, not a shadow of excuse, if the theory be true, for the transparent absurdities and self-contradictions which abound everywhere in these writings, and which can only be accounted for on the supposition that the current hypothesis is fundamentally false and intrinsically self-contradictory.

I now ask those professors of physical science, therefore, who shall in the future feel it their duty to attack *Evolution of Sound*, not to skip "here and there," and try to find some trifling defect in the use of scientific terms, or even some well-founded objection to the author's "egotistical" style; but to grapple with the main arguments advanced against the wave-theory, and either answer them or admit their impregnability.

Let them, for example, squarely face the problem of a certain species of locust shaking four cubic miles of air into condensations and rarefactions by the motions of its legs, thus generating heat enough to add "*one sixth*," or 174 feet a second, to the velocity of its sound throughout this vast area, and exerting sufficient mechanical power to actually oscillate—bend "once in and once out"—400 times a second, 2,000,000,000 tons of tympanic membranes, as demonstrated to be the case, if there is any truth in the wave-theory. (See *Evolution of Sound*, pp. 129, 175, etc.)

Let them grapple with the problem of magazine explosions, as explained by Prof. Tyndall, in which it is absolutely shown, that, according to the wave-theory, *houses*, and even *horses*, *cattle*, and *human beings* have been blown to atoms by a "*sound-pulse*," no distinction whatever being possible, according to the current theory, between a compressed air-wave caused by the explosion, and its accompanying sound. (See pp. 103, and onward.)

Let them grapple with the arguments against the foundation-law of "interference," without which the wave-theory of sound confessedly has no existence, and in which Prof. Tyndall's explanations of the double-siren, the sounding of two forks half a wave-length apart, thereby causing neutralization of their waves, and the division of a stream of sound into two branches by the Konig instrument, are disastrously exposed, and turned against the theory. (See pp. 186, 280, 307, etc.)

Let them explain away the startling analogies, as presented at the close of Chapter V., existing between *odor*, *sound*, and *light*, which demonstrate that if one is the result of corpuscular emissions and not wave-motion, as all science agrees, the others must be also. (See pp. 223 to 230.)

Finally, without naming a score of such insurmountable objections urged against the current theory, let them grapple with the very law of wave-motion, in which the most conclusive proof is for the first time given, that the velocity of all waves must be in proportion to wave-length, while all sounds travel at the same uniform velocity, whether the theoretic wave-lengths be long or short, thus showing that sound does not travel by wave-motion at all. (See pp. 317 to 326.)

Until these crushing considerations are taken up and disposed of by advocates of the undulatory theory, it is worse than a waste of valuable time to talk and write, as does my learned reviewer, about the "instantaneous pulses" of a tuning-fork's prongs sending off *air-waves* 1120 feet in a second. And I hereby give due notice to all such critics, let them call it "egotism" or what they like, that the author of *Evolution of Sound* does not propose to remain an idle spectator, and allow them to reiterate their stereotyped "condensations," "rarefactions," "superpositions," and "instantaneous pulses," while at the same time deliberately ignoring the overwhelming arguments against their theory, just enumerated, without holding them to a rigid account.

Again thanking you for the interest you have taken in my work, I am sincerely yours,

WILFORD.

Problems Propounded by Prof. I. L. Kephart, A. M.

LEBANON, Pa., Jan. 16.

WILFORD (Care of HALL & Co.)

Dear Sir: I have read your *Problem of Human Life* with pleasure; and what I admire most is your demonstrative evidence of the fundamental truths of religion—the existence of God, and the substantial and conscious nature of the soul—upon purely scientific grounds, and without in the least depending upon the Bible for your proofs. This is what the scientific world has long needed; and in this respect I regard your work as a godsend to this age.

There is, however, a single point in your argument on Sound to which I beg leave to call your attention, as it is in direct conflict with all we have been taught on the subject in works on Natural Philosophy and Physics; and unless you are able to explain it satisfactorily, and harmonize the phenomena involved with your views as published in *Evolution of Sound*, it must prove a serious stumbling-block in the way of many persons accepting your otherwise strong assaults upon the undulatory theory. But let me assure you that in presenting this difficulty, I do so only out of a desire for information and not for the sake of criticism.

Natural Philosophy, or rather Physics, teaches (and I think correctly too) that a *pebble*, dropped into the ocean, actually stirs or displaces the entire mass of its water. Of course, you deny this; because, on page 113 of your book, you ridicule, as a philosophical absurdity, the idea that a man, by thrusting his finger into the water, stirs the whole ocean, or produces any effect on the water, except to a very limited distance around.

Now, you will readily admit, if the problem here suggested can be shown to be correct, that it seriously weakens your argument based on the stridulation of the locust shaking four cubic miles of air with a force sufficient to vibrate 2,000,000,000 tons of tympanic membranes, which I admit you show must occur, according to the wave-theory of sound. As you will necessarily deny the correctness of this pebble difficulty, allow me to prove it.

To make the matter plain, we will confine the illustration to a less body of water than the ocean, and to a cubic foot of *lead*, instead of a *pebble*. We will assume that we have a *tank* that is 1000 feet long, 1000 feet wide, and 1000 feet deep, and that it consequently holds 1,000,000,000 cubic feet of water; and, when it is filled, the upper water surface of the tank is exactly 1,000,000 square feet. This volume of water, then, weighs (counting 62 pounds to the cubic foot) 62,000,000,000 pounds, or 31,000,000 tons. Now, if a cubic foot of lead (weighing 704 pounds) should be dropped into this tank, it will certainly stir or displace every particle of this mass of water; for it will sink to the bottom, and cause the water to rise one one-millionth of a foot in the tank. This is surely not a "philosophical absurdity."

Then the question is, did or did not the cubic foot of *lead*, by being dropped into the tank and raising the entire mass of water, exert a force equal to 31,000,000 tons? I think (upon the principles of hydraulic pressure, as explained in the second edition of "Snell's Olmstead's Natural Philosophy," pp. 133–4) that it did; and may not the wonderful force which (as you so clearly prove) the locust exerts, according to the wave-theory of sound, be accounted for in the same way? In other words, if a cubic foot of lead can exert a force of 31,000,000 tons on the water of this tank, displacing or stirring its 1,000,000,000 cubic feet, it proves the correctness of the principle that a *pebble* must, on being dropped into the ocean, displace and agitate its entire mass of water by raising its level to the equivalent of the pebble's bulk. And if so, what is to hinder a locust shaking the air throughout the entire area permeated by its sound? You undoubtedly see the pertinence and force of this difficulty.

I shall be much gratified if you can succeed in solving these problems of the *pebble* and the *tank* satisfactorily, and harmonizing them with your positions on sound; and I have no hesitation in saying that if you can fairly do so, that your arguments against the wave-theory are unanswerable.

Hoping to hear from you on the subject, I am, very respectfully yours,

I. L. KEPHART.

Wilford's Reply.

OFFICE OF HALL & CO.
NEW YORK, Jan. 24.

PROF. KEPHART, A. M.

Dear Sir: Your letter of inquiry, calling my attention to certain philosophical difficulties in connection with my arguments against the current theory of sound, came duly into my hands. I am thankful for these suggestions, and for the mathematical argument which accompanies them. Your candid manner excites my admiration, being in such marked contrast to the bitter opposition the book is receiving at the hands of a few professors of physical science, who have not shown the fairness or even the courage to first read the arguments against the undulatory theory of sound before casting the book aside as unworthy of attention.

I therefore take great pleasure in replying to your inquiries; and will try to convince you that the problem of the "pebble" and the "tank" are founded on a radical misconception of the physical laws; and that the standard works on Natural Philosophy and Physics which teach such pitiable nonsense, as that the mechanical action of a *pebble* can shake the entire ocean, or *a cubic foot of lead*

can exert a pressure of 31,000,000 tons on a tank of water, ought to be unceremoniously thrown out of our schools and colleges, and sent to the paper-mills to be ground over.

First, then, let us consider your problem of the "pebble," and the actual effect produced by so small a body sinking into the ocean. It evidently displaces a quantity of water at the surface, directly above and around the spot where it enters, equal to its own bulk. Of this there can be no doubt. I also freely admit that the entire ocean level is disturbed, and must be re-adjusted, since it is raised to the equivalent of the pebble's bulk, the same as the water in the tank is raised to the equivalent of the bulk of one cubic foot of *lead*. But then I assert that this disturbance of the ocean's surface-level is not produced at all by the mechanical force of the pebble entering the water; and that herein alone lies the error on which this problem is based, and which I will now endeavor to point out.

Writers on Natural Philosophy never seem to think of taking into account, in dealing with such problems as these, that mighty mechanical energy, which always stands ready to act, namely, the universal force of *gravitation*. The moment we recognize this unlimited mechanical energy, the difficulty vanishes. When the pebble, for example, has settled below the surface, and has raised the water around and above it to the aggregate of its own bulk, it has done all it has the mechanical power of doing, so far as our problem is concerned. But *gravitation*, ready with its countless millions of tons of physical force, takes up the displaced water where the pebble has left it, just the same as if a drop of water containing that quantity had fallen there in place of the pebble, and proceeds to adjust the ocean and equalize its surface-level in conformity with this addition of bulk; and this tireless mechanical energy will go forward in the prosecution of its work till it is finished, even should it require the displacement of the entire ocean to effect it, though it requires nothing of the kind,—the surface only needing to be re-adjusted, as will appear after a little.

Now, I ask you, where is there a work on Natural Philosophy or Physics which says one word about this ever-present mechanical force of gravity as the true key to the solution of such difficulties as these? I venture to believe that there is no such a work to be found, or you would have undoubtedly known of it, and thus been saved the trouble of propounding these problems. No! Writers on physical science, it seems, prefer to leave the student under the impression that a wonderful miracle had been wrought by teaching that a pebble, independent of gravity, possesses the mechanical force to actually stir the entire ocean; and that, too, without the slightest regard for the necessary relations existing between cause and effect.

As this method of calling to our aid the force of gravity clearly solves the problem, showing that the pebble does nothing in the premises but displace the water at the surface equivalent to its own bulk, there is only one thing for the authors of these standard works on physical science to do, and that is to endeavor to trap me by asking: Since you admit that the ocean's surface was really *stirred*, and that it would not have been thus *disturbed* but for the pebble falling into it, then was not the pebble the *cause* of the mechanical disturbance necessary to bring about this vast re-adjustment? I answer, emphatically, Yes. But here, again, Natural Philosophy needs a shaking up, as such a quibble would make no distinction, in accounting for these physical effects, between the *proximate* or *direct mechanical cause* of a certain result, and the *remote cause* (like that of the *pebble*), which, as I will now show, has nothing to do with the solution of these problems. Let me illustrate.

A mighty bolder may be so poised on the peak of a mountain that a single inch of hard clay may hold the balance of power in sustaining its weight and keeping it in its position. A locust, taking shelter beneath this rock from a rainstorm, may shake from its wings a single drop of water, which, striking this lump of clay at its centre of support, so softens it that it yields to the almost infinitesimal fraction of preponderating weight in that direction; and this law of gravity, with its enormous energy, coming into play, takes up the work where the locust left it, just as it takes up the small protuberance of water where the pebble left it, and down goes the boulder, crashing through the forest with the besom of devastation, pulverizing other boulders in its path, and cutting down trees that have stood the mountain blasts of a thousand years!

How shallow would be the natural philosophy which, leaving out of the account this mechanical force of gravity, coolly tells the student of science that because the shaking of this locust's wings was the remote cause of the boulder's fall, an insect, therefore, has sufficient mechanical power in its wings to break down trees ten feet in diameter! Yet this is substantially what your difficulty of the *pebble* implies, and what our standard works on physical science teach. Is it any wonder, then, that a writer, whose common sense leads him to detect the prodigious absurdity of such teachings as these spread out in our standard authorities on science, should be carried somewhat to the extreme in slapping right and left the authors of such works?

The true explanation of the matter is simply this: The pebble displaces its bulk of water at the surface as it enters, which displacement gravity adjusts, in the manner already explained, in order to equalize the surface-level of the ocean,—while the *pebble*, in sinking, produces no effect on the mass of the ocean except displacing the water directly in its path, or that which comes in contact with it, and which, by the mobility of its particles, passes from below, taking its place above as the pebble settles. The effect on the water by the *pebble's* descent, after it is once below the surface, is the same as that of the moving *fin* of a fish. It adds nothing to the bulk of the water; and hence the effect of such disturbance does not require adjustment at a distance, because it does not extend further than required to transfer the water from one side to the other as the fin or the pebble advances.

So, also, is it with the stridulation of the locust. It is already in the midst of the ærial ocean; and, as it adds no corporeal substance to the mass of the air by singing, there is no adjustment of the atmosphere at a distance necessary, requiring gravity to come into play, as when the bulk of the pebble is added to the ocean, or as when a quantity of gas is generated and added to the air at a magazine explosion. Hence, the trifling vibratory movement

which generates the music of the locust can produce only a direct mechanical effect upon the surrounding air to a distance in exact proportion to the limited physical strength of the insect, and which disturbance the mobility of the atmospheric particles re-adjusts, without the mechanical effect extending, possibly, half a dozen inches from the locust. This motion of its legs, therefore, can not produce such an effect upon the air as to be even a *remote* cause for gravitation to come into play at a distance.*

In regard to the "tank" problem, I desire to say that if "Olmstead's Natural Philosophy," or any other work on physical science, teaches that a cubic foot of lead can exert a pressure on the tank or the water it contains of 31,000,000 tons, it inculcates a scientific fallacy only surpassed in absurdity by the supposed possibility of a locust exerting the mechanical force attributed to it by the wave-theory of sound, or of a cricket kicking the earth out of its orbit.

The real mistake in writers on physical science, who inculcate such *unnatural* philosophy as this tank problem teaches, is in supposing that the cubic foot of lead displaces its bulk of water at the *bottom* of the tank instead of at the *top* where it enters, which would, in such a case, of course add one one-millionth of a foot thickness all over the bottom; and consequently would lift the entire mass of water that much higher in the tank, thus exerting, as you have supposed, a force of 31,000,000 tons. Such a stupid performance, however, on the part of this cubic foot of lead, would evince about as much mechanical shrewdness as was exhibited by the *farmer* who rigged machinery in his barn to windlass his horse up into the hay-mow to keep him from starving, never thinking that the hay might be thrown down to the horse! The author of a work on Natural Philosophy who could deliberately write out and publish such a preposterous principle of science as that the cubic foot of lead waits till it gets to the bottom of the tank before producing its displacement for no apparent reason but to exhibit its physical strength in lifting the whole 31,000,000 tons of water, would undoubtedly, in a fair contest with this farmer, carry off the first prize for stupidity.

It is perfectly plain that the cubic foot of lead, by settling into the water, displaces its bulk at the top where it enters, and thus adds, through the assistance of gravitation, the one one-millionth of a foot of water as a top layer all over the surface after adjustment has taken place, the same precisely as if such a thin sheet of water had distilled from heaven into the tank in the form of dew; and it is indisputably clear that such a layer, by no possibility, communicates any more pressure to the tank than it adds to the weight of the water already in it, namely, one cubic foot, weighing 62 pounds, the foot of lead having nothing to do with this pressure as it rests on the bottom with a weight of exactly 642 pounds, which is the weight of the lead minus the weight of the cubic foot of water it displaces. Thus the sinking mass of lead acts on the water, after being once submerged, the same precisely as does the *pebble* in sinking into the ocean, causing no displacement except of the water immediately in its path and to a limited distance around, sufficient only to cause an equilibrium as the lead advances.

Although this exposition of the "pebble" and "tank" problems, it seems to me, can admit of no question or doubt in the mind of any man who will reason on the subject, or who will take the trouble to shut up his standard authorities for one minute, and look at the question as if it had never before been discussed, yet it is a fact that, for the want of this mental independence, professors of physical science are teaching students all over this land the very absurdities involved in these problems as philosophical truth, just because they happen to be laid down in some standard work as a mathematically established principle of science. And for the same reason (the want of a little self-reliant thought) these responsible teachers lecture their classes on the beauties of the undulatory theory of sound, which involves the monstrous impossibility of an insect mechanically and directly compressing four cubic miles of air by the movement of its legs, and thereby generating heat enough throughout this vast area to add "one-sixth," or 174 feet a second, to the velocity of its sound!

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* At a recent meeting of the Polytechnic Club of this City, I was greatly amused as one of the leading members of the association took the platform in opposition to my argument in Evolution of Sound based on the stridulation of the locust, and declared that it could be *scientifically demonstrated* that "when a cricket jumps from the ground *it kicks the earth away in the opposite direction to a distance exactly in proportion to the weight of the two bodies.*" And this he asserted to be "a principle of philosophy well established and familiar to every one posted in physical science," which scientific (!) statement was applauded by most of the members present.

Now it seems a pity to disturb this polytechnic philosopher in the enjoyment of a principle of science, "so well established and familiar," but the cause of true philosophy has a paramount claim upon our consideration. To begin with, I am free to admit even more, apparently, than this scientist claimed, and yet show that his assertion is totally without foundation in reason or philosophy. For example, I am prepared to concede that a grain of sand, falling from space to the ground, actually causes the earth to rise part way to meet it, unless an equivalent movement should occur on the opposite side of the earth at the same time; and I concede further, that this principle is in perfect accord with the law of gravitation, namely, that all bodies attract each other with a force in exact proportion to the quantity of matter they contain; and consequently that the earth, in rising part away to meet the grain of sand, must thereby disturb the solar system to a conceivable extent, and possibly all the systems represented in the starry firmament to a corresponding degree. Such is the wonderful relation of gravity to every atom of matter in the universe. Yet this scientific admission involves no absurdity whatever, since the effects produced in the case here supposed result from the action of the mighty and universal force of gravitation, and in no manner involves such an impossibility as a cricket's displacing the earth by means of its physical strength, or, as our philosopher expresses it, *kicking* the earth out of its orbit.

To show the fallacy of such a statement, it is plain that the cricket would produce the same effect upon the earth should it climb a pole to the same height, instead of jumping, because the lower end of the pole rests upon the earth, and the cricket in climbing would necessarily bear down on the earth with the force needed to overcome its own weight by pulling itself up, thus proportionately pushing the earth away in the opposite direction, according to this stunning logic. Our philosopher should recollect that the weight of the cricket, which has to be overcome by the act of jumping or climbing, simply represents the pull downward on this same insect by the earth's attraction; and to suppose, as he does, that the cricket can push or kick the earth away, is but reversing the well-known experiment of lifting one's self by the straps of one's boots. The rustic who tugs at a sapling, trying to pull it up by the roots, and who would insist that in so doing he presses the earth out of its orbit with his feet, teaches the same "well established" science that was applauded by this club.

Yet some of these investigators are the very men who pass judgment on *Evolution of Sound* without even reading a single argument it contains; and then *egotistically* condemn the "egotism" of the author, and brand him a "sciolist" and "lunatic," as a number of recent letters from colleges bear witness, because he had the temerity to call in question a theory which undeniably teaches that an *insect* possesses the physical energy of more than a million horses!

I do not deny that it seems *egotistical* in the extreme for any "*one man to pit himself against the whole scientific world*" by attempting to break down an established theory of science which has held undisputed sway for hundreds of years. But then, what is to be done about it, supposing the "one man" should happen to be right, and the whole scientific world wrong? Would it still be "egotism?" Such a thing has occurred before, and might possibly occur again, which makes it a risky business for professors of physical science to *call names*, in lieu of a candid investigation of the new hypothesis and the arguments advanced to sustain it. For should these physicists, who make such undue haste to commit themselves on the popular side, happen to be *mistaken* in the present case, as good judges are beginning to acknowledge them to be, they can ill afford to face their record in the future, while the "one man" can very well afford to go into history as the "egotist," "lunatic," or even "idiot," who, single-handed and alone, succeeded in overturning a theory which had received the unanimous endorsement of the scientific world for centuries. I can afford to wait for the final verdict.

Hoping that the explanations here given of your problems of the "pebble" and "tank" may prove satisfactory, I am, very truly yours,

WILFORD.

LEBANON, Pa., Jan. 28.

WILFORD (Care of HALL & Co.)

Dear Sir: Your kind and highly interesting letter, containing your answer to my inquiry, was received two days ago, and read with great pleasure and with *entire satisfaction*. I would have replied sooner, but I desired, before doing so, to consider your letter thoroughly. I also took the liberty of showing it, with your other letter to me, to Prof. L. McFadden, of Lebanon Valley College, and fully acquainting him with the whole matter of our correspondence. He is a young man whose father is Professor of Natural Science in Otterbein University, at Westerville, Ohio (my *alma mater*). The young Professor purchased one of your books (through my recommendation), read it hastily through, and during a short vacation visited his father, and left the volume with him to read. He is very much interested in it; and, on reading your last letter, containing your solution of the "tank" and "pebble" problems, he expressed a desire to have his father see it. I took the liberty of granting him the privilege of sending it to him; so your letter is now on its way to Otterbein University, but will be returned to me again. Pardon this liberty, as I have acted with a desire to aid your work.

I wish now to say that your letter has fully satisfied me that the "pebble" problem is false, as well as the "tank" problem. Your reasoning is perfectly conclusive to my mind that the authorities which teach such principles of philosophy and physical science are wrong; and consequently I have no hesitation in admitting that, in my opinion, *the undulatory theory of sound is hopelessly shattered.*

Indeed, I wish to state, right here, that your first letter to me, after you had received the problems, in which you so positively asserted your ability to prove them *false*, set me to thinking on the matter. Previously I had, as I suppose most students do, simply taken what the books taught respecting these things as science and fact, without stopping to question their correctness. But, as already stated, your letter set me to *thinking*, as to the correctness of the "tank" problem; and on the evening of the day before I received your explanation, I had arrived at the conclusion that it must be *false;* and so expressed myself to my son, who is now a senior in the classical course of Lebanon Valley College. In discussing the matter with him, I entered into a careful calculation of the physical and mechanical questions involved; and I assure you that my method of explaining the falsity of the "tank" problem, and the actual change effected by inserting the cubic foot of *lead*, was in many respects exactly like your own. I am, therefore, fully satisfied that your reasoning is sound; and that the works on physical science which teach the contrary are wrong. I am consequently now prepared to drop the undulatory theory of sound as a *monstrous absurdity*.

I will be pleased to aid you in your fight, so courageously inaugurated; and, if at any time you see where I can be of service to you, please inform me, and command my services.

Most respectfully yours,

I. L. KEPHART.

In another letter to WILFORD, dated Feb. 11th, Prof. KEPHART says:—

"I am glad to learn that there are a few investigators of physical science who can lay aside their prejudices, and give your arguments a candid reading. All such must be convinced that the undulatory theory of sound is a scientific delusion, and wholly without foundation in fact. I am still reading *Evolution of Sound*, and the more I examine it the greater is my astonishment that the wave-theory should ever have been accepted as correct, much less that it should have been believed in for centuries by so many eminent men. * * * Sincerely yours,

I. L. KEPHART."

CHAPTER VII.

Review of Prof. Haeckel.

SPONTANEOUS GENERATION, EMBRYOLOGY, ETC., ETC.

[Synopsis of Contents.]

Darwin entitled to the credit of Modern Evolution as a System.—Brief statement of the views of Darwin and Haeckel.—Spontaneous Generation the start of Evolution according to Haeckel.—This hypothesis examined.—The *Moneron*, the simplest of all animals, the first generated organism.—Haeckel's contradiction of himself, Darwin, and Huxley, pointed out.—Philosophical objections to Spontaneous Generation.—The Reign of Law in Nature.—Variously illustrated.—Intelligent design in Nature demonstrated.—Examination of Prof. Haeckel's Great Laws of Ontogeny and Phylogeny.—Their self-contradictory character pointed out.—Similarity of Embryological Development examined.—The Little Human Tail and Human Gills examined.—Haeckel's unfortunate Plates against him.—The Cut of the Embryonic Fish suicidal.—Haeckel's Infinite and Unlimited Law proves that a God might develop from a Worm.—Haeckel's arguments fully met by his own subsequent admissions.—Another Fundamental Law (Biogeny) introduced and examined.—Shown to be full of self-contradictions.—Serious difficulties proposed on the origin of Unisexual from Bisexual Organisms.—Shown to be impossible but by Special Creations.—Darwin's Theory of Sexual Selection examined.—It demonstrates the existence of a Personal God.—Conclusion.

In attempting a refutation of the evolution hypothesis, no more satisfactory or effective method presents itself than a critical examination of the writings of the highest representative authorities on the subject. Such authorities—acknowledged universally to stand pre-eminently foremost—are the three great scientists—Darwin, Huxley, and Haeckel—chosen for special review in this work. If their positions can be shown to be untenable, and their arguments fallacious and self-contradictory, it is reasonable to conclude that evolution, as advocated by any other and all other writers, must fall to the ground.

Mr. Darwin is, in the strictest sense, the father of modern evolution, though the general principles of the hypothesis have been urged by many previous naturalists, while Professor Haeckel, of the University of Jena, who was among the first to adopt Mr. Darwin's views, is now considered the boldest, most radical, and advanced advocate of the system who has written on the subject, and by many is regarded as the ablest. In reviewing the arguments of these eminent scientists, I shall not undertake to follow any particular order, aiming only to make sure that not one class of facts or fair inferences, relied upon by these authorities, shall escape critical examination.

As a suitable commencement of this general review, I have deemed it advisable to devote one chapter principally to the two great works of Professor Haeckel—The History of Creation, published some seven years ago, and The Evolution of Man, just issued, with incidental references to Mr. Darwin's views as occasion may suggest.

The chief difference between these two eminent representatives of the new philosophy, relates to the manner in which the primordial form of life (from which all other forms are supposed to have devel-

oped) took its rise. Both agree that at an early period in the world's history no living thing existed upon this planet. Both agree that the primitive form of life, as the nucleus of the countless tribes of animals extinct and extant, could not have been imported from some other planet or stellar world. Hence, at a certain definite time, the "primeval parent of all other organisms" must have come into existence out of inorganic matter by some means not now apparent; and while Mr. Darwin concludes, as the only rational supposition, that God miraculously formed the first organism and breathed into it the vital spark which constituted it a living creature, Prof. Haeckel as distinctly rejects the idea of, or necessity for, a God, or any other intelligent power in the universe, and holds that this primitive animal, from which all other animals, including man, have sprung, arose "by spontaneous generation out of inorganic matter," by laws inherent in the matter thus organized. With the exception of this single difference in their views, these two greatest representatives of modern evolution, however much they may contradict each other in detail, are in perfect accord, both teaching that from this single primitive form of life,—or at most, a very few such simple forms, without any subsequent supervision of the God of Nature,—the entire animal kingdom has developed by transmutation, under the natural laws, principles, and conditions; designated variously as "environment," "struggle for existence," "heredity," "laws of descent and adaptation," "natural selection," "survival of the fittest," etc. Although Mr. Darwin is justly entitled to the credit of having given the first grand impetus to the doctrine of modern evolution, and of having collected and published to the world the first methodical classification of facts bearing upon this novel solution of the origin of species, it is more than doubtful if he has not been entirely outstripped, and his researches eclipsed by his younger and more vigorous German coadjutor, of the University of Jena. The patient industry, and untiring persistence, however, of either of these great scientific workers, in trying to formulate and sustain the theory of evolution, have entitled them to all praise as persevering investigators of the phenomena of natural science,—a persistent effort, to say the least, worthy of a better cause. The following brief extracts from their works will give the reader a condensed idea of their respective views on the origin of animal forms, including the initial form of life:

"There is a grandeur in this view of life, with its several powers, *having been originally breathed by the Creator into a few forms or into one.*"—"The similar framework of bones in the hand of a man, wing of a bat, fin of a porpoise, and leg of a horse, . . . and innumerable other such facts, at once explain themselves on the theory of descent with slow and slight successive modifications."—"In regard to the members of each great kingdom, such as vertebrata, articulata, etc., we have distinct evidence . . . that within each kingdom *all the members are descended from a single progenitor.*"—"*All the living forms of life are the lineal descendants of those which lived long before the Cambrian epoch.*"—DARWIN, *Origin of Species*, pp. 420, 425, 428.

"But a truly *natural and consistent* view of organisms *can assume no supernatural act of creation for even those simplest original forms*, but only a *coming into existence by spontaneous generation*. From Darwin's view of the nature of species we arrive therefore at the natural theory of development."—"The fundamental idea which must necessarily lie at the bottom of all natural theories of development, is that of a gradual development of all (even the most perfect) organisms out of a single or out of a very few quite simple and quite imperfect original beings, *which came into existence not by supernatural creation but by spontaneous generation*, or archigony, *out of inorganic matter.*"—Prof. HAECKEL, *History of Creation*, v. i., pp. 48, 75.

Let us now commence our examination of the evidence upon which these broad conclusions are based, and as "spontaneous generation," without the aid of supernatural intervention (not even so much as Dr. McCosh's "favorable conditions, assorted by Divine wisdom"), lies at the very foundation of the theory of descent as taught by the German school of philosophers, we will first pay our respects to that wholly consistent and somewhat plausible assumption, as the start of evolution. And let me say here that the apparently crucial experiments of Dr. Tyndall and others, by which they have so frequently demonstrated that living *bacteria* will not appear in liquids from which all germs have been excluded, are not sufficient to satisfy the mind of the logical, and particularly skeptical, reader. Other decoctions, from which germs may be equally excluded, it may be and is claimed by Dr. Bastian and other advocates of spontaneous generation, have not yet been tried, and that when tried, under other conditions, they

may result differently. Hence, the negative testimony, that *bacteria*, or living animalcules, have not been produced in the decoctions already tried, and under the conditions alluded to, though well enough, as far as it goes, does not meet the case of Prof. Haeckel's ingenious method of reasoning. That sort of evidence requires to be answered in kind, its very logic and philosophy need to be overthrown, if they can be, and the principles involved in the hypothesis demonstrated to be self-contradictory and absurd. This accomplished, and the negative testimony of experiment will then come into play and clinch the logical nail. If the philosophy or scientific possibility of spontaneous generation, as urged by its ablest living advocate, shall fairly break down, with the evidence of all the crucial experiments on record corroborating its fallacy, then surely this method of accounting for the origin of life and the commencement of evolution must be abandoned as a hopeless failure.

In order to secure a reasonable basis for his arguments in support of spontaneous generation, Prof. Haeckel was fortunate enough to discover that exceedingly simple class of organic beings, called *monera*, "the simplest," he declares, "of all known organisms, as well as the simplest of all imaginable organisms," being mere lumps of pure albumen, without organs or heterogeneous parts. This tiny, pelagic animal, no larger than a pin's head, which inhabits the bottom of the ocean, Prof. Haeckel considers so slightly removed from inorganic matter that it must have required but a trifling effort of Nature to usher it into being from anorgana, and requires but a trifling effort of the imagination for us to conceive of the change necessary to produce such a simple organic being from not-living matter. Hence he flatters himself, and tries to flatter his readers that the spontaneous generation of such an imperfect creature out of inorganic matter was not an unreasonable supposition. It never seemed to have entered the mind of this renowned scientist that there is a spanless chasm separating the living, moving, voluntary animal, however simple, from the not-living, inorganic clod. All thought of this bridgeless hiatus was brushed aside by a single stroke of his pen, as of no consequence contrasted with the important object he had in view, of eliminating God from His works and starting evolution without the aid of supernatural intervention. Although this eminent savant could see these little creatures voluntarily move their bodies, pick up and absorb atoms of nutrition and assimilate them into their own organic structure, thrust out their so-called false feet, or *pseudopodia*, which he calls "finger-like processes,"—nothwithstanding he observed that the moneron grows by food assimilation, the same as a more complex organism, and that it propagates its species by a division of its body into two equal parts, each part again, by nutrition and growth, becoming an exact duplicate of the former whole,—yet, so intent was he upon the elimination of God from the universe, and of establishing an orderly and consistent harmony between Kant's Cosmogony and Lamarck's and Darwin's Theory of Descent, that the life and mental powers of this animal were belittled almost to nothing, while the inherent laws, properties, and forces of inorganic matter were exalted almost to the level of intellectuality itself. Yet this desperate effort to establish what he must have known to be an irrational and impossible hypothesis, is regarded by his materialistic adherents and admirers, as the acme of philosophical reasoning, and the quintessence of impartial scientific investigation.

I defy, however, any candid man, who has sufficient intelligence to reason logically on a philosophical subject, to carefully examine Prof. Haeckel's arguments for spontaneous generation, based on the *moneron*, and not come to the conclusion that there lies at the bottom of this whole effort an uncandid and one-sided desire to belittle and misrepresent this living animal, to serve the purpose of spontaneous generation as an excuse for ignoring God in the works of creation. Permit me then first to quote briefly what he says about this little creature, as a better foundation for my comments:

"Of *still greater*, nay, *the very greatest importance to the hypothesis of spontaneous generation* are, finally, the exceedingly remarkable *Monera*, those creatures which we have already so frequently mentioned, and which are not only the *simplest of all observed organisms*, but even the *simplest of all imaginable organisms*. . . . Through the discovery of these organisms, *which are of the utmost importance*, the supposition of a *spontaneous generation loses most of its difficulties*. For as *all trace of organization—all distinction of heterogeneous parts—is still wanting in them*, and as all the vital phenomena are performed by one and

the same *homogeneous* and *formless matter*, we can easily *imagine their origin by spontaneous generation.*"

"The whole body of these *most simple of all organisms*—a semi-fluid, formless, and simple lump of albumen,—consists, in fact, of only a single chemical combination." . . . "Formerly, when the doctrine of spontaneous generation was advocated, it failed at once to obtain adherents on account of the *composite structure of the simplest organisms then known.* It is only since we have discovered the *exceedingly important Monera*, only since we have become acquainted in them with *organisms not in any way built up of distinct organs*, but which consist solely of a single chemical combination, and yet grow, nourish, and propagate themselves, that this great difficulty has been removed, and the hypothesis of *spontaneous generation has gained a degree of probability* which entitles it to fill up the gap existing between Kant's Cosmogony and Lamarck's Theory of Decent."

"Only such *homogeneous organisms* as are yet not *differentiated*, and are *similar* to the inorganic *crystals*, in being *homogeneously* composed of *one single substance*, could arise by spontaneous generation and could become the *primeval parents of all other organisms.*"

"We have before this become acquainted with the simplest of all species of organisms in the *monera*, whose entire bodies when completely developed consist of *nothing* but a semi-fluid albuminous lump; they are *organisms* which are of the *utmost importance* for the theory of the *first origin of life.*"

"The simple method of propagation of the Moneron by *self-division*, is, in reality, the most universal, and most widely spread of all the different modes of propagation." . . . "A *pinching in takes place*, contracting the middle of the globule on all sides, and finally leads to the separation of the two halves. Each half then becomes *rounded off*, and now appears as an *independent individual, which commences anew* the simple course of *vital phenomena* of *nutrition* and *propagation.*"

"When the Moneron *moves itself*, there are formed on the upper surface of the little mucous globule *shapeless finger-like processes*, or *very fine radiated threads;* these are the so-called *false feet*, or *pseudopodia.*"—HAECKEL, *History of Creation*, vol. i. pp. 185, 186, 187, 330, 332, 334, 344, 345.

To suppose that an organic being can exist wit.. all the functions of vitality, nutrition, growth, reproduction and voluntary motion, *and yet be destitute of parts and organs corresponding to such functional endowments*, just because these parts and organs are not visible under the microscope, is to assume an absurdity so self-evident and monstrous as justly to entitle its author to no consideration at all as a philosophical reasoner. How, I ask, in the name of science, can the moneron "move itself," and voluntarily thrust out its "so-called false feet or pseudopodia" in "finger-like processes," without corresponding muscles or their equivalent organism, even though they may be invisible? And how can these voluntary operations take place without corresponding vital and mental powers? And how can these vital and mental powers exist and manifest themselves in such voluntary movements without brain, nerves, &c., or their equivalents, since Prof. Haeckel, time and again, tells us that *life* and *mind* are "nothing" but the complicated motions of the molecules of the brain and nerves "*placed together in a most varied manner*"? (History of Creation, vol. 1. p. 199.) If this living, moving, thinking, volitional, growing, propagating animal has no organs, equivalent to brain and nerves, however transparent or invisible, then where are the cerebral "molecules" to be "placed together in a most varied manner" by which to keep up those peculiar motions constituting the life and mental powers of this creature? As he distinctly tells us that this living animal has neither organs nor parts,—neither brain nor nerves,—and yet that it possesses *life* and *mental* powers, it flatly contradicts his definition of life and mind as being but the motion of cerebral molecules,—thus proving life and mind to be a *substantial something* independent of such molecular motion and thereby overturning, by his own reasoning, his entire materialistic philosophy!

It seems almost like a waste of time to follow this author and point out the fallacious character of his position and arguments as based on the supposed spontaneous generation of these lowly organisms. The reasoning is so self-contradictory and consequently so self-annihilating, from first to last, that one scarcely has patience to reply to it. Take, for example, this vital feature of the argument, and upon which the whole superstructure of spontaneous generation is reared, namely, that the moneron is "homogeneously composed of *one single substance*,"—a "*formless and simple lump of albumen*,"—and its utter falsity is made manifest by the following self-contradictory sentences which I quote from Prof. Haeckel himself:

"In *all living bodies without exception* there is a certain quantity of *water combined* in a peculiar way with *solid matter.*" "*All animals* and all plants, *in fact all organisms*, consist in great measure of *fluid water*, which combines in a peculiar manner with *other substances.*"—*History of Creation*, vol. i, pp. 327, 329.

How in the name of reason can the body of the moneron consist of only "*one single substance*"—*albumen*—when "all animals," "all organisms," "all living bodies without exception," consist of *water* and "*other substances?*" *Water*, surely, is not *Albumen!* Having started out, it seems, with the desperate purpose of showing probable ground for the possibility of spontaneous generation, it became necessary to describe the moneron ("the *simplest of all imaginable organisms*") as *composed of one single substance*," even though he should be forced flatly to contradict it in the very next chapter. Is such an outrageous falsifier of Nature fit to teach the world science?

He not only contradicts himself, but flatly contradicts Mr. Darwin:

"We cannot fathom the *marvelous complexity of an organic being;* but on the hypothesis here advanced (pangenesis) this complexity is much increased. *Each living creature* must be looked at as a *microcosm*—formed of a host of self-propagating organisms, inconceivably minute, and as numerous as the stars of heaven."—*Animals and Plants*, vol. ii, p. 483.

Yet Prof. Haeckel declares that this "living" animal so far from containing "a host of self-propagating organisms," is "composed of one single substance"—"one and the same homogeneous matter," and instead of constituting it a "microcosm," as Darwin has it, in order to make it a suitable subject for spontaneous generation he declares it absolutely to be without organs or parts. But he not only contradicts himself and Mr. Darwin, but he is equally in conflict with Prof. Huxley:

"No living being is throughout of *homogeneous substance.*"—HUXLEY, *Elementary Physiology*, p. 15.

Prof. Haeckel, however, maintains, as just quoted, that this spontaneously generated "primeval parent of all other organisms" is *homogeneously* composed of *one single substance.*" Now, which statement are we to believe: this special and evidently ill-considered or purposely fabricated plea for the irrational hypothesis of spontaneous generation, or the deliberately considered statements of the three high authorities quoted, including Prof. Haeckel himself? Clearly, judging from the testimony of these three witnesses, spontaneous generation falls to the ground as an utter impossibility, since Prof. Haeckel distinctly asserts, as above quoted, that "*only such homogeneous organisms as are . . . homogenously* composed of *one single substance could arise by spontaneous generation!*" Now, as the moneron is the "simplest of all imaginable organisms," and according to Haeckel, contains not only "albumen," but "water" and "other substances," and according to Darwin is a "microcosm," and according to Huxley cannot be "throughout of *homogeneous substance*" it follows demonstrably by the united testimony of the three witnesses that a moneron could not have arisen by spontaneous generation, not being "homogeneously composed of one single substance," and consequently that Prof. Haeckel's theory, so far from filling up the "gap existing between Kant's Cosmogony and Lamarck's Theory of Descent," ingloriously breaks down at the very start!

I might thus, without writing another sentence, leave Prof. Haeckel's History of Creation as so much waste paper, based, as it is, on this spontaneously generated moneron; but I cannot afford to be so mercifully unkind to the reader. The professor's relentless and bitter assaults upon everything in the shape of religion, and his boastful denial even of the existence of a God in the origin and control of the universe, entitle him to no lenity or mercy at the hands of an impartial reviewer. He *gives* without the least respect to the most sacred feelings and sentiments of the religious world, and he must be prepared to *take* with the same measure he metes.

Let us now examine for a moment the philosophy of this assumption that a living, organized being can by any possibility be constituted of one single substance, or be destitute of organs or parts, a supposition upon which this entire so-called "History of Creation" is founded. To assume such things of any living animal, just because the microscope does not reveal organic parts corresponding to manifested organic functions, is to fly into the face of reason and common sense, and trample under foot all that we know of the relations existing between cause and effect. To admit, as does Prof. Haeckel, that a living animal had the power voluntarily to thrust out its *pseudopodia*, move its body, cut itself in two, and grow by food assimilation without organic structure or parts by which these results are effected, even though such organs are beyond the range

of the most powerful microscope, is to write philosophical drivel so puerile as to justly forfeit all claim to be reasoned with as a rational human being. It is only the fact that these books are placed in public libraries, and are read and believed in as profoundly scientific by evolutionists generally, that makes them entitled to any kind of serious reply.

Take the admitted fact that the "moneron *moves itself*," and then ask this high authority how anything can "move itself" without possessing and using some structural arrangement of parts or organs? The cilia of the rotifer, for example, are seen to move and whirl with indistinguishable rapidity as viewed under a powerful lens, but who that pretends to philosophical knowledge would suppose that no muscular organs or analogous parts exist at the base of these ciliated hairs to effect such motions just because they are wholly invisible under the most powerful microscope? Yet this superficial philosopher, whose writings are sought by the learned world, sees the moneron thrust out its pseudopodia in "finger-like processes" and "move itself," and yet denies the existence of any muscles or analogous organs at the base of these "processes" to cause such projection to take place, just because the microscope does not reveal them, and more especially because his theory needed just such an organless animal to make spontaneous generation out of inorganic matter appear feasible! An investigator who can thus virtually deny the existence of anything in the organic structure of an animal that he cannot detect by the magnifying power of the microscope, even after he witnesses the voluntary motions which can only occur by means of organs corresponding to such vital functions and movements, may be competent to fill the chair of Natural History in the University of Jena, but he would not pass muster here as assistant teacher in a village school.

What if the moneron does appear to be but a lump of pure albumen or a small mass of semi-transparent sarcode, does this fact preclude the idea of separate organs or heterogeneous parts? Because organs are translucent or even transparent, is this proof that they do not exist? Prof. Haeckel is surely aware of the fact that many pelagic animals such as different species of meduce, or the common jelly-fish, are so transparent as to be scarcely distinguishable from sea water, and even some species of crustaceans, which are as transparent as glass itself, yet which necessarily possess all the complexity of organic parts common to opake species of the same class. Would he deny that such an animal possesses eyes because of their invisibility, notwithstanding he witnesses its alertness in escaping from approaching objects? Would he not rather conclude, as a logical naturalist should do, that the various voluntary and involuntary functional movements of such animals necessarily go to prove the existence of corresponding organs, whether they can be seen or not?

Take the corpuscles of blood as an illustration, and let this learned scientific authority examine one of them never so closely with his best microscope, and will he discover in it anything but an apparently "formless" mass of homogeneous matter? All the visual power he can bring to bear upon it will give him no clue to the well-known fact that it contains numerous substances, such as chlorides, carbonates, phosphates, water, &c., besides its principal ingredients of albumen and fibrine. A microscope of a thousandfold greater power would do no better. Yet it has been demonstrated by chemical analysis that this single blood-corpuscle, which the ordinary microscope barely reveals, contains absolute particles of *iron*, *salt*, *potash*, *lime*, *sulphur*, *phosphorus*, *sugar* and *magnesia*, which, though we speak of them as solutions, exist nevertheless in absolute masses as really and literally as do pebble-stones that are washed along our brooks, had we the magnifying power in our lenses strong enough to detect them. Whether such perfection in the microscope will ever be attained or not, a *true* philosopher does not ask the evidence of his eyes before he can believe in the existence of these constituent substances of the blood, nor would he be so weak as to deny the existence of invisible organic structure to an animal when it clearly shows that it possesses the vital functions of nutrition, growth, reproduction, and voluntary motion which he knows can only be accomplished by the operations of corresponding parts and organs.

Not only are many of these blood corpuscles so diminutive as to be entirely beyond the reach of the microscope, but even the veins and arteries themselves,

which convey them through the animal organism by hundreds of thousands, are often too small to be seen by the aid of a powerful glass. An able authority on these marvels of physiological science, assures us that:

"The investigation of the phenomena of circulation has exhibited the mode in which arterial blood is distributed over the body in *minute vessels* not appreciable by the naked eye, and often *not even with the microscope*, and so numerous that it is impossible for the finest-pointed instrument to be forced through the skin without penetrating one and perhaps several. . . . . As the precise arrangement of these *minute vessels is not perceptible* by the eye *even when aided by powerful instruments*, this arrangement has given rise to controversy."—"We see *blood* proceeding to the liver, and the vessels that convey it ramifying in the texture of that viscus, and *becoming so minute as to escape detection, even when the eye is aided by a powerful microscope.*"—DUNGLISON, *Human Physiology*, pp. 72, 475.

Yet Prof. Haeckel, by denying the existence of organs in the moneron because they are not visible under the microscope, all to serve his erratic project of spontaneous generation, virtually denies this authoritative statement of Dr. Dunglison, and must consistently maintain that there are no terminal capillaries conveying the blood from the arteries to the veins, since the microscope does not reveal them, and therefore the blood must jump across this chasm without conduits if it gets across at all; or possibly he will claim that it ceases to exist at the termination of the arteries, and that new blood, for the venal circulation, is formed by "spontaneous generation." Why not? But if these capillary conduits do really exist, and yet are so minute as to be invisible by the aid of the microscope, to say nothing of the globules of blood which freely float through them, and to say nothing of the granules of iron, salt, sugar, potash, phosphorus, sulphur, lime, &c., which constitute these corpuscles, is it not the weakest of philosophical reasoning for a great scientist to deny the existence of heterogeneous organs and parts in any animal, however lowly in the scale of vitality and organic structure, simply because he is unable to detect the existence of such organs under the microscope?

But then he has further asserted that monera are pure *albumen*, and therefore must be of "one single substance." How does he know this? How does he determine that they may not also contain *fibrine*, since it is impossible for any chemical analysis to distinguish positively between *fibrine* and *albumen*? I prove this by the following high authorities:

"Physiologists have been accustomed to speak of the *albuminous* tissues, but the author believes he is justified in asserting that *no chemical difference exists* by which *albumen* and *fibrine* can be certainly distinguished."—CARPENTER, *Animal Physiology*, p. 294.

"Chemical analysis has led to the remarkable result that *fibrine* and *albumen* contain the same organic elements, united in the same proportions, so that two analyses, the one of *fibrine* and the other of *albumen*, *do not differ.*"—LIEBIG, *Organic Chemistry*, p. 41.

Hence, if this eminent German naturalist cannot possibly know but that *fibrine*, as well as *albumen*, makes up a part of his indispensable little "homogeneous" organism "without organs," may not many other substances as well as complex organs and parts, though invisible, be also involved in the moneron, especially as he has himself assured us that "all living bodies *without exception*," contain "water" as well as "other substances?" Really this great evolutionary revolutionizer needs to study caution in making assertions as a special branch of science.

As a fair specimen of the difference between Prof. Haeckel and Mr. Darwin—the former trying to belittle an organic being almost to the dust of the earth, in order to suit it to his spontaneous-generation theory, and the latter trying to portray the wonders of natural selection in its development of a living creature—look at the following from Mr. Darwin's pen, in contrast with Prof. Haeckel's disparaging description of his spontaneously generated homogeneous, organless, albuminous "*primeval parent of all other organisms*":

"The *most humble organism* is something *much higher than the inorganic dust* under our feet; and no one with an *unbiassed mind* can study *any living creature, however humble*, without being struck with *enthusiasm* at its *marvelous structure* and *properties.*"—DARWIN, *Descent of Man*, p. 165.

But in vain do we search through Prof. Haeckel's description of the moneron for anything bearing even a faint resemblance to that "enthusiasm" which so inspired the father of modern evolution in his examination of "the most humble organism;" nor do we find one word in the entire History of Creation, about its "marvelous structure and properties," the reason for which is clearly implied in Mr. Dar-

win's saving clause—"unbiassed mind." The professor, with more *bias* than scientific discrimination, had his theory of spontaneous generation to sustain in order to form a rational foundation for evolution without admitting a God, which was so clearly lacking in Mr. Darwin's admitted miraculous interposition of the Creator for the first simple organisms; and hence he must necessarily belittle and degrade the "marvelous structure and properties" of this wonderful little organism almost to "the inorganic dust under our feet" in order to sustain his view of the origin of life on this earth by "archigony," as he calls it. A more *biassed* and even bigoted treatise on a scientific subject hardly exists in any language.

But there are also general philosophical objections to the hypothesis of spontaneous generation which render it wholly inadmissible, aside from the self-contradictory statements of its chief exponents, and in addition to the acknowledged absence of any experimental tests going to favor its possibility. The very idea of life originating out of not-living matter, independently of supernatural intervention, and that, too, without any such thing as pre-existing life or mental powers in the universe from which vitality and mentality could come, is a self-evident absurdity on its face. Such hypothesis would be even more difficult to accept than the unnecessary and unscriptural dogma that God created the world out of nothing. No man would be more ready, than Prof. Haeckel, to detect and point out such a philosophical impossibility as the idea of something having been created out of nothing, and he would be justified in so doing on the general axiomatic ground that "from nothing nothing comes." Yet he labors through a large portion of the "History of Creation," to prove that the *life* and *mental powers* of the first living organism—powers so wonderful as to constitute it "the primeval parent of all other organisms"—came into existence out of absolutely *nothing*, since no life or mentality existed in the universe prior to the spontaneous rise of this marvelous little animal. Hence, "poetic imagination," to which he ascribes all religious belief in the supernatural, and on account of which there is no end to his ridicule of Christians, exists in his own brain to a degree unparalleled even in that of an insane religious fanatic. It is impossible to conceive of a more superstitious and inflamed poetic fancy than the one which enables its possessor to believe in the *creation* of the most important thing about an animal—its life and mental powers—out of nothing, and that, too, without a *creator!* Those who believe in the creation of the world out of nothing, do not make themselves ridiculous by adding to it the absurdity of such *creation* without an almighty power for its accomplishment. But Haeckel's inflamed poetic fancy pictures his own soul as originating out of nothing, in the person of his "primeval parent," the moneron, without the aid, even, of any originating power whatever. This modern Democritus is so surcharged with poetic imagination, that he sees not the least difficulty in believing, "with full assurance," as he expresses it, that the most important *something* connected with man or the lower animals, could not only come into existence out of nothing, but that there can easily be a *building* without a *builder*, a *generation* without a *generator*, *laws* without a *lawgiver*, and a *creation* without a *creator!* I solemnly aver that if all the religious faith in the supernatural, of all the theological seminaries, colleges, and universities in Christendom, were boiled down and concentrated into one chair, it would not constitute a tithe of the poetic imagination which now falls to the lot of the single chair of natural history in the university of Jena. Yet this revolutionary prodigy of the nineteenth century, with an arrogant claim to about all the "philosophical culture" of the age,* ridicules a religious belief in God and His works of creation and providence, as but a superstitious poetic fancy, too weak and childish for a scientific thinker to entertain for a moment, and only suited to the brains of sentimental women and precociously developed children! A scientific investigator who is possessed of such "philosophical culture" that he cannot

* "What is even more detrimental to the general understanding of nature as a whole than this one-sided tendency, *is the want of a philosophical culture, and this applies to most of the naturalists of the present day.* . . . It is not to be wondered at that the *deep inner truth* of the *theory of descent* remains a sealed book to those *rude empiricists.* . . . Even in our own day *most paleontologists* examine and describe fossils *without knowing* the most important facts of embryology."—HAECKEL, *History of Creation*, vol. ii., pp. 247, 249, 250.

conceive of a single grain of sand, coming into existence out of nothing, even with the aid of almighty power, renders himself supremely ridiculous in the eyes of the thinking world by teaching for science, as does Prof. Haeckel, that the great soul and intellect of Sir Isaac Newton, for example, actually came into existence out of nothing by spontaneous generation; because the mental powers of Newton all came from those of the *moneron*, "the primeval parent of all other organisms," there being no other source of mentality in the universe from which he could derive intellect, save that of his animal ancestors, which, of course, had obtained their supply from the same spontaneously generated "primeval parent!"

To assume that the spontaneous generation of the first living organism was the result of the *laws of Nature*, acting upon inorganic material, and so combining its lifeless particles as to generate life and mental power, and that these laws were eternal in their nature and operation, is simply admitting the existence of God, to all intents and purposes, under another name. For *laws* of Nature, which could so manipulate lifeless matter, and so shape it, as to create a living, volitional, moving, growing, propagating animal, must possess life and mentality to be imparted to such material structure, since nothing can impart to an object that which it does not itself possess. These laws of Nature, which possessed this power to change inorganic dust to organic protoplasm, albumen bioplasm, or whatever we may please to term it, and then were capable of transfusing into such lifeless mass the elements of vitality and mentality, or volitional instinct, must have possessed the capability of first designing an organic structure, with its complex parts adapted to the exercise of such vital and instinctive functions. And after having planned such an organism—requiring the very highest conceivable order of intellectuality—these "eternal laws of Nature" must have possessed the power of transferring to such lifeless mass a fraction of their own life and mentality in order to animate the organism thus designed and shaped. Such assumed laws of Nature, therefore, clearly involve the very idea which we understand by the personal attributes of an omnipotent, omniscient, and omnipresent God; and their assumed work, in thus producing a single organic being out of inorganic matter, would be the equivalent, in every sense of the word, of the direct personal act of an intelligent creative Will. Prof. Haeckel's attempt, therefore, to attribute the origin of life and mental power, in the moneron, to the operation of the "eternal laws of Nature," in order to eliminate the intelligence and hand of God from His works of creation, is but an unintentional conversion of his lifeless, designless, mindless and willless materialistic philosophy into a sort of improved form of pantheism, by changing Nature into a Personal God, having every quality and attribute ascribed to Him by Christian or Jew, thus affording another self-contradictory exhibition of his singularly inconsistent philosophy.

We do not doubt the reign of law as inseparable from every work of God in creation and providence. We hold that God could no more act, in the construction of a living form, without the use of the laws of Nature, which He had ordained for the purpose, than He could deny himself or cease to exist,—or than He could create a world out of nothing; for such creation out of nothing, and such alone, would be without law and in defiance of it. The laws of Nature are God's mode of operation in the physical universe, or His method of manifesting Himself to His creatures, and may, to this extent, be considered a part of Himself, just as man's voluntary acts, through the instrumentality of his hands and fingers, are a part of himself.

But as the reigning Monarch and Lawgiver of the universe, it is but rational to believe that special laws may also be enacted for special purposes, which, after having served their ends, as in miraculous interpositions, may be abrogated and set aside by the same power that enacted them; just as statutes in human legislation are annulled when no longer needed. But that anything is done without law by God, by man, or by the operations of the elements of Nature, I deny equally with Prof. Haeckel, or any other evolutionist.

There is no such thing as *chance* or *accident* in Nature, and no such a word as *happen*, scientifically speaking, though, by unscientific usage, we may speak of a thing as having happened by chance or accident, when the cause is not apparent or not foreseen and provided against. Every act, however trifling, in the complex realms of motion, is as certainly determined by in-

flexible enactment, and by laws as fixed and settled as are those which control the movements of a planet. Not a down or thistle-pappus, whirled and drifted by the cyclone, but at last will end its journey in some definite location determined by law; and this would be again repeated, and a thousand times repeated, with the nicest precision, the down falling in the same position without one hair's variation, should the same wind act upon it and the same force be exerted under similar conditions. Thus, through laws ordained by Heaven not a single sparrow falleth without His all-searching notice, while our very hairs are numbered.

We often fail to recognize the presence of law in the operations of Nature, owing to the complex intermingling of laws and causes of phenomena, proximate and remote. There is no effect, however, produced in the universe but it depends on a cause involved in a law of Nature. The direct or immediate cause of one operation may be the secondary cause of another so remote that we can scarcely trace or detect their relation one to another; and could we trace or untangle all the causes of an event, immediate or secondary, efficient, proximate, or remote, we would find them but links, connecting other causes, correlated in one grand concatination, back to God the primal fountain—the ultimate causation of all proximate or secondary conditions.

Thus the thistle-down was anchored, after being whirled through the heavens for days, perhaps, carried by ærial currents in various directions, till at last entangled in the meshes of some grassy fiber, not by chance or accident, but by law. For the pappus was pulled down toward the the earth by the law of gravity, while it was carried upward and onward by the counteracting force of the wind. But the wind had its cause in heat, rarefying air in strata. Heat was caused by the rays of the sun, but modified by other causes such as those of rain-clouds, which again acted as causes in modifying the direction or force of the wind. Again, these rain-clouds were caused by heat coming from the sun and falling upon the surface of some body of water, changing it into vapor, thus causing it to rise high into the air where a cold stratum of the atmosphere caused it to condense into rain and fall upon the meadow, thus causing that particular spire of grass to shoot forth as the immediate cause of arresting and anchoring the pappus. And in this way do causes, and laws, and forces, intermingle and ramify through each other, interlaced beyond all comprehension of the most cultivated human intellect, while the sum of all conditions, proximate, secondary and remote, is embodied in the great ultimate cause of all causation—God himself,—as much surpassing Nature, and her complicated laws and forces, as the sun in the heavens outweighs the down of the thistle.

But notwithstanding we are thus forced to recognize the operation of law in every event that occurs, there is and must be something above law in Nature, as there is something even above Nature in the universe, by which her laws have to be not only enacted, but intelligently directed, in order to the accomplishment of the very things which Prof. Haeckel claims as the result of forces that act without intelligence and without a purpose. He says:

> "All the different forms of organisms, which people are usually inclined to look upon as the products of *creative power, acting for a definite purpose*, we, according to the theory of *selection*, can conceive as the *necessary productions of natural selection*, working *without a purpose*."—HAECKEL, *History of Creation*, vol i., p. 176.

Passing by the question of the development or improvement of specific forms by natural selection, for the present, it is well to confine Prof. Haeckel to the first living animal—"the primeval parent of all other organisms," which confessedly did not and could not originate by "natural selection," because there manifestly can be no selection till there are animal forms from which to select, and no survival of the fittest, till animals, *fit* and *unfit* for survival, first exist, and consequently must have either been created or spontaneously generated. The stubborn question, then, presents itself to this radical phase of materialistic philosophy: is it rational to suppose that an *animal*, possessing all the functional organs of life necessary for growth, procreation, nutrition, voluntary motion, mental power, etc., could have been thus constructed by the action of purposeless laws and forces, without intelligent direction having been given to them, by which to bring the particles of matter together in suitable relation for the exercise of such vital and mental functions, and the production of such vital and mental phenomena? The

mere asking of the question is to emphasize the answer in the negative. As well might we expect the wind of the desert to drift the sand into furrows and ridges in such manner as to constitute the letters of the alphabet, and in such order as to spell out and write out the Lord's prayer precisely as recorded in the book of Matthew.

Should Prof. Haeckel chance to visit a far-off sand-plain in some uninhabited region of the world, and there read the Lord's Prayer, or the Declaration of Independence, in plain letters in the sand, where no human foot-prints or other signs were visible, he would nevertheless instantly conclude that some educated human being had been there before him. But were that hypothesis absolutely precluded by circumstances, and should he be forced to believe that the letters, words and sentences were really produced by the action of the wind in drifting the sand, he would then as certainly and instantly conclude that some intelligent power must have had control of the wind and given direction to its currents by which these intelligent and intelligible results had been accomplished. He would not for one moment think of attributing this orderly and purposive arrangement of the sand-particles into letters, words and sentences to the operation of the settled laws of Nature, or to the interaction of the physical forces, unless such laws and forces were absolutely under the direction of some intelligent power capable of thus controlling their action. Notwithstanding this would be his philosophical conclusion without a moment's hesitation, yet his first living animal—the *moneron*—(which contains within its inconceivably complex organism all the organs and parts, though invisible, needed for the purposes of nutrition, growth, reproduction, self-division, voluntary motion, mental power, etc.) presents to the mind of this philosopher no orderly or intelligent arrangement of parts or particles, no adaptation of means to ends, that might not easily have resulted from the purposeless washing of the ocean waves, and their designless action upon some chance atom of sedimentary deposit, two hundred million years ago! He has no trouble at all in believing that the blind and will-less laws and forces of Nature, with no intelligent direction whatever, might have easily organized this first living animal, which Darwin declares no "unbiassed mind can study . . . without being struck with enthusiasm at its *marvelous structure and properties*," and which, for grandeur of conception, intelligent originality in design, and inconceivable skill in execution, as far surpasses the supposed letters and words of sand in the desert, as the magnificent oration of a Webster transcends, in intellectuality, the unintelligible chattering of the magpie.

That an intelligent design cannot occur in Nature without the intervention of an intelligent designer, is an axiom so well settled, even in the roots of science, that to deny or seek to evade it, from whatever pretext, indicates a mind devoid of balance. Organized or living bodies, in the very nature of organic formations, cannot come into being from inorganic matter without a creative power behind them and above them capable of forming such structures, and possessing the life and mental powers for transference to such organisms necessary to make them living, volitional beings. I care not whether this creative energy be designated as a law of Nature, or as the God of Nature, it amounts to the same thing, since such organizing power, as I have already urged, must not only possess intelligence to design the structure, but the life and mental powers with which to animate the organism after it is shaped. It must therefore stand forever as a settled and self-evident proposition, against which the waves of atheistic materialism will dash in vain, that no animal structure, with parts suited to ends and uses, and where results are gained by the motion of such parts in combination, could have come originally into existence *without previous plan and purpose on the part of some intelligent designer and artificer*. I simply defy the mind of mortal—and here evolutionists are challenged—to conceive of an animal organism of the simplest form in Nature where the living adaptation of its parts and vital functions operate in harmony with the objects and uses of its being, without admitting the prior existence of wisdom, plan, forethought, in such structural adjustment. Such a conception would be as impossible, in the very nature of things, as when looking upon a complicated time-piece to conceive of it as having originally come into existence by the accidental falling together of cogwheels, journals and journal-boxes, without an in-

telligent designer or mechanical constructor. It is true, that individual time-pieces now examined, may have been turned out by ingenious machinery, and may not have cost a single minute's serious thought on the part of the mechanic or artizan who put them together and set them to keeping time; just as a young fox now comes into the world by the machinery of established laws of Nature, without the special attention of any intelligent designer or supervisor. But leaving this individual machine-made clock or watch, let us go back to its earliest progenitor,—the first clock or watch that was ever made,—and conceive of it, if we can, coming into existence by the unconscious mingling of journals, cog-wheels, etc., without admitting the pre-existence of intellectual genius for its design, and mechanical, personal execution for its construction. So the present specimen of a young fox, with its inborn and inimitable cunning, is not the guide to the overthrow of spontaneous generation; but go back to the first fox, or, if evolutionists prefer it, to the first *moneron*, out of which the fox developed, and which must have contained, in their incipiency, the elements of the fox's cunning, and then try to conceive of it, with its complex, though invisible organism, and its nascent mental powers and vital functions, springing out of a little lump of inorganic dirt and without the intervention of pre-existing mind to plan its structure, or intelligent skill and energy to give direction to the atoms constituting its organism. Such a conception is a self-evident impossibility.

Thus do we demonstrate, in the most conclusive manner, that the spontaneous generation of a living animal is an impossibility in the very nature of things, so long as a less complex clock or watch could not make itself; though we are not required to prove a negative, considering it all-sufficient to rest on our logical rights and rationally claim the impossibility of spontaneous generation as fully established so long as its advocates can produce no proof in the affirmative.

But the most amusing and absurd feature of this hypothesis, on the part of its greatest exponent and advocate, remains to be exposed. Prof. Haeckel, after virtually giving up the contest and acknowledging that spontaneous generation is not now possible, and that it has never been proved by experiment, absolutely challenges his opponents (think of it, ye disciples of Watts!) *to prove its impossibility*, and declares, with a confident air of satisfaction (which he seems to think logically settles the whole question), that "The *impossibility* of such a process can, in fact, *never be proved!*" He even gives his reasons why its "impossibility" cannot be proved, by the fact that in the primeval times, when the first *moneron* came into existence by spontaneous generation (as if he knew by personal experience), "the *general conditions of life were entirely different from those of the present time*," and refers to "the enormous masses of carbon" then uncondensed into coal, as conclusive proof that "*a spontaneous generation which now is perhaps no longer possible, may have taken place.*" Such logic may do for the university of Jena, but it will hardly pass current among scientific thinkers here. But I will quote his statement sufficiently full, for the reader to see that the professor has not been misrepresented :

"The *impossibility* of such a process can, in fact, never be proved. For how can we know that in remote primeval times there did not exist *conditions quite different* from those at present obtaining, and which *may have rendered spontaneous generation possible?*" . . . "Think only of the fact that the *enormous masses of carbon* which we now find deposited in the primary coal mountains," etc. . . . "At that time, under conditions quite different from those of to-day, a spontaneous generation, which now *is perhaps no longer possible, may have taken place.*" . . . "Indeed we can even *positively* and with *full assurance maintain* that the general *conditions of life in primeval times must have been entirely different* from those of the present time." —HAECKEL, *History of Creation*, vol. i., pp. 341, 342.

Let us now examine this *carbon* argument which plays so important a part all the way through this discussion of the moneron in the History of Creation. Professor Haeckel thinks that the amount of uncondensed carbon floating in the air in the Carboniferous age may have rendered spontaneous generation possible, yet, strange to say, he distinctly teaches that spontaneous generation took place unnumbered millions of years before the Carboniferous period commenced! I quote :—

"The *first* and *longest division* of the organic *history* of the earth is formed by the primeval epoch or the era of the tangled forests. It comprises the *immense period* from the *first spontaneous generation*, from the *origin of the first terrestrial organisms*, to the *end of the Silurian*

system of deposits. During this immeasurable space of time, which in all probability *was much longer than all the other four epochs taken together*, the three most extensive of all the Neptunic systems of strata were deposited."—*History of Creation*, vol. ii., p. 9.

Thus, according to this learned savant, all this "immense period" (at the beginning of which spontaneous generation occurred), longer than all the rest of the history of the earth put together, ended millions of years before the Carboniferous age began! Yes, after this "immense period" had ended, the entire Devonian age intervened before the Carbon age was inaugurated! Yet this naturalist, who monopolizes most of the "philosophical culture" of his profession, would establish the probability of spontaneous generation by the excessive presence of carbon at least 50,000,000 years (as the most moderate evolutionists estimate it) before the Carbon period had commenced!

How does this embodiment of philosophic culture know; or what right has he to suspect that there was an atom of carbon on this earth, condensed or uncondensed, as far back as the commencement of the Devonian age, to say nothing of the Laurentian? There are no coal deposits in those strata to prove it. If living beings could come into existence by spontaneous generation, why could not carbon? Besides, how does he know but that the earth was visited by a monstrous comet at the close of the Devonian age, and that it left its *carbon tail*, which inaugurated the Coal period? "Indeed, we can *positively* and with *full assurance maintain*," that, since the "conditions of life" were "entirely different" in those "primeval times," it may have been customary for comets to visit the earth and leave their tails as a token of friendly regard, and I can even "positively" assert that one immense tail was composed entirely of carbon, which, in time, condensed into *coal*, inclosing a few specimens of vegetation which have successfully fooled modern geologists, and made them think the coal mountains were of vegetable origin! "The *impossibility* of such a process can, in fact, never be proved," and, of course, it must therefore be accepted as science! I also "positively" "maintain," and "with full assurance," that *diamonds*, which are composed of pure carbon, originated in that way, owing their spontaneous generation to the tail of a comet! Haeckel cannot disprove it, since the "conditions of life" were so "entirely different" in those cometic times. Hence, there could have been no carbon to cause spontaneous generation of monera at the time his theory requires! I fear this great naturalist has more of his peculiar "philosophical culture" than will prove good for him, as we shall see in a minute.

"Indeed," he says, "we can even *positively* and with *full assurance maintain* that the *general conditions of life*" at that time were "*entirely different* from those of the present time!" But how could the "conditions of *life*" have anything to do with inorganic matter, prior to the existence of life on this earth, or in the universe? This reference to the "conditions of life," as favorable to spontaneous generation, before life existed, is sheer nonsense, and has equal force when applied to the origin of diamonds. But with all deference to the authority of such a sweeping assertion, and in all seriousness, I will now prove "positively" that the "conditions of life" were exactly the same in those "primeval times" as they are at present, since the very species of fish and mollusks which lived long before the Carboniferous period commenced—in the Devonian and Silurian ages—not only continued to live all the way through the Carboniferous period, but have come down to the present time without the slightest change in their organic structures, as witness our still existing ganoids and numerous species of shell-fish. Here is proof which he probably will not ignore. Darwin says:—

"Some groups [of mollusks], as we have seen, have endured *from the earliest known dawn of life to the present day*." . . . "In the genus lingula, for instance, the species which have *successively appeared at all ages* must have been connected by an *unbroken series of generations* from the lowest Silurian stratum to the present day."—*Origin of Species*, pp. 293, 294.

Thus, instead of the conditions of life being "entirely different," we here have the positive proof that they were "entirely" the same; for what better evidence do we need than the fact that fishes which lived millions of years before the age of carbon began, and also numerous species of mollusks, have continued with an "unbroken series of generations" through the Carboniferous period and all other subsequent periods down to the present time unchanged, as this highest living authority

on Evolution, Mr. Darwin, assures us? So much for this cheap assertion about "the general conditions of life" being "entirely different," as the only evidence in favor of a possible spontaneous generation in the past, which he admits "is *perhaps no longer possible!*" Was there ever a more complete scientific failure than this?

But suppose we admit the correctness of Prof. Haeckel's "*philosophical*" argument for the present, what does it prove? Let us see. How does he know but that the various species were separately created by miraculous power in those "primeval times," when the "conditions of life were entirely different?" "The impossibility of such a process can, in fact, never be proved," and therefore it is scientific! How does he know but that a "carbon" *gorgon* existed in those early times capable of working miracles and creating new species by special acts of power, and that he or she, as the case may be, has since retired from the earth? "Think only of the fact that the enormous masses of carbon" "may have rendered" a miracle "possible" at that age, "which now is perhaps no longer possible!" It cannot be disproved, and therefore, according to the logic expounded from the University of Jena, special creations by an intelligent carbon god must be accepted as *philosophically* established! Professor Haeckel's highly "*philosophical*" mode of reasoning seems to be a kind of two-edged logical sword!

How, in fact, a man believing in spontaneous generation can reasonably object to miracles, or to the separate creation of each individual species by the direct interposition of an infinite Creator is more than I can imagine. As a proof that a belief in miracles must produce less of a mental strain upon a logical mind than the acceptance of the impossible process of spontaneous generation, we see Mr. Darwin deliberately choosing the former plan for the first few simple beings rather than the latter. We may rest assured that had there been the least rational ground for spontaneous generation, this shrewd naturalist would never have been found reverently but reluctantly bending the knee by resorting to the special intervention of an infinite Creator to "breathe" into that "larva" of a mollusk to find something by which to start evolution! He would have almost given his life for Haeckel's scientific assurance, with a reasonable proof of spontaneous generation. Professor Haeckel, however, was equal to the strain: for while believing firmly in spontaneous generation, he ridicules the belief in miracles as but the creation of a superstitious and poetical faith. If the father of evolution laid its foundation in superstition and a poetical fancy, what are we to think of the superstructure? But look at the difference as to the probability of the two systems of creation. While the miraculous production of a living being, by an act of the Creator, is only the transfer of a vital spark of a pre-existing life, having intellect capable of planning the structure Haeckel's method, by means of a carbon miracle, is not only to construct an *ingenious* organism without prior *ingenuity* or mentality, but absolutely to originate *life out of nothing*, or without there having been a spark of life in the universe before it! Such a miracle would seem to defy human imagination. Yet Professor Haeckel is equal to the emergency. The world is surely in need of "philosophical culture," especially among believers in a carbon god which can not only construct ingenious organisms in the absence of all ingenuity, but can transfer life and mental powers to inorganic matter, while it has neither life nor mental powers to transfer!

Thus much for the History of Creation and its philosophical reasoning in favor of spontaneous generation as the origin of life, which brings us to consider the *Evolution of Man*, by the same author, and its ingenious arguments in support of the theory of descent.

The aim of Prof. Haeckel in this work is to show, from the marked similarity of anatomical structure and the uniform embryonic development of all vertebrated animals, from the fish up to man, that they must have arisen by transmutation and gradual stages of development from a single primeval form of life, and that form a *one-celled organism* like the spontaneously generated *moneron*. The entire argument of these two large volumes is based upon this general proposition, and its collateral elaborations, that man must have thus originated by natural selection and survival of the fittest from the primeval ganoid, the earliest known vertebrated animal, while this fish must be a lineal descendant by heredity and adaptation, of the amphioxus, the ascidian, and the worm.

I join issue with this great authority, and expect to show, by a fair cross examination of his positions, that he believes nothing of the kind himself, and that every argument he frames and every law he lays down in support of his theory of descent, as well as his system of embryonic development, is self-contradictory, self-annihilating, and literally overthrown by his own subsequent arguments. But before entering upon this cross-examination I wish to state, and urge upon the reader, by a few pertinent considerations, that no possible explanation of this admitted uniformity of anatomical structure or similarity of embryonic development, so fully and rationally accounts for the observed facts and phenomena, as that of special acts of creation for the different species by an intelligent and personal Creator. I have dwelt upon this argument of the evolutionist at some length in the tenth chapter, in review of Prof. Huxley's conclusions drawn from comparative anatomy; but will add a thought or two here preparatory to the main examination of the embryonic hypothesis as employed in support of evolution.

In the first place it seems to me that, admitting a special creative act, for each species demonstrated, it would be unreasonable to expect an entirely distinct process of embryonic development or plan of anatomical structure for each new species thus produced by such an intelligent artificer. In fact a scientist would assume *a priori*, the exact opposite to be the case if he would reason logically. A mechanic who should undertake, for example, to design a hundred different machines, for as many different kinds of work, all to be constructed of gear-wheels, journals, pullies, belts, etc., of various powers and combinations, would be regarded as eccentric and conceited, rather than practical, if, in each individual machine he should vary the form and pitch of the cogs, the size, shape and number of the arms or spokes, the form of the hubs, or the material of the belts or the kind of wood and metal used in constructing the wheels, journals, etc., merely for the sake of variety, especially when one single plan for all these parts and one single kind of material would fully have answered the purpose. Prof. Haeckel, in his wisdom, would doubtless see a great absurdity in such a uniform plan of structure in so many different machines each for a separate kind of work, and would scout the idea that one mechanic could have designed them all. He would declare as his deliberate conviction, that they must have individually grown or developed, one out of another, by some kind of mechanical selection, or they would not show such a typical resemblance in their general plan of structure.

Suppose this learned naturalist possessed the ability, and should take a contract, to construct models for a similar number of different vertebrate species of animals, and should undertake to map out a plan for the embryonic course of development in each particular case, for future reproduction, I will venture the assertion that there would be seen as much uniformity in such anatomy and mode of development in the main portions of these organisms, as is now witnessed in the same number of vertebated forms, unless he should act with special reference to his pet theory of descent. Besides, there is no doubt but that this tendency toward a practical adherence to one fundamental type or plan of structure would occasionally involve some trifling rudimentary parts in some of his models of animals not needed in their specific work and mode of life, but which were of practical utility in other forms previously constructed on the same general plan, and which this naturalist would weave into the exceptional forms on the principle of unity of design, symmetry of structure, or general artistic resemblance in carrying out the entire contract. Professor Haeckel would laugh at the naturalist who, on examining his general plan should declare that these symmetrical rudimentary parts in some of the organic forms designed, were proof positive that the models had grown one out of another by some sort of artistic selection or survival of the fittest, and he would equally smile at the simplicity of his critic who would pompously write a book to prove that the general uniformity of type, in all these vertebrated models, was conclusive evidence that intelligent purpose or inventive skill had nothing to do with them!

Should the author of The Evolution of Man ever undertake such a task as the one supposed, and should he first make a model of a marsupial with five toes on each foot, a jackal with three toes on the hind feet and six in front, a fox with four toes in front and six behind, a lemur with two thumbs on each of its hands and seven

toes on each of its feet, a baboon with two thumbs and six fingers on each of its four hands, and a man with eight fingers on each of his hands, and three toes on each foot; and should he continue this diversity through all the other models of the list, varying other parts of their anatomy in a correspondingly arbitrary degree (all of which he would no doubt possess the ingenuity to do, and which would possibly serve the purposes of life for these different species just as well as a uniform general type of structure), I can assure him that such a variegated physiological and anatomical salmagundi would be regarded by a judicial critic as an egotistical display of versatility and inventive skill, conspicuous for its ingenuity rather than for its practical advantages in the struggle for existence.

In like manner God could, had He so willed, have formed each species, throughout the entire animal kingdom, on a different plan of structure or type of anatomy, and have ordained an entirely distinct programme of embryonic development for each order, class, or tribe, as easily as he could have created the first organisms, without having any pattern to follow, as admitted by Darwin, with which to inaugurate evolution; or as easily as he could make some classes of embryonic animals develop by uterine growth, and other classes by external eggs and the entirely different process of nidulation; or as easily as He could create distinct and radical types of anatomy for the different sub-kingdoms such as vertebrata, articulata mollusca, etc. But it did not so please Him, as it would not so please Prof. Haeckel were he to undertake the same task with ability to carry it out. After a personal God has been apodeictically proved, as will be done at the close of this chapter, and His existence shown to be a necessity in the universe, as the originator of organic life and the creator of specific forms, then all difficulty as to this uniformity of plan in structure and development disappears, since this is clearly the manner in which any intelligent and consistent artificer would have proceeded, unless controlled by self-conceit or an overweening desire to display his inventive skill rather than his practical good sense. As the general plan of anatomical structure and development in the different species of animals shows about the uniformity, diversity, and adaptability to use that would meet the approval of a modest and practical designer and artificer, it is clearly not derogatory to the character or attributes of a personal God of infinite capabilities to credit Him with this diversified uniformity and versatility as the work of His Almighty hands.

Now, in opposing the Darwinian theory of descent by transmutation or evolution as generally understood, I do not necessarily oppose the true use of evolution in the place where it belongs. But evolution, in the proper sense, belongs to the one who creates or produces, not to the thing created or produced—to the mental operation of the worker, rather than to the work accomplished. It is reasonable to suppose that a wheelbarrow, for example, may have evolved the idea of a cart, the cart evolved the idea of a wagon, the wagon that of the locomotive, etc.; but this evolution took place in the mental operation and constructive progress of the various workers whose inventive genius led them step by step from the simple one-wheeled barrow to the complex eight-wheeled locomotive. It surely does not support the idea that the barrow evolved itself into the cart by survival of the fittest;—that the cart developed itself into the wagon by the environment of other machinery and mechanical selection; or that the wagon grew into a locomotive by the accumulation of spontaneous variations from age to age without the aid of intelligent design on the part of the countless inventors whose mental workings alone did the evolving of this complex machine from the primordial design of the simple barrow. So, if there is or has been evolution in the succeeding orders of organic life on this earth, as there no doubt must have been, from the moneron up to man, this evolutionary progress does not preclude special acts of creation for the species, but must have taken place in the progressive acts of the creative will of the great Artificer of Nature, and these evolutionary transitions in creative progress from the simple one-celled organism to the complex mammal have been the result, in each stage of development, of intelligent design and skillful adaptation to environment and use. Not a bone in the osseous structure of a fish, nor a feather in the tail of a pigeon, has ever been evolved or permanently developed, except as the re-

sult of intelligent purpose either on the part of the creative will or the selective judgment of the fancier or breeder. The fact, as Haeckel and Darwin insist, that every animal, from the highest to the lowest, begins its embryonic existence with a single cell or ovule, does not preclude the necessity of original intelligent design in each step in this mode of development of the perfect animal from such simple start. The fact, as they further insist, that these ovules are exactly alike in all animals, and that there is not the slightest difference between those of the man and those of the horse or dog, is proof positive that without intelligent design in the ordination of the original laws of organic development, there would be no certainty that the ovule of the horse might not develop into a dog, or man, if it should develop at all, and *vice versa*, as more fully elaborated in a subsequent chapter. Two such small pellets of protoplasm or bioplasm, exactly alike, and of homogeneous substance, as evolution teaches, could by no possibility change into complex organisms of such diverse characteristics,—one differentiating into a monkey, for example, and the other into a whale,—except by the operation of laws intelligently enacted and specifically applied to those very cases by a creative Will above Nature.

For example: two masses of metal, of precisely the same material and size, at one time were placed before two American mechanics for development. These metallic ovules possessed no life, and could not move or perform labor till they had been transformed by intelligent design and inventive skill. But the intellects of the two mechanics overshadowed them and their living, thinking souls breathed into them the breath of mechanical life, infusing into their inorganic molecules a part of their own natures, so to speak, and the two motionless eggs of metal began to show signs of embryonic development and to take on the forms of things of life and thus gradually to differentiate into two very strange mechanical organisms. As in the order of Nature, first the embryonic forms appeared, embracing many mechanical features in common with previously existing species of machinery, such as screws, journals, pulleys, levers, gear-wheels, cranks, etc., and at first, like most undifferentiated embryonic machines, could scarcely be distinguished the one from the other. Haeckel and Huxley, who happened to step into the shop at this time, and seeing these developing forms of mechanism, were puzzled in attempting to classify them, but finally decided on the principles of comparative anatomy, and the uniformity of all embryonic development, and especially from their recent examination of the remains of ancient fossilized battering-rams in the British Museum, that these two partially developed machines must have evolved by mechanical selection from some early Egyptian war-engine, since this primeval progenitor, as well as the paleontologic hieroglyphics of that ancient people describing it, clearly shows the same kind of pulleys, crank-motion, and cog-gear, though not so cleverly differentiated as in the devices before them.

Of course these naturalists are able to see no intelligent design or purpose in the manner in which the cogs match into each other, or the wheels, pulleys and shafting combine; notwithstanding they are forced to admit that as means they are evidently adapted to certain ends to be accomplished, though all this must be the result of a purposeless mechanical selection, independent of personal, intelligent supervision. The two mechanics, in the meantime, unknown to these naturalists, continue their work of development and adaptation, by pouring into these embryonic structures the fertilizing influences of their own inventive natures, while the levers, bands, cranks, pulleys and gear-wheels continue every day to differentiate more and more, till at last the first signs of life appear by the motion of a distant shaft which causes the two machines to start into action with a strange humming and clattering sound. The outlines of the two machines have now so far changed by differentiation, since they first began to assume shape, that no one, not initiated into the secret of the two inventions, would believe for a moment that they had ever been exactly the same in form and substance, and that they had both developed with such strangely different forms and characteristics from two metallic, homogeneous eggs, precisely alike. Haeckel and Huxley in their philosophical ramblings, again call at the shop and in the absence of the mechanics chance to see these strange pieces of mechanism, and their interest is excited anew at their altered appearance since they had previously examined them.

They wonder what different kinds or species of apparatus they will finally differentiate into; for all the time they have no knowledge or belief that intelligent design or inventive skill has anything to do with them, but look upon them as veritable cases of spontaneous variation and mechanical development, the effects of environment and mineralogical selection, without necessarily involving any such poetical fancy or superstitious nonsense as a personal plan or intelligent supervision.

But the natal day at last arrives. The two machines are born and are clad in their richest robes of paint and varnish. The people are invited to the exhibition; the motive-power is attached; and the curtain is lifted; and behold! one stands before the gazing multitude of spectators a *Howe* sewing-machine, and the other a *Hoe* printing-press! The one seizes a piece of silk and, with its sewing, frilling, hemming and embroidering devices, sends forth from its clattering fingers a robe of exquisite design and finish fit for a queen to wear; while the other grasps a web of paper and automatically, with the most majestic movements of its revolving types, its swirling ink-rollers, its flying tapes, and intelligent hand-like folding devices, rains a shower of elegantly printed and folded newspapers at the rate of twenty thousand copies an hour!

How comes it, cry the multitude, that these two lifeless and homogeneous masses of metal have thus developed into such complex machines, and how was it possible for them, so exactly alike at the start, to differentiate into two such diverse forms of mechanism, suited to such entirely different and remarkable styles of labor? Prof. Huxley steps forward and in one of his characteristic lectures on the "demonstrative evidence of evolution," assures the admiring crowd of lookers-on, that like the differentiation of the horse from the orohippus, these machines must be a case of lateral development in two directions from James Watt's first pumping engine, because in both machines he could see the old Watt rudimentary crank-pins and rings around the hubs, with some other typical parts such as peculiar bolt-heads, not necessary for practical use in the present apparatus; while Prof. Haeckel, fresh from the University of Jena, exhibits one of his infallible ontogenetic and phylogenetic embryological plates, and a couple of his "systematic surveys," by which he demonstrates the impossibility of any intelligent design in the origin of either of these machines, and winds up his evidence by announcing the universal law of *crankology*, as the fundamental principle of all mechanical science, demonstrating that as both machines commenced existence in two undifferentiated lumps of metal exactly alike, they must therefore have arisen by phylogenetic gradations from their earliest progenitor, the primitive one-celled stone-hammer of the lake-dwellers of Switzerland, by mineralogical selection and crystaline differentiation; and hence, that mechanical ingenuity, or purposive, intelligent design could have had nothing to do with them!

But at the close of these scientific inquiries and explanations by the eminent authorities present, the two inventors, *Howe* and *Hoe*, being loudly called for by the audience, step forward and in a few brief sentences upset the entire system of designless evolution based either upon survival of the fittest, or crankology, by announcing in the most positive manner that intelligent design and personal mechanical skill were in every wheel, journal, band, pulley, crank and bolt of both machines, and that every movement of each part, as well as every result of the movements of these parts, in the work accomplished, had been forseen and planned with the nicest accuracy even before the two masses of metal had received the first blow; while they declare, upon their own unimpeachable authority, that every step of progress in the differentiation of these two complex mechanical organisms, from their first embryonic arrangement of parts to the finishing touch, had been the result of skillful execution in pursuance of the original plans carefully devised in the minds of the two inventors. And they wind up their remarks by a wholesome lesson on natural science to these exponents of modern evolution, that without intelligent design and skillful execution, no complex adaptation of means to ends or separate parts to special uses can be found either in nature or among the works of man. And the moral is: since such machines as these can not come into existence except by intelligent design and mechanical skill, on the part of a supervising intellect and power above them, then how is it conceivable that the complex physical and

mental powers of man himself, who is capable of designing such inventions, could have arisen by a purposeless and designless system of evolution from a moneron, —a lump of undifferentiated albumen,— without the intervention of some intelligent power higher than the work thus accomplished?

But this is not all there is in the lesson here taught by the gradual development of these two mechanical achievements. The same ingenious artificers, who planned and developed these first or parent machines, were also capable of devising and establishing combinations of mechanical laws, powers and appliances by which these peculiar species of machines might be perpetuated and turned out by automatic machinery, every part as perfectly developed as though it had passed under the special care and supervision of its original inventor and constructor. By this means the established work of carrying on the manufacture of these sewing-machines and printing-presses is now effected without the special miraculous intervention of a Howe and Hoe. The work is thus done by the settled combination of mechanical laws, powers, and appliances, though it requires the profound logic of the University of Jena to reach the modern scientific conclusion that because these machines are now made according to established laws, no intelligent design could have been needed to construct the primordial machines—the progenitors or prototypes of the species—nor any personal skill in establishing the system of laws and appliances for their reproduction! Out of pity for Huxley and Haeckel the reader is left to carry out this unmistakable analogy to the works of God in Nature.

Thus, having prepared the way, we come to the examination of the arguments and reasoning of the author in favor of the theory of descent based upon embryology; and I state but the simple truth, when I say, that the entire two volumes of *The Evolution of Man* are devoted to the single proposition and its various elaborations, that in the embryonic development of a human being from an ovule or single cell, which is embraced under the general name of "ontogeny," we have a brief recapitulation of "phylogeny," signifying the development of the race of man's animal ancestors from some simple, original, one-celled organism, such as the moneron; and that this *ontogenetic* recapitulation of man's *phylogenetic* or tribal pedigree includes substantially, all the types of organic structure through which man's lineal descent from the moneron has brought him up to his present magnificent estate. In other words, these volumes teach that the diverse forms taken on by the human embryo, during its progressive growth and development, from the fecundation of the ovule to birth, represent the forms of all the animal species through which its lineal descent can be traced—such as the monkey, dog, jackal, marsupial, tortoise, fish, amphioxus, ascidian, worm, amœba, cytod and moneron! Yet, fundamental and broad as is this general law of ontogeny and phylogeny, it is a positive fact that the only two marked or even perceptible features of the human embryo which are claimed to present the slightest resemblance to the peculiar forms of lower animals, are the so-called "gills" of the fish, which appear on the neck of the embryo from the second to the eighth week of growth, and the little "human tail," resembling that of the puppy or tortoise. These two embryonic features, and these alone, constitute the entire stock in trade, upon which this expensive work of ontogeny and phylogeny has been carried on, and in elaboration and defence of which these two profound and ponderous volumes were written. Hence, if, in a fair and impartial sifting of the argument upon these two ontogenetic similarities, they shall break down and be demonstrated to be without the slightest foundation in physiological or anatomical science, then evidently the phylogenetic branch of the argument falls to the ground. This is the task we undertake first to accomplish in reviewing this great work.

To treat the reader fairly, as I propose to do all through this argument, I must quote Prof. Haeckel's own words sufficiently to show that he is not misrepresented. At the commencement of the *Evolution of Man* he makes the following quotation from his former work, *General Morphology*, as representing his present position on the subject:

"The history of the evolution of organisms consists of two kindred and closely connected parts: *Ontogeny*, which is the history of the *evolution of individual organisms*, and *phylogeny*, which is the history of the *evolution of organic tribes*. Ontogeny is a *brief and rapid recapitulation of phylogeny*, dependent on the physiological

functions of heredity (reproduction) and adaptation (nutrition). The individual organism *reproduces in the rapid and short course of its own evolution the most important of the changes in form* through which its ancestors, according to laws of heredity and adaptation, have passed *in the slow and long course of their paleontological evolution.*"

On page 6, vol. i, he further explains his meaning:

"This fundamental law, to which we shall recur again and again, and on the recognition of which depends the thorough understanding of the history of evolution, is briefly expressed in the proposition that the history of the germ is *an epitome of the history of the descent;* or in other words that *ontogeny is a recapitulation of phylogeny;* or, somewhat more explicitly: that the series of forms through which the individual organism passes during its progress from the egg-cell to its fully developed state, *is a brief, compressed reproduction of the long series of forms through which the animal ancestors of that organism* (or the ancestral forms of its species) *have passed from the earliest periods of so-called organic creation down to the present time.*"

From such a sweeping definition of "this fundamental law" of ontogeny and phylogeny, in which no stronger words are to be found in the language, we would naturally expect, on examining a human embryo under the microscope, at the proper period of gestation, to behold an absolute microcosm of animal forms and structures, embracing every conceivable shape and outline into which protista, sponges, polyps, worms, ascidians, fishes, reptiles and mammals had ever been moulded by that "scrutinizing" principle of Nature called "natural selection;" since we are assured that this embryo actually embraces "*an epitome* . . . . . of the *long series of forms* . . . . . from the earliest periods of so-called organic creation down to the present time." But, as just remarked, nothing of the kind is seen, even in Prof. Haeckel's own specially prepared plates, which we may be sure would leave nothing of this kind out. On the contrary, the entire ontogenetic "epitome" dwindles down to the pitifully fabricated "gill-arches" of the fish and the contemptibly misrepresented "human tail" of the tortoise.

In the *History of Creation*, as well as in numerous places in the *Evolution of Man*, Professor Haeckel makes a specialty of presenting illustrative plates, with figures of the embryos of various animals at correspondingly early and later stages of development, such as fish, tortoise, chicken, dog, rabbit, calf, hog and man, in which at the earlier stage the "gills" and caudal appendage of each are very distinctly and prominently shown, but at the later stages disappear entirely, or increase in prominence as the specific character of the embryo requires. A superficial reader, or one a little bit endowed with evolutionary proclivities, examining these plates and reading the author's positive assertions in regard to them, would be almost certain to conclude that man must have descended from the fish and the tortoise, or some other species of *gilled* and *tailed* animals, or else the human embryo could not exhibit such prominently developed gill-arches, and such an exuberantly elongated caudal structure.

But I must not neglect to give the reader proof from the pen of Prof. Haeckel that the so-called "gill-arches of the fish" and the "little tail of man," seen in the human embryo, are relied upon as the main pillars of the theory of descent as elaborated under "this fundamental law" of ontogeny and phylogeny. I quote a few brief paragraphs from the *History of Creation:*

"I wish especially to draw attention to Plates II. and III., which represent embryos in all stages of development, and in which we are not able to recognize a trace of the full-grown animal. . . . . Every one surely knows the *gill-arches of the fish.* . . . . Now these *gill-arches* originally *exist exactly the same* in *man*, in *dogs*, in *fowls*, and in *tortoises*, as well as in other vertebrate animals."

"Finally, while comparing the embryos on Plates II. and III., we must not fail to give attention again to the *human tail*, an organ which in the original condition man shares with all other vertebrate animals. . . . . Now man in the first months of development *possesses a real tail* as well as his nearest kindred, the tail-less apes (orang-outang, chimpanzee, gorilla), and vertebrate animals in general."—"In this intimate connection of ontogeny and phylogeny, I see *one of the most important and irrefutable proofs of the theory of descent. No one can explain these phenomena* unless he has recourse to the *laws of inheritance and adaptation; by these alone are they explicable.*"—"The rudimentary little tail of man is an irrefutable proof of the fact *that he is descended from tailed ancestors.*"—HAECKEL, *History of Creation*, vol. i, pp. 289, 307, 308, 310, 314.

We shall soon see whether this defiant asserter of evolution is safe in so emphatically challenging the world for any other explanation of these embryonic forms save by calling in the theory of descent. To commence with these so-called "gills," I peremptorily deny that the embryos of the various animals represented in Prof. Haeckel's plates show anything of the kind,

or any marks about the neck that can be fairly construed as representing these branchial organs peculiar to the fish. I will give my reasons for this unequivocal antagonism. If Prof. Haeckel's elaborately and carefully prepared plates are critically examined they, alone, will verify the truth of what I am saying, as any one having a copy of his works will see, as I proceed; for it is certain that the artist, under the direction and inspiration of such a predetermined ontogenist and phylogenist, and such an inveterate plate-maker, would leave no defect in his embryonic figures which would detract from their force in aiding to demonstrate a fundamental law so universal and important as the one he here lays down in the *Evolution of Man*. By the most casual examination, however, of any of the cuts, it will be seen first, that these "gill-arches" are not on the *side* of the neck at all, where fish-gills are located, but almost directly across the *throat* of the embryo, proving, what I supposed on first glancing at them, that they are folds in the flesh of the neck, as the head of the embryo, at a very early stage is (in the case of all animals) abruptly bent down upon the chest. This abrupt bend causes five or six wrinkles of the muscles of the neck, which, not being filled out by flesh as the embryo rapidly develops during the first few weeks, leave openings or slits which physiologists and anatomists have superficially mistaken for a typical representation of fish-gills, and which modern evolutionists have eagerly seized upon as a veritable proof that "man and all the vertebrated animals have descended by transmutation from some branchial ancestor." These flesh-folds, as the embryo develops and as the abrupt curvature of the neck straightens, are gradually absorbed into adjacent parts, and thus go to make up the jaws, nose, mouth, tongue, ears and other organs of the head and neck, by differentiation, as is clearly manifest by following the progressive changes from the earliest appearance of the embryo to its complete specific form, which occurs in the human organism at about the seventh or eighth week of gestation. I prove that this is the disposition which Nature makes of these neck-folds, by Prof. Haeckel himself:

"The first pair of gill-arches differentiate into the rudiments of the upper and lower jaws. . . . . The gill-openings disappear by concrescence. From the gill-arches develop the jaws, the tongue-bone, and the bonelets (ossicles) of the ear."—*Evolution of Man*, vol. i, p. 404.

By substituting *neck-folds* or *wrinkles* for "gill-arches" or "gill-openings" in this citation, it would no doubt state the truth in reference to this branch of embryology. No better proof is needed as to the correctness of this view, than reference to Prof. Haeckel's plates, in which these neck-wrinkles disappear gradually in all mammals as the organs of the head assume shape, though they remain slightly visible long after the throat-openings in these wrinkles are entirely closed.

This rational and consistent explanation of these so-called gills, here for the first time given, is abundantly confirmed by reference to Prof. Haeckel's plates (Evolution of Man, vol. i, p. 362), in which he is so unfortunate as to introduce a cut of the *fish* itself, which, as we shall soon see, like the vaulting ambition which o'erleaps itself, lets the bottom out of the whole embryological argument as urged in support of evolution. This unfortunate cut of the fish clearly shows that the throat-folds, which appear at an early embryonic stage (the same precisely in the fish as in all other animals), are entirely distinct physiological marks from the true gill-arches which the same embryo clearly shows in the next stage of the cut, *and no doubt would have shown in the first stage along with the throat-folds had a candid presentation of the facts been recorded.* But no; the object of the author appears to have been to represent the early stage of the fish-embryo exactly like that of the human embryo, with the same throat-marks or so-called gill-openings, and in the same position; and then, at the second stage of the embryo, to show their transition and metamorphosis into *true gills* (on the side of the neck where they naturally and properly belong), with the throat-folds entirely vanished! How, let me ask this candid authority, did this second stage of the embryonic fish thus emerge into well-formed gills in the true piscatorial position at a single bound, without retaining a sign of the early throat-marks? And how comes it that the early stage of the cut shows these throat-folds without a sign of the true gills in the place where they belong, and where they appear in the next stage of the cut? Prof. Haeckel's main object in introducing this *fishy* phase of the embryonic question into his argument,

was, as he admits, to show that these "gill-arches," which appear at the throat of the embryonic fish as in all other animals, differentiate into true gills and in the true position, while he also admits that in all other animals they differentiate into the various organs of the head, such as jaws, nose, tongue-bone, ears, etc. He does not try to tell us how the fish gets its jaws, nose, tongue-bone, etc., since its throat-folds are used to construct true gills!

But the most transparent deception about this "gill"-argument is this: If these throat-folds of the embryonic fish, in the first stage of the cut, are really the commencement of the true and correctly formed gills of this fish, as Prof. Haeckel claims, which so distinctly show themselves in an entirely different position on the neck in the second stage, is it at all likely that they would make this transition and travel this distance at a single leap, or without a gradual change in the form, as well as position, while the embryo is developing? No! The common sense of every physiologist or anatomist would tell him if these throat-folds in the embryonic fish really become the true gills by differentiation, that the transition of such marks, both in form and position, would be gradual and slow, and had such been the fact in the case of the fish, it is evident that Prof. Haeckel could easily have given a number of figures representing these throat-marks gradually but distinctly assuming shape and crawling over to the side of the neck by many embryological transitions. The very fact that he has not presented figures showing this unmistakable transition, is proof of the most positive kind that no such transition or differentiation takes place, and that instead of it the throat-folds disappear by differentiation and concrescence into nose, jaws, tongue, etc., as the same throat-folds disappear in mammals, and that the true gills of the fish appear in their proper place and form when they first show themselves, without any relation or reference to these embryonic wrinkles of the neck.

There is no excuse for this neglect on the part of Prof. Haeckel, to show these numerous transitions of the fish-embryo, since our present facilities for hatching fish artificially would have enabled him to record these stages of development (even every hour of progress if necessary), and to have watched them under the microscope for every change, however minute. In this way an absolute "systematic survey" of piscatorial embryology might have been easily mapped out in order to demonstrate this theory, had Prof. Haeckel dared to risk his ridiculous "fundamental law" of ontogeny upon such a crucial test. To suppose that a scientific investigator, who delves to the bottom of the ocean, and traverses every clime in search of monera, sponges, protista and cytods of all kinds to help out his theory of development, did not *think* of such a demonstrative test of the correctness of his pivotal gill-argument, is to declare him an ignoramus in his professorship of natural history. To suppose that he thought of it and then neglected such an overwhelming opportunity to settle this gill-question forever, on the supposition that the facts of such gradual transition were in his favor, is to credit him with a degree of stupidity and even imbecility in his work which his ingenious twisting of science and natural phenomena nowhere warrants in his books. The conclusion, then, is irresistible that the facts are against him, and that he *knew* it, and hence that these neck-folds observed in the early embryos of all animals have nothing whatever to do with gills, have no true resemblance of them, and consequently that ontogeny, as based on this vaunted "epitome," or "brief and rapid recapitulation of phylogeny," ignominiously breaks down so far as this stereotyped gill-argument is concerned.

But there is another self-annihilating feature about these cuts of the embryonic fish that must not be overlooked. In the figure representing the *early* embryo there are *six* distinct slits or creases across the throat, while in the second stage of the figure, in which the true branchiæ appear, there are only *four* gill-openings, just as there ought to be. Now, if these throat-marks or so-called gill-openings are really the first appearance of the true branchiæ of this fish, how happens it that the number of openings decreases one-third in the next figure at a single transitional bound? Is it likely that the embryonic fish really possesses one-third more true gill-openings in its earlier or undeveloped stage than it possesses when fully developed? To show the conclusiveness of the argument here involved against this ontogenetic law, we have only to examine a score or more of separate cuts in these plates, representing the developing embryos of the different

animals, and we will find that in not one single instance, does the number of true organic parts, shown in the earlier stage of a figure, *decrease* in the later stage. Take the legs, arms, fingers, toes, fins, claws, hoofs, eyes, ears, etc., of the different animals represented, and it is an incontrovertible fact that the exact number shown at the earliest appearance of any of these organs, persists without increase or diminution in the fully developed embryo! Thus again, and in an unanswerable and unexpected way, are these throat-folds demonstrated to have no sort of relation to gill-arches, even in the embryonic fish itself, and consequently, as a matter of course, cannot represent "gills" in any other embryonic being illustrated.

'Tis true, Prof. Haeckel might have directed his artist, had he thought of it, to give two more strokes of his graver across the neck of his developed embryonic fish, and thus have made the number of true gill-openings correspond to the six pseudo branchiæ across the throat of the earlier figure. But it is presumable that he was scarcely willing to risk the experiment of forcing upon the scientific world, even upon the high authority of the University of Jena, more real gill-openings than his fish possessed, though he virtually does this in the six throat-slits of his earlier figure, which he positively declares to be the true gills of this fish.

But finally, to shatter this ontogenetic and phylogenetic law, and expose the fraudalent character of the entire fish-gill argument, we have only to inquire: if these so-called gill-arches in the human embryo are really intended to represent man's lineal descent from the fish and thus "recapitulate" his phylogeny, then what do the very same gill-arches or throat-folds represent in the fish itself? Is it thus intended that the "ontogeny" of the fish shall "recapitulate" itself, instead of its "phylogeny" or tribal descent from still lower animals in the ancestral line? If so, then of what use is this boasted fundamental law of "ontogeny" in epitomizing "phylogeny," if, instead of reproducing earlier ancestral forms, it simply reproduces its own specific form twice in two different locations on its own neck? Pshaw! If this law of "ontogeny" could recapitulate the ears of an *ass* somewhere on the embryo of a *goose*, it would come nearer recording its own phylogenetic character than by making a fish go through the sham performance of recapitulating its own gills! Thus again does this vaunted law, so fundamental and universal that it requires two large volumes to elucidate its ramifying application, stultify itself, and reduce every argument based upon it to self-nugatory nonsense.

Unfortunate Haeckel! Like Balaam of old, he opened his mouth to curse Israel, but God hath changed it into a blessing! This comes from his maladroit but providential blunder of unwittingly incorporating this disastrous cut of the embryonic *fish* into his plates among those of other animals. Had he been content to let well-enough alone, or had he been shrewd enough to keep the fish entirely out of sight, he might have retained the key to the true solution of this gill-arch problem in the secret archives of his own brain, and the unwary might have been hoodwinked to believe that possibly there was something in this embryological fish-gill argument. But his anxiety to *curse* was too great. The glittering evolution gold of Balak dazzled his eyes; he yielded to the temptation, and inserted the cut of the embryonic fish; and behold! the entire ontogenetic law is thereby shattered and the theory of descent broken down. He has, in his zeal to misrepresent Nature, overcharged his "phylogenetic" gun just one grape-shot too much, and its recoil has split the "gill-arch" hypothesis wide open, scattering the fragments of its epitomized "recapitulation" into the dust.

But while the theory of descent thus muddles every thing it touches, converting every argument it advances into distorted self-contradiction, how beautifully simple and every-way consistent is the explanation here given of these embryonic throat-folds in all animals, on the supposition that they furnish substance for differentiation into jaws, nose, mouth, etc., making them appropriate alike to the mammal, the bird, the reptile and the fish! But how ridiculously inappropriate, as typical of descent from lower forms, are these "gill-arches" when epitomized and recapitulated in the fish itself!

Now I protest, before evolutionists write another syllable about this "fundamental law" or these ontogenetic "gill-arches" in embryonic infants, as proof of man's descent from "some branchial ancestor," that they set to work logically and scientifically

to dispose of the same identical throat-folds in the fish itself, and either show some sense or meaning in such a slipshod "fundamental law" of ontogeny, or else abandon the gill-argument entirely as urged in favor of evolution. For, the idea of such a "recapitulation" of "gill-arches" in two distinct locations on the neck of the embryonic fish, *to show its descent from itself*, is an absurdity which no epithet in the language can exaggerate. I insist further, before this "gill"-argument is again impudently thrust into the faces of opponents of evolution, that Prof. Haeckel or some one of his ontogenetic colaborators shall give us a "systematic survey" of these embryonic throat-folds in the fish, and thereby prove by a series of authenticated engravings, that the *six* pseudo gill openings change, by numerous gradual transitions, to *four*, and that they crawl over from the throat to the side of the neck by the same slow but unmistakable transitions, thus becoming the true gill-arches of the fish. And I call upon the press of the country, which has, like many of the clergy, yielded a too ready assent to the claims of this theory, not to pass these criticisms of the pivotal arguments of Darwin, Haeckel, & Co. by in silence, but that they urge upon these high authorities in natural science the necessity of answering the points here made against evolution, or forever after holding their peace.

Now as regards the "little tail of man," about which Prof. Haeckel and Mr. Darwin have so much to say, and which is regarded by all evolutionists as such a powerful proof of man's descent "from tailed ancestors," I wish to remark, that a more manifest and inexcusable misconception upon an important scientific question, was never harbored by men making pretensions to philosophical knowledge or accurate scientific observation. I propose to make Prof. Haeckel my principal witness in the demolition of this "tail" argument, as has just been done in the "gill" argument, and, as the reader will soon see, with the same disastrous results; demonstrating by his own unmistakable teaching, even admitting all he claims in regard to these embryonic appearances, that they can have nothing whatever to do with man's descent from lower animals. But before putting this eminent scientist upon the witness-stand, and forcing him utterly to demolish his own fundamental law of ontogeny as a "condensed recapitulation" of phylogeny, I wish critically and anatomically to examine this question of embryonic development, and ascertain if there is any foundation in fact for this assumption of a "human tail," or in other words, see if any such thing exists as an abnormal caudal structure in the human embryo at any stage of its development. I deny that any such thing exists.

First, then, I call the attention of anatomists and physiologists to the demonstrable fact that this so-called "human tail" does not disappear at all from the embryo as Prof. Haeckel assumes, but absolutely continues to grow in size and length with the gradual growth and development of the embryo. All there is of this so-called "tail," when closely examined, is the well-known and normal *os coccyx*, or extension of the spinal column below the frame-work of the hips, which only appears to be abnormally elongated in the early embryo in proportion to its body, owing to the fact that the spine is the first part of the animal frame-work to develop, and of course, to the eyes of superficial observers, appears to be very much extended in length,—to be in fact, a veritable "human tail," nearly equal in length to that of the embryonic puppy or tortoise. This elongated appearance, however, clearly results from the fact that the fleshy portion of the body has not yet developed at this early stage, proportionately to the growth of the spinal column. But as soon as the embryo has advanced beyond this early stage, in which this so-called tail appears so elongated, it is perfectly clear, even from Prof. Haeckel's plates, that, so far from the *os coccyx* becoming shorter, it actually increases in length with the growth of the embryo, only the flesh of the lower trunk, as well as the legs, now begin to develop more rapidly and to cover up this exterior portion of the spine, till at about the fifteenth week of human gestation it is entirely hidden from view; and then, to the sagacious eyes of Haeckel and Darwin, this "little tail of man" has become "aborted;" and this is what they urge as a conclusive ontogenetic proof of phylogeny! The panting ostrich thrusts its head into the sand, and thinks it has successfully eluded the hunter because it fails to see him. This ludicrous performance, however, shows more logical common sense

than does Haeckel's audacious proclamation that the "human tail" has become aborted and ceases to exist, because the body of the embryo has extended around it and covered it up! Should Prof. Haeckel chance to find a man in some savage tribe, who had met with an accident that had removed the flesh and laid bare the *os coccyx*, he would be out with a monograph proclaiming a new race of tailed-men by the same "philosophical culture" which prevents his observing this true cause of "abortion" in the little tail of the human embryo!

The plain truth is, evolutionists are so anxious to rake up some sort of evidence favorable to the theory of descent, that they seem not only to lose their reasoning powers when drawing plain inferences, but they have become so blinded by their overweening desire to prove their blood-relationship to the brute creation that they appear to have lost even their faculties of observation. Had it not been for this, Prof. Haeckel could easily have seen that the human embryo has no sign of a tail, except the *os coccyx* which stays with it during life and grows with its growth; while it is an observable and undeniable fact that every single vertebra, or joint of the spine, which first appears in the embryo, continues to increase in distinctness and size as the child develops. These purblind investigators, however, observing the lower extremity of the spinal column projecting beyond the pelvic portion of the frame-work not yet so fully developed, never think to count these vertebræ, but, like mere children in science, jump at conclusions and suppose that this vertebral column becomes shorter and shorter, when in reality it is nothing but the other portions of the frame-work and flesh of the embryonic body developing downward to cover it! If these superficial anatomists will take the trouble to once count the vertebræ of a human and canine embryo when first completely formed, and then count the same joints in the matured skeletons of the two species, they will learn to their suprise that not one joint or fraction of proportionate length has in either of them gained or lost by development since their spinal columns first appeared complete in the embryos.

It should be observed, however, that in the embryos of animals with very long tails, normally, the extreme terminal vertebræ may not develop and show themselves so early as the more important joints of the spine forming the frame work of the body, and this tardiness in the development of the less important vertebræ (by the way a sensible thing on the part of Nature) makes the contrast between the apparent length of spinal column in the human embryo and that of a dog, for example, less conspicuous, and, as a consequence, causes the human spine to appear disproportionately long. But it is nevertheless an indisputable fact in embryonic anatomy that no joint of the spine of any animal ever disappears or becomes aborted after it has once developed, and hence Haeckel's little "human tail" is a myth,—a weak invention of his own highly "poetic imagination."

Thus by a fair anatomical survey and statement of the case, here for the first time given, it is seen that this "human-tail" argument, which has played such a prominent part in support of evolution, and produced such havoc with theological views of creation in the estimation of Haeckel and Darwin, turns out to be no "tail" at all, under any careful observation or fair reasoning. And I will only add that the view here taken will be fully sustained by any candid and competent anatomist who will examine Prof. Haeckel's plates. These alone will show that all the "human tail" there is or that ever appears in the human embryo is the normal *os coccyx*, which, so far from disappearing or becoming "aborted," as evolutionists would teach, continues with every human being through life. One can scarcely avoid expressing astonishment, on reading the arguments of these eminent authorities, at the superficial character of most of their scientific observations and reasonings. Such puerility positively tends to weaken one's faith in the value of all scientific authority, and renders even our best text-books objects of suspicion and distrust.

But there is the same inconsistency in this "tail" argument, and in the plates supporting it in Prof. Haeckel's books, as was recently brought to light in our examination of the "gill" argument. These unfortunate plates, which claim to represent the embryonic infant with the tail of the *tortoise*, as proof that man descended "from tailed ancestors," also show the fish embryo with an exact copy of the little "human tail" so that the one cannot be

distinguished from the other. Now the fish evidently did not descend from the tortoise, according to evolution, nor from any other "tailed ancestor" having such a slender caudal extremity. What business, then, has this fishy cut, I would like to ask our representative authority on embryology, with the little "human tail" of the tortoise, since Professor Haeckel distinctly tells us, in his fundamental ontogenetic law, that the tortoise (with its "gill-arches," as represented in his plates) must have descended from the fish? O, I see how it is, now! The fish has descended from the *musk-rat* or from some other tailed amphibian, and that's the way it has come into possession of its *fac simile* of the little "human tail!" But, the reader is ready to say, this is a mistake; because it is distinctly claimed by evolutionists that all these amphibious animals descended from the fish, since they all have "gill-arches" like the infant. What of that, my friend? Evolution also tells us that all cattle are lineal descendants of the fish, since they too have "gill-arches;" and Prof. Haeckel as distinctly assures us that *whales* and "many genuine fishes" have no doubt evolved from "hoofed animals" (History of Creation, vol i, p. 14; vol. ii, p. 251), which were in the habit of going into the water for food, as do musk-rats and otters! This double-geared, back-action system of descent is not only a convenient but a wonderful thing, take it all in all, and doubtless we shall never again see its like on earth. How transparent it makes the whole problem of this tail of the tortoise or musk-rat attached to the embryonic fish! If a buffalo bull can *evolve* from a sturgeon, retaining its phylogenetic "gill-arches," and then *evolve* back again into a black bass, or other "genuine fishes," taking along the ontogenetic rudimentary "little bones" of their "lost hind-legs," as Professor Haeckel teaches (History of Creation, vol, i, p. 14), why not a beaver, after *evolving* from a porgy and retaining its "gills," then *evolve* back again into a flounder, carrying with it its ontogenetic "tail?" The whole theory of descent is thus full of marvels and is actually slopping over with "philosophical culture."

Now I beg the reader not to think for a moment that I am trifling with the subject, or treating Prof. Haeckel with sarcasm instead of solid, sober argument. I mean every word I say when I urge that, according to his plain and unmistakable teaching, otters, beavers, and musk-rats, as well as horses, monkeys and men, could naturally and legitimately be expected to evolve back into fishes, carrying with them an "epitome" of their peculiar organs, by the same identical law of heredity and adaptation which transmuted a fish into a monkey or a man. Shall I prove it? Here it is:

> "An eighth and last law of adaptation we may call the law of *unlimited* or *infinite adaptation*. By it we simply mean to express that *we know of no limit to the variation of organic forms occasioned by the external conditions of existence.*"—*History of Creation*, vol. i, p. 242.

Prof. Haeckel, therefore, can reasonably "believe" and "with full assurance maintain," as he did about spontaneous generation being possible in the carboniferous age, that his embryonic fish obtained its *fac simile* of the little "human tail" by having descended from a Kaffer or Hottentot. Why not? If this "eighth and last law of adaptation" is "unlimited," there is no reason, as I show in a future chapter, why an elephant should not be transmuted into a mouse, as well as a mouse into an elephant, or a man into a fish, as well as a fish into a man. And if this "eighth and last law of adaptation" is "infinite," Haeckel ought not to be an *atheist* another day, since there would be no trouble in such an "infinite" law transforming a worm into an "infinite" God! If our philosopher, in order to retain his atheism, shall insist that such transformation of a worm into a God is impossible, and therefore beyond human belief, then his "last law of adaptation" becomes the "last ditch" of evolution, for being neither "unlimited" nor "infinite," it breaks down as a law, and and with it the entire theory it supports, as will now be shown:

Look at the argument. Prof. Haeckel cannot *believe* in the development of an "infinite" God from a moneron, even under the manipulation of a "law of *unlimited* or *infinite* adaptation," because he says this would require a "poetic faith," and "*where faith commences science ends.*" (History of Creation, vol. i., p. 9). Then there is evidently no "science" in evolution, since its very commencement depends upon the spontaneous generation of the moneron by the influence of "carbon," "which now is perhaps no longer possible;" and Prof. Haeckel "believes" that it so occurred,

and even maintains it "with full assurance." Hence, as it requires "faith" to conceive of the start of evolution, there "*science*" ended. And as it requires "faith" to conceive of its continuance in "hoofed animals" *evolving* into whales and "many genuine fishes," it is plain that "science" has no more to do with the progress of evolution than it had with its start. Hence as the whole theory of descent depends upon "faith," even vastly more "poetic" than to accept creative intervention by an intelligent God, it follows that Prof. Haeckel has thus publicly abandoned evolution as totally *unscientific*, since "where *faith* commences *science* ends."

We have seen, two or three pages back, that the fish, by ontogenetically "recapitulating" its own "gill-arches" on another part of its embryonic neck, converted Haeckel's fundamental law of phylogeny into a farce. In the same manner the tortoise, by "recapitulating" its own tail in its early embryonic condition, without the slightest regard to Haeckel's fundamental law, places the "tail" and "gill" argument in the same category. If there is any consistency in this law, why does not the embryonic tortoise, instead of so prominently displaying its own tail, recapitulate the forked tail of the early ganoid—its oldest vertebrated ancestor—and thus pay some respect to Haeckel's fundamental law of phylogeny? And if there is any truth in this principle of ontogeny in recapitulating the early animal forms through which our ancestral line of descent has brought us, why do all vertebrate embryos show *heads*, in excessive proportions, among their first-developed and most prominent features? Prof. Haeckel tells us that the acephalous or headless *amphioxus* was one of the nearest lineal ancestors of the vertebrate sub-kingdom. Had this "fundamental law of ontogeny" taken the precaution to develop all vertebrate embryos, including man, with *headless bodies*, up to a certain period, and then suddenly cause them to assume heads, it would have shown some resemblance to a fundamental "phylogenetic" principle, and Haeckel could, with some show of reason, have claimed such an embryonic performance as a veritable "recapitulation" of an early ancestral form. But with this ridiculous law of ontogeny causing all vertebrate embryos to show big heads at the very start, in defiance of their acephalous great-grandfather, the *amphioxus;*—with embryonic fishes recapitulating their own "gill-arches," and the tails of their *descendants* rather than those of their *progenitors;*—with the embryos of tortoises "recapitulating" their own tails instead of the forked tails of fishes or other forms peculiar to their earlier ancestors; it is high time for Prof. Haeckel to call a convention of evolutionists, and reconstruct such a crazy law of "ontogeny," or else abandon forever his fundamental principle of "phylogeny" as a self-convicted fraud impertinently thrust into the science of embryology.

But I have at last reached the proper place for my promised evidence from Prof. Haeckel himself,—proof conclusive and overwhelming,—that, even supposing embryonic infants do possess real "gills" and a veritable "human tail," *this is no evidence at all of "phylogeny," or that man descended from "gilled" and "tailed" ancestors.* If I am able to produce such proof as this, from the unmistakable statements of this authority, without misconstruction of his language or straining its meaning, then clearly, it must force conviction upon the mind of every candid reader that the theory of descent is unworthy of confidence and should be cast aside as but the worthless rubbish of modern speculative thought.

To fulfill this pledge I now call attention to the *ascidian* or "*sea-squirt*," a class of animals generally supposed to belong to the *mollusca*, but at any rate universally admitted (even by Prof. Haeckel and Mr. Darwin) to belong to the general division of *invertebrata*, and to have developed long before any vertebrate animal had an existence. Prof. Haeckel urges many considerations to show that the sea-squirt was one of the near, if not nearest, progenitors of the first *vertebrate* animals, that is, animals having a backbone and spinal marrow. Yet it is declared by this great authority, without apparently seeing its bearing upon his "fundamental law" of phylogeny, that the young sea-squirt possesses the distinct rudiments of a backbone (*corda dorsalis* or *notochord*) and spinal marrow (medullary tube), which becomes less and less distinct as this larva develops, till finally in the matured ascidian both rudiments disappear! Here is the proof:—

"In the mature sea-squirt there is *no trace of a notochord, an inner bony axis.* This adds in-

terest to the *fact*, that the *young animal*, as it emerges from the egg, *has a notochord*, above which lies a rudimentary *medullary tube*. In the mature sea-squirt this tube is *entirely shriveled up*."—*Evolution of Man*, vol. i, p. 432.

Thus we have the overwhelming fact confronting this "fundamental law of ontogeny and phylogeny" that the young of an *invertebrate* class of animals, anticipates the backbone and spinal marrow of the coming *vertebrate* sub-kingdom; and we have the still more important fact that these organs, so plainly visible in the young, entirely disappear in the matured animal, precisely as the "gill-arches" and "little tail of man" are claimed to disappear as the young vertebrate develops! Yet there is no "phylogeny" about this peculiarity of the young sea-squirt, because its rudimentary backbone precedes, as Haeckel himself declares, all vertebrated animals, is found no where else among invertebrates, and consequently the young ascidian does not show this rudimentary *notochord* and *medullary tube* as a "recapitulation" of any ancestral forms of life through which its line of descent had brought it. Further, this rudimentary spine extends into the animal's *tail*, and though it appears in the young, and becomes aborted in the full grown ascidian, it does not and cannot "recapitulate" any preceding or ancestral form. Here is the crushing proof:—

"In this *tail* now develops a *cylindrical chord* composed of cells, the anterior end of which extends into the body of the larva between the intestinal and *medullary tubes:* this is the *corda dorsalis, an organ which, except in this one case is found only in vertebrates, and of which no trace is to be seen in invertebrates.*"—*Evolution of Man*, vol. i, p. 456.

"This *one* case," Prof. Haeckel, is all-sufficient to burst your "fundamental law," and scatter its fragments to the four winds. It proves beyond the possibility of criticism that an important organ may appear in the early young of a species,—*even the rudiment of a spine extending into a tail*,—not normal to the matured animal, without "recapitulating" phylogeny, or signifying any thing pertaining to tribal descent from ancestral forms. Where, then, I ask, is the pretended evidence that infants descended from "tailed" ancestors, even if they do possess "tails" at an early stage of development? Echo answers, *where?* Prof. Haeckel responds—*no where!* Because, if the young sea-squirt can exhibit a well-defined rudimentary spinal column extending into a tail, not normal to the matured species, and that, too, without involving a recapitulation of "phylogeny," or even the previous existence of a single ancestor possessing such an organ from which it could be inherited, then, verily, the "fundamental law" breaks down, and with it Prof. Haeckel's entire theory of descent based upon it, since embryonic infants may possess "tails" *ad libitum* without the least reference to the puppy or tortoise! Thanks to Prof. Haeckel for thus unwittingly calling our attention to this valuable young "sea-squirt," with its lucky *corda dorsalis* and *medullary tube*, which, so utterly shatters this "fundamental law" of ontogeny! Again did Balaam open his mouth to curse Israel, but these three times hath God changed his curse into a blessing! Had this philosopher of Jena, like his prototype of old, possessed an intelligent ass to warn him of his folly, he might have been saved this humiliation, unless like the prophet he was too self-willed to take advice from his superiors.

But this is not all there is to be extracted from this prophetic young "sea-squirt." Prof. Haeckel is not satisfied to stop with its rudimentary *spine* and *tail* which so completely explains away the little "human tail" in the embryonic infant as meaning nothing phylogenetically. He even points out the additional and sweeping fact that this ascidian larva develops *gills* (millions of years, according to evolution, before fishes existed), which, in the mature sea-squirt, disappear, and hence can be a recapitulation of nothing; thus disposing of the embryonic "gill-arches" of the infant in the same summary way. Here is the proof:

"*Gill-openings* afterwards appear in the anterior section of the intestinal canal, by which the whole anterior intestine is transformed into a *gill-body*. This remarkable arrangement is, as we found, *quite peculiar to vertebrates*, and, *except in the ascidians, occurs no where else*."—*Evolution of Man*, vol. ii., p. 85.

What need we of further witness? The clear case here brought to light, of the anticipatory development of *gills* and vertebrate *tail* in this larva, not normal in the matured ascidian, and ages before gilled and tailed vertebrates existed, sets aside at a single sweep the argument based upon ontogeny as a "recapitulation" of phy-

logeny, since the ascidian admittedly had no such vertebrate ancestors! Besides it shows that the gills observed in the larvæ of frogs, newts, etc., so much relied upon by evolutionists as collateral evidence in support of their theory, prove nothing in regard to the doctrine of descent or the transmutation of species. This single admitted fact of the larval development of vertebrate organs, confessedly having noing to do with phylogeny, and so clearly brought out in our cross-examination of Prof. Haeckel upon his vaunted and desperate law of ontogeny, is so conclusive against his embryological theory, and so utterly subversive of evolution, that Christian believers can well thank God with fervency of heart that out of this threatening cyst of scientific venom we have been able, by the aid of providence, to extract its own complete antidote.

A single thought further before bidding adieu to Prof. Haeckel's valuable young protegé, which he has done more to bring into notoriety than all other writers put together. By following his description of this singular animal, we observe that, after emerging from the egg, it not only develops with rapid progress till it has secured what many other opponents of evolution never succed in getting,—*backbone*,—but it immediately after commences deteriorating just as rapidly, and shows the first premonitory symptoms of this retrogressive movement, like most "theistic evolutionists," by a paralytic shock in the region of the *corda dorsalis* and *medullary tube*. Its *backbone* begins to shrivel up. Its locomotive and steering apparatus then drops of. Every personal characteristic of its former self disappears. It loses all self-respect; and sinks to the bottom of the ocean a shapeless mass of sarcode, and fastens itself upon a rock, like a semi-lifeless sponge, there to spend its days the embodiment of stagnation and sloth. Before making the application of these facts to an important lesson of science, let us confirm them by quoting from Prof. Haeckel:

"When these organs are complete, the progressive ontogeny of the ascidian is at an end, and retrogression now commences. The freely swimming ascidian larva sinks to the bottom of the sea, relinquishes its power of free locomotion and becomes fixed. . . . The tail, which is of no further use, is now lost. It undergoes fatty degeneration, and is cast off with the entire notochord. The tail-less body becomes a shapeless bag."—*Evolution of Man*, v. i., p. 458.

The lesson I wish to draw from this strange development and sudden metamorphosis of the ascidian is the following: If this eminent scientist is correct in his facts,—and it is difficult to suppose that he would fabricate facts directly and fatally opposed to his own theory,—then how wonderfully and instructively does this sudden but temporary development of a true vertebrate *gill-body*, *notochord*, and *medullary tube* in this one species only,—long before vertebrate forms had been inaugurated upon the earth,—point as with the finger of prophecy to something certainly to take place in the distant future,—an event which only the all-wise Author of Nature could thus have foreseen and thus so beautifully foreshadowed? How conclusive should such prophetic evidence in the records of Nature be to honest advocates of evolution, that our development from lower forms, if such be true, must have been preordained by the creative will of Him who breathed into the first few simple beings, as declared by Mr. Darwin, and whose all-wise forethought must have designed every organic change, and every conceivable condition of environment, calculated to lead to such changes, from the lowest Laurentian invertebrate worm, up to the appearance of perfect man upon the earth? The purposeless laws of a blind and will-less system of Nature could not thus have predicted an event ages before it was to have occurred! Evolutionists would do well to give heed to this "sure word of prophecy," especially coming as it does from the unmistakable voice of their own prophet, and recorded in his own hand-writing, and giving as it does, on the supposition that evolution be true, such indisputable proof of intelligent design in all this progressive concatination of development. And when they have drank into the full fruition of this prophetic lesson of science gathered from the ascidian larva, they might profitably add that of the pupa, whose semi-lifeless existence suddenly emerges from the chrysalis into the imago of immortality, giving it a higher and brighter form of life, whose papilionaceous flight prophesies of the resurrection and the nobler state of the human soul.

But on the contrary, to those who reject evolution as the causal explanation of man's origin, and who regard the specific forms of the animal kingdom as the pro-

gressive but intelligent work of the Creative Will, and as His special acts of intervention, what a conclusive proof does this young ascidian furnish that species could not have been evolved out of forms, which, as Prof. Haeckel admits, *had no previous existence?* And what incontrovertible evidence does this retrogression of the agile larva of the sea-squirt furnish, that something besides "survival of the fittest" is needed to account for the phenomena here brought to light? For here is evidence, perpetually before our eyes, handed down from time immemorial, that the "fittest" does not survive, and that the more highly organized form is not perpetuated; but, by a law entirely outside of evolution, is caused to degenerate into a form the weakest, lowest, and least fit to survive of any imaginable organism. In vain will evolutionists cudgel their brains to invent a law of environment, struggle for existence, natural selection, or survival of the fittest, which, by any possibility, could have led to this astonishing metamorphosis and degeneration, which seemed to have been specially and prophetically ordained by God himself, in His progressive work of creation (corresponding with the progressive geologic history of the earth), as a permanent refutation of evolution, and as a permanent system of semi-miraculous interpositions established by law to illustrate His continual supervising presence and power in the universe.

But strange as it may appear to the reader, after all this discussion of fundamental laws and principles, we have not yet reached the real *bottom* of this embryological question, as presented by this eminent naturalist. 'Tis true we have his "fundamental law of *ontogeny* and *phylogeny*," with the "irrefutable" argument based upon embryonic "gills" and "tails," which we have examined and endeavored to overthrow,—with what success the reader will judge. But he has something even more "fundamental" than this "fundamental law." He has a wheel within a wheel, and hence we find a "fundamental law of *biogeny*," also cropping out and lying at the foundation of *ontogeny;* for, while ontogeny teaches the fundamental principle that all embryonic beings, during early development, assume and pass through the forms of their animal ancestors from the earliest commencement of organic life on earth, this bottom "law of *biogeny*" teaches that all embryos, of whatever animal species, commence existence in a *single cell*, proving thereby that all animals, including man, must have descended "phylogenetically" and "originally" "from a *one-celled organism*"—for example, the *moneron!* This, surely, is "fundamental" enough for all practical or theoretical purposes, and is a fit foundation for the other "fundamental law" of ontogeny and phylogeny which is built upon it.

This law of "biogeny," however, is just as defective, and involves as many self-contradictions and absurdities, as the other fundamental law of "ontogeny." As Prof. Haeckel stakes his entire two volumes of *The Evolution of Man* upon this substratum law of "biogeny," the same as he did on the fundamental law of "ontogeny," it would be well for the reader first to see exactly what this bottom law involves, as stated in Prof. Haeckel's own words, including also his own *italics* :—

> "Let us here make use for the first time of our fundamental biogenetic law, and apply this causal law of development to the human egg-cell. This results in an extremely simple but highly important conclusion. *From the one-celled organism of the human egg and of the eggs of other animals, the conclusion directly follows according to this fundamental law of biogeny, that all animals, including man, descend originally from a one-celled organism.*"—*Evolution of Man*, v. i., p. 140.

If this law of biogeny, lying at the very bottom of embryology, ontogeny, phylogeny, and consequently at the very foundation of the theory of descent, can be fairly broken down, and shown to be self-contradictory, Prof. Haeckel himself would no doubt be willing to agree that evolution as a system of scientific belief must be false from its foundation up, and hence unworthy of confidence. To this simple and easy task I now invite the reader; and in analyzing this law and what it involves, I shall, as usual, make Prof. Haeckel both the witness and the judge.

Before commencing this exposition I ask the reader to turn back to pages 353–4, and re-examine Prof. Haeckel's description of the *moneron*, "the primeval parent of all other organisms," which came into existence by spontaneous generation, thus constituting it man's "earliest ancestor." This fact, upon which the previous two volumes of *The History of Creation*, were based, must not be lost sight of for a

moment, being just as "fundamental" to the start and progress of evolution as is this "fundamental law of biogeny" to the theory of descent. How then, I ask, do these two fundamental laws or classes of facts agree? I assert that they flatly contradict each other, because the *moneron*—the "primeval parent of all other organisms," and consequently the "oldest ancestor of man"—is not a "one-celled organism" at all (Prof. Haeckel himself being judge), but is a "cytod" and an "undifferentiated" mass of "formless matter;" whereas a "cell" or "ovule," as the start of an animal organism, is a differentiated structure, divided into a "nucleus" and an external cell-body of protoplasm. Here is the proof:

"Nucleus and protoplasm, the inner cell-kernel and the outer cell-slime, *are the only two essential constituents of every genuine cell.*" "The *nucleus* and the *protoplasm* are the only two active, *essential* and *always present parts of the cell-organisms.*"—*Evolution of Man*, vol. i, p. 127.

Now as it is an "essential and always present" characteristic of "every genuine cell" that it should be differentiated into "nucleus and protoplasm, the inner cell-kernel and the outer cell-slime," it follows that man and all other animals did not descend "*originally* from a *one-celled organism*" as this "fundamental law of biogeny" requires, and consequently the law is false. Look at the quotations referred to on page 354. I requote:

"Only such *homogeneous organisms* as are *not yet differentiated* . . . . could arise by spontaneous generation and could become the *primeval parent of all other organisms.*"

Hence this "homogeneous" organism of "formless matter"—"albumen"—having "not yet differentiated" into "*nucleus and protoplasm*, the *inner cell-kernel* and *outer cell-slime*" being our "primeval parent" and not being a "cell" in any sense, saps the foundation of this "fundamental law of biogeny" which declares that "*all animals, including man*, descended *originally* from a *one-celled organism.*" The law having thus broken down, we proceed to demolish its fragments by numerous details of evidence.

First let us ask this author what is a "cytod?" Is it a "cell?" He answers emphatically, no; because cytods are "more simple elementary organisms" than cells. Here is the proof:

"*Cells* by *no means* represent quite the lowest grade of organic individuality, as that is usually understood. There are yet *more simple elementary organisms* at which we will now give a passing glance, in order to return to them hereafter. These are *cytods* . . . . For example, the remarkable *monera are cytods of this kind.*"—*Evolution of Man*, vol. i, p. 130.

But this "fundamental law of biogeny," in making "*all* animals, including man," descend from a "one-celled organism," must include *monera* themselves; for what is the use of a *fundamental* law that does not begin at the *bottom?* But as *monera* were spontaneously generated and did not descend from any organism, here is one admitted exception, and consequently the bottom plank drops out of this "fundamental law!" But the self-contradiction does not stop here. It would not be *Haeckelian* if one of his fundamental laws in support of evolution did not contradict itself at least half a dozen times before he gets done elaborating it. He assumes, for example, that the *amœbæ* and *protista*—the first one-celled organisms—were developed from the *monera*. I quote:

"During that time [the Laurentian epoch] there came into existence by spontaneous generation the oldest and simplest organisms—those in which life began on this planet—namely, the *monera*. From these, *one-celled plants and animals first developed, the amœbæ and many kinds of protista.*"—*Evolution of Man*, vol. ii, p. 10.

Now, as "one-celled plants and animals" and "many kinds of protista" descended from the spontaneously generated *moneron*, all these animals constitute exceptions to this "fundamental law of biogeny," because they must be included in "*all* animals," and they surely did not descend from a "one-celled organism," since the *moneron*, their immediate progenitor, was a "*cytod*," and not a "cell!" But as these "one-celled plants and animals" and "many kinds of protista," instead of descending from a "one-celled organism" as this law of biogeny requires, could actually descend from a cytod,—an organism which was not a cell at all, then what becomes of this "fundamental law?" How could "all animals" develop "*originally*" from a one-celled organism, when the very first developed animals were themselves "one-celled," and actually developed "originally" from a "cytod?" This *Haeckelian* law of biogeny is so "fundamental" that it is getting down out of sight, and be-

comes more and more muddled at every additional quotation.

But this is not all. After telling us in many forms of expression all through *The History of Creation*, that the *moneron* —this undifferentiated *cytod* of "formless matter"—was man's "oldest ancestor" and the "primeval parent of all other organisms," he flatly contradicts it by declaring that the one-celled amœboid animals, which developed from the moneron, as just quoted, are our "oldest ancestors:"

"The *amœboid* nature of the young egg-cell, and the one-celled condition in which each man begins his existence as a simple parent-cell or cytula-cell, justify us in affirming that the *oldest ancestors* of the human race (as of the whole animal kingdom) *were simple amœboid cells.*"—*Evolution of Man*, v. 2, p. 29.

This unfortunate generalization leaves the poor little spontaneously generated cytod of a moneron, with its "homogeneous," "undifferentiated," "formless" organism, out in the cold after all! As the "one-celled" amœbæ are thus "the oldest ancestors of the human race, as of the *whole animal kingdom*," monera (from which amœbæ descended) are, of course, not included, and consequently are not our blood-relations as this authority insists. But as "amœboid cells" are our "oldest ancestors" (since Prof. Haeckel saw the necessity of beginning with a "*one-celled* organism" by hook or by crook, even if he had to make one, in order to sustain his "fundamental law of biogeny"), it follows that the moneron is not the "primeval parent of all other organisms," since it is not among the "oldest ancestors!" But what is worse for Prof. Haeckel's theory of descent, he is obliged entirely to abandon spontaneous generation as the start of evolution, since "the *oldest ancestors* of the human race"—the amœboid animals—must be the *start;* and as they came by *parental* development from lower forms, as just quoted, they could not have come by spontaneous generation! Thus the whole theory of descent, with its fundamental law and spontaneously generated commencement, falls into a confused mass of chaotic fragments, somewhat resembling Prof. Haeckel's nebulous star-dust.

But even this is not the end of this long chapter of inconsistencies and self-contradictions upon this so-called "fundamental law of biogeny." The law distinctly declares that man begins his existence in a one-celled egg, as a proof that he must have "descended *originally* from a *one-celled* organism. Now I deny that man begins his organic existence in a "one-celled" egg or ovule, and will prove it by Prof. Haeckel himself. Man, as well as all other vertebrates, begins organic being in a *two*-celled egg, or what Prof. Haeckel calls a "*parent-cell* or *cytula-cell*," since no embryonic development commences till fertilization of the ovule takes place by the addition of the spermatozoön or male cell. Here is the proof, as usual from the pen of Prof. Haeckel:

"The *new cell*, which is the *rudiment of the child*—the newly generated organism—*originates in an actual amalgamation or coalescence of the two cells.*"—*Evolution of Man*, vol. i, p. 176.

Hence the "fundamental law of biogeny," based upon the fact that all animals begin existence in a one-celled egg or ovule, as a proof that they originally descended from a "one-celled organism," again contradicts itself and ignominiously breaks down. We could go on in this way and pile up these self-contradictions over the dead and already buried carcass of this "law of biogeny," till it would take more than a Schliemann to dig it out. But what is the use? Those who are not already convinced of the utter fallacy of the theory of descent as based upon its fundamental laws of "biogeny," "ontogeny," "phylogeny," and embryology in general, would not give up the absurd doctrine though one should rise from the dead to disprove it.

Before bringing this chapter to a close, I desire to call the attention of Prof. Haeckel and Mr. Darwin to a serious difficulty lying right in the path of their great law of development—natural selection and survival of the fittest;—a difficulty which they perhaps have never thought of, or at least one which I have never seen urged by any opponent of the theory of descent. I refer to the well-known fact, as taught in the writings of these authorities, that the lower forms of invertebrate animals are *bisexual;*—that is, they contain the sexual functions and organs of procreation in one and the same individual, and consequently do not require the union of two individuals to perpetuate their kind as with all present vertebrate tribes.

Now if the present *unisexual* species have really descended from *bisexual* forms by natural selection and survival of the fittest, it becomes a first-class evolution puzzle to determine in what way natural selection, survival of the fittest, or any other law of Nature could go to work to make this radical change from a *single animal* having both sexes in itself, with every facility for multiplying and perpetuating its kind, to a *couple of individuals*, each possessing half of this procreative function and half of the organic structure necessary to accomplish such a result. The very thought of such a fundamental change, under the circumstances, or even of the commencement of such a change, by the survival of the fittest (!) is enough to make a sober evolutionist's head swim. In fact I am sure that Mr. Darwin never thought of it while he was writing *The Origin of Species*, or he would instantly have dropped his pen, and the world would never have been blessed with that wonderful revolutionary system of natural science called *Darwinism*.

Prof. Haeckel even holds that this change from the *bisexual* to the *unisexual* form and mode of procreation took place as late as among the vertebrate species. He says:—

"*Each individual* was capable of *reproducing itself* independently, and the separation of the sexual organs took place at a later period. *We may therefore assume that the primitive vertebrate possessed both ovaries and testes.*"—*Evolution of Man*, vol. i, p. 266.

Now, is it possible to suppose that a great naturalist fit to represent the University of Jena, could have discussed this subject, as did Prof. Haeckel, even in its details, and not have once thought of the problem here suggested as to the manner in which natural selection went about making this radical transformation of one perfect individual "vertebrate," possessing the full sexual power of reproduction, into two imperfect individual vertebrates possessing half a sexual capacity each, and that, too, by "survival of the *fittest?*" It is perfectly clear that neither he nor Mr. Darwin could have thought of this worse than Chinese puzzle, involving the possible modus operandi by which this change could be effected under their "scrutinizing" law of natural selection, but just took it for granted, and concluded that it was as simple and easy as for the first young chicken to learn how to pick its way out of the shell, as so satisfactorily explained in the next chapter. This we are bound to believe, as a matter of course, since they never intimate this problem or anything referring to it as an objection; and besides they are so *candid* and almost *judicial*, in their investigations of natural phenomena, as every one concedes, that they certainly must have noted the difficulty and admitted its force had it occurred to them. As it wholly escaped their attention I take the liberty of thus incidentally referring to it, and suggesting a few thoughts upon it.

Mr. Darwin, fortunately for science but unfortunately for evolution, has defined the powers of "natural selection" with great preciseness and care. He not only tells us what it can do, but what it cannot do. In the first place it acts by *slight modifications only*, and cannot make a *great and sudden leap* in animal structure, such as changing a *bisexual* animal into two *unisexual* animals, giving half of this procreative power to each. Here is the positive proof:

"Natural selection *acts only* by taking advantage of *slight successive variations;* she can never take *a great and sudden leap* [such as the production of a male or female animal], but must advance by short and sure though *slow* steps."

"As natural selection acts solely by accumulating *slight successive favorable variations*, it can produce *no great sudden modifications* [such as a change from *bisexual* to *unisexual* organism]; it can *act only by short and slow steps.*"—DARWIN, *Origin of Species*, pp. 156, 413.

Thus it is perfectly plain that "natural selection" could not *suddenly* have separated some bisexual animal, transforming it into two separate beings, male and female, as this would have been a "great and sudden leap," equal to any miracle possible to conceive of as the work of a personal God; and of course Mr. Darwin does not intend thus to stultify evolution by changing natural selection into a personal Creator. Hence, if a bisexual animal were ever changed into two unisexual individuals by natural selection, it must have been effected "by taking advantage of *slight successive alterations*," as just quoted, and as the "only" way natural selection "acts." But this would have been equally impossible, because Mr. Darwin distinctly teaches, in a score of places in his different works, quoted in subsequent chapters, that natural selection can save no variation of an animal organism which occurs in Nature unless such variation is *beneficial* or *profit-*

able to the being; while it just as surely *destroys* any variation that may occur which is *injurious* to an animal, or tends to its *disadvantage* in the struggle for existence. Here, also, is a specimen of the positive proof:—

"Natural selection *acts exclusively* by the preservation and accumulation of *variations which are beneficial.*"

"Natural selection *acts only* by the preservation and accumulation of small inherited modifications, *each profitable to the preserved being*"

"On the other hand *we may feel sure that any variation in the least degree injurious* would be rigidly *destroyed.* This preservation of favorable individual differences and variations, *and the destruction of those which are injurious*, I have called natural selection or survival of the fittest."
—DARWIN, *Origin of Species*, pp. 63, 75, 97.

This settles the whole controversy, for it is certain that the slightest variation of a *bisexual* animal toward either the male or female side of its organism, would be injurious, as it would tend proportionately to weaken the other side of its sexual function, and thus unfit the individual for the work of perpetuating its kind. Any important sexual variation, therefore, of any individual would destroy itself by destroying the power of producing offspring and thus transmitting its peculiarities; while the very tendency toward separation would thus die with the individual and no progress would be made. Every slight variation that might thus chance to occur in nature, would inevitably end with the individual in which it occurred, and thus the tendency toward a division of the *bisexual* form into two half-sexual forms would make no headway. The very law of the "survival of the *fittest*" would thus utterly extirpate any *bisexual* individual in which the least weakening of either half of its procreative functions should occur; for it would necessarily deteriorate it, sinking it below the average normal status of the tribe. Hence the normal, perfect, bisexual forms, being the "fittest" to procreate their kind, would survive, while the impotent individual in which one-half of its procreative power was deteriorating, should any such tendency occur, being unfit to reproduce its kind, must perish with its unreproductive tendency. This can hardly fail to be clear to the reader.

Thus I demonstrate by an entirely new argument, and one to which no reply can be made, that as the lower forms of life were all bisexual, the first unisexual animal, or rather, in fact, two animals, *male* and *female*, must have been miraculously created, since it was impossible for them to have developed from bisexual forms by any law claimed or even supposable to exist in Nature. Hence it becomes a demonstrative proof, beyond the power of human intellect to question, in favor of the existence of an intelligent power in Nature, which is superior to, and independent of, Nature, and which we have a clear right to designate as a personal God. But this is not my only, or my strongest, proof, demonstrative of God's existence.

I have not yet spoken of Mr. Darwin's theory of "Sexual Selection," to which he has resorted in certain difficult emergencies to help out natural selection; and I have never seen this apparently plausible hypothesis replied to and its vulnerability exposed as I conceive it deserves; for when closely examined it constitutes, in my judgment, one of the most demonstrative and irrefutable arguments against the general doctrine of designless evolution, and in favor of the purposive immanence and agency of God in Nature that is possible to frame. A page or two devoted to this exposition may, therefore, not be amiss here.

The substance of Mr. Darwin's views may be found in his *Descent of Man*, chapters xiii and xiv. In these chapters he attributes, for example, the beautiful plumage of the male argus-pheasant, polyplectron, and bird of paradise, to the selective preference or intelligent choice of the female birds from age to age in constantly mating with the more beautiful males, leaving those not so elegantly and artistically decorated without partners, and consequently without progeny! In this manner the descendants of the more beautifully ornamented male birds have become handsomer each generation, till their plumage has attained its present indescribable beauty in form and color. The reader will please observe that this explanation is given by Mr. Darwin, not as a fanciful or provisional hypothesis to account for these forms and tints and a thousand other ornate characters of male animals, but it is seriously and elaborately argued as the only possible explanation of these wonderful male characters and which the founder of modern evolution confesses cannot be explained by natural selection and survival of the fittest, since they are of no benefit

to their possessors in the struggle for existence. The whole hypothesis, however, shows a most lamentable want of critical observation and logical discrimination which will astonish the reader when it is pointed out, and which will take but a few paragraphs to do.

Let us suppose, according to Mr. Darwin's reasoning, as expressly urged in the work referred to, that this sexual selection has actually proceeded from age to age under the artistic choice of female polyplectrons, for example, in constantly preferring as their mates the more artistically decorated males. It is perfectly evident, with a moment's reflection, that the male birds from which this selection was made must have been, at an early period, as nearly alike in form and color,—even in artistic ornamentation,—as are a flock of male polyplectrons now, though we may admit them then less beautiful as a flock, than at present. This being so, the whole theory falls to pieces, for it is a fact that if two mature males of this species were to be taken at random from a flock and placed before the most accomplished human artist, for examination, he would not be able to distinguish the least difference in the exquisite beauty of form and tint in the ornamentation of the two birds. Now to assume that the female bird is capable of making distinctions in the delicate blending of tints and colors in the feathers of two such males, so as to select the more beautiful of the two, is to attribute to this animal qualities of artistic taste and selective judgment superior to those of the most cultivated human intellect. The very suggestion of such a thing exposes its absurdity. To seriously assume that a female polyplectron at any former age of the world possessed the delicate taste and judgment necessary to determine the difference between the blending colors and arrangements of tints in the male birds of that species which would defy the discriminating powers of the most experienced human artist, is to insult the commonsense of the reader, as well as that of the whole scientific world. And this Mr. Darwin unwittingly does all the way through his elaborately investigated hypothesis of "sexual selection."

It is clear, therefore, that the female bird makes her choice between a number of equally beautiful males on some other principle entirely different from the one supposed by Mr. Darwin, and one which in no way involves the impossible supposition that the female comes to the conclusion, for instance, that the ball-and-socket ocelli of the wing-feathers of her mate is a little bit more neatly adjusted and shaded than those of the competing male by his side, which, by the way, is just as eagerly chosen by her sister hen, who claims to be equally artistic in her taste! And after all of the females have thus selected their partners I will guarantee that the disconsolate males left (provided there were in the flock more males than females) would be found, upon critical examination by a human artist, to be just as beautiful in every respect as the ones selected, proving that the exquisite ornamentation of the plumage of a male bird is not at all a factor in this pairing operation, and has nothing to do with it.

If Mr. Darwin shall doubt my judgment and wish to determine the incorrectness of the objection here raised to his theory, he can easily settle the question even to his own satisfaction. Let him, as a demonstrative and final test, separate all his male argus-pheasants from the females just before the pairing season commences, and then let him carefully mar the feathers of one half of the males by clipping away small portions of the ocelli of these wing-feathers which they are in the habit of so proudly displaying in the presence of the females, and though any artistic eye would instantly detect the difference in beauty between the clipped and unclipped birds, I will stake what little logical judgment I possess, or ever expect to have, that when the males are turned loose among the females it will not produce the slightest effect upon their artistic choice or on the result of the pairing, and Mr. Darwin will have the satisfaction (or more probably dissatisfaction) of witnessing the selection of mates go on as of old with no reference whatever to these marred ocelli, or to his elaborately framed theory of "sexual selection!" Now should this be the actual result witnessed, it would forever explode Mr. Darwin's hypothesis as the solution of the cause of such wonderfully artistic ornamentation in the plumage of these male birds, leaving this magnificent argument in favor of intelligent design in the forms of Nature where it ever has been, and to be explained, as it only can be, by the intelligent agency of the Creative Will.

As a conclusive proof that the female polyplectron does not make choice of a mate by her discriminating artistic taste in determining the fine points of difference in the beauty of the ocelli of two competing males, we see her eating and scratching away, paying no attention at all to the antics of her wooer as he proceeds with his courtship. Though Mr. Darwin lays great stress upon the fact that the male bird spreads his wings so as to present their beauty to the best advantage to the female, yet she never looks at his feathers, much less examines them with that scrutinizing and artistic inspection necessary to determine what Mr. Darwin's hypothesis requires, and what no human artist, however accomplished in his profession, could begin to achieve. Instead of fixing her artistic eyes with a spell-bound critical gaze upon these gorgeous and inimitable spangles of his spread wings, in order to settle the question of their comparative superiority over those of his rivals, as the theory of sexual selection imperatively demands, this artistic female does nothing but scratch and pick, with her eyes down to the ground, and without caring the value of a worm whether his feathers are white, black, blue or green. Yet Mr. Darwin's highly scientific theory makes her, with all this manifest indifference, a thousand-fold more critical and capable of judging artistically of the nice difference between the plumage of these birds than a human artist, with the closest possible inspection, and with the aid of magnifying lenses to assist his vision!

But as every argument urged in support of evolution almost necessarily carries with it, as we have seen and shall see, its own self-annihilating rebuttal, this theory of "sexual selection" is no exception, but contains within it the most unanswerable proof of the existence of intelligent and purposive design by a personal Creator in the thousands of forms and colors all around us in Nature, where no selection either "natural" or "sexual," can have taken any part, as admitted by Mr. Darwin himself.

First, let me quote this author to show that intelligent choice and purposive display on the part of these birds were actually necessary for the production of the forms and colors of the male plumage, and without which, of course, such artistic works of nature would not have existed:—

"He who thinks that he can safely gauge the *discrimination* and *taste* of the lower animals may deny that the female argus-pheasant *can appreciate such refined beauty;* but he will then be compelled to admit that the extraordinary attitudes assumed by the male during the act of courtship, by which the wonderful beauty of his plumage is fully displayed, are *purposeless;* and this is a conclusion *which I, for one, will never admit.*"—*Descent of Man*, p. 400.

Granting this reasoning to be sound, then I ask: if the beautiful ocelli and inimitable shading of the argus-pheasant's wings depend for their origin and existence upon the intelligent choice and purposive display of beings possessing and exercising mental powers capable of taking in and comprehending these artistic beauties, then how about the *microscopical* beauties of these same feathers, in which equally artistic patterns and arrangements of tints occur, but which are utterly beyond the artistic choice or purposive display of animals, because they are beyond the inspection of any unassisted eye? Thus, under the force of this single question, Mr. Darwin is obliged to admit by every principle of logic and reason that artistic beauties in Nature, not useful in the struggle for existence, and beyond the ken of animal or human vision, must have been produced by a purposive and artistic choice on the part of an intelligent power independent of, and above Nature. And further, if these microscopical hues and patterns of tints in the plumage of the argus-pheasant can thus only be accounted for by postulating intelligent design and artistic taste on the part of a mind capable of scanning the very molecules of these feathers, then how can the wonderful mechanical adaptation of the feathers themselves, as means to ends, and even the existence, form, and structure of the wings, be explained without admitting the intelligent working of a power and intellect above Nature; especially in view of the fact that these wings and feathers, in their incipiency, at least, could have been of no use to the bird, but were rather injurious, and hence could not have been produced by natural selection, as recently quoted, and as more fully shown in the eleventh chapter? To assume in one breath that the evolution of animal forms and organic structure proceeds by a purposeless natural selection and without intelligent design on the part of any power in the universe, and then in the next breath insist that even the colors of a polyplectron's wing could not have come into existence without the purposive display and intelligent choice of beings possessed of mental faculties and artistic taste, gives us a fair illustration of the incoherent and bungling character of this entire philosophy which would eliminate God from Nature and carry on His intelligent and artistic works by the pitiable machinery of a designless and self-contradictory system of evolution. I solemnly declare that I can conceive of no greater absurdity in philosophical reasoning than first to argue that the form and tint of a feather could not have originated without the mental operations of purpose, choice and artistic taste, and then that the very animal which exercises this choice and artistic discrimination actually came into existence with all its mental powers by the action of mindless and purposeless laws of Nature, and without the aid of any intelligent power whatever! If Mr. Darwin and his coadjutors think that such a self-contradictory system of philosophy can become permanently established in the minds of the independent scientific investigators of this age, after their sober second-thought shall be brought to bear upon it, they will wake up not a dozen years hence, as I confidently predict, the worst-deceived school of philosophers who have ever framed a scientific hypothesis.

Take for example, the indescribable beauties, artistic forms of sculpture, and exquisite geometrical outlines of chasing found in the microscopical shells of ocean, which no art can imitate

or approach, and then let us ask ourselves, how came these wonderful forms and artistic tints without mental discrimination on the part of some intelligent artificer, when the ocelli of a polyplectron's wing could not exist without intelligent purpose and artistic selection? There evidently could be no sexual selection among these mollusks as Mr. Darwin himself distinctly admits, because many of them, possessing the most exquisitely tinted and sculptured shells, are *acephalous*—without heads or eyes—and even exist in the darkest caverns of the ocean. They cannot have acquired these gorgeous colors and artistic patterns by natural selection to give them any advantage in the struggle for existence as protection from other animals, since Mr. Darwin is forced to admit that these brilliant colors make them more conspicuous objects to their natural enemies (See *Descent of Man*, pp. 262, 263). Hence the artistic hand and designing intellect of a power superior to, and independent of, Nature is absolutely demonstrated to exist, or else we have distinct and well-defined effects without any conceivable cause.

But after Mr. Darwin has thus deliberately excluded these intelligent designs and artistic patterns of microscopical shells both from sexual and natural selection, there actually seemed to be nothing left for him to do, on the principles of scientific honesty and high-toned philosophical investigation, but to get down upon his knees to the God of the universe and reverently acknowledge His hand and intellect in these ten thousand forms so utterly inexplicable upon any conceivable principle of natural law or physical philosophy. Does he do this? Has he the judicial candor, as a fair-minded investigator of Nature to make, as he must have felt, this honest and public confession of the truth that a personal God reigns in the universe, and that His intelligent creative acts alone can explain these artistic beauties of Nature, which confessedly cannot be accounted for by any other law or principle of science? I say *other* law or principle of *science*, because the personal existence of God, which is thus demonstrated to be indispensable to the existence of certain observed phenomena, becomes as much a scientific law or fact as does the law of gravity itself. What, then, does this candid, judicial investigator do, who was even obliged, in sheer desperation, to call in a personal Creator for his first simple forms with which to start evolution? To have humbly and truthfully confessed the hand of God in the sculpture and shading of a periwinkle's shell, would of course have been to admit tens of thousands of similar acts of creation equally impossible otherwise to explain, and this he knew would open the door to the origin of all species by the same consistent cause, without any necessity for his new-fangled laws of natural and sexual selection. Hence, to avoid such a disastrous denouement as this, some other explanation must be given, if only the most contemptible apology for a solution What, then, reader, is the substitute for the personal God of Nature that the father of modern evolution offers to the scientific intellects of this age to satisfy them of the truth of this great evolutionary departure? Here it is. All of it. Every word of it:

"They are *probably* the direct result, as in the lowest classes, *of the nature of the tissues; the patterns and sculpture of the shell depending on its manner of growth!*"—*Descent of Man*, p. 263.

Great heavens! Is this all that can be said by the most eminent naturalist of the age as a reason for eliminating the hand and intelligence of God from his artistic works, "the *nature of the tissues*" and their "*manner of growth?*" Not a syllable does he utter as to who organized these "tissues," or how the animal came by such a "nature" or "manner of growth" as to enable it to accomplish these artistic designs *which only intelligent choice and purposive display could effect in the wing of an argus pheasant!* Should the reader chance to hear a learned and scientific engineer explain the origin of a complex printing-press, by seriously declaring that it was owing to the "nature" of its cog-wheels and journals and the "manner," in which they worked, without the least reference to the one who designed or constructed the machine, he would have a vivid illustration of the puerility of Mr. Darwin's solution of ocean shells. But if the "nature of the tissues" of a mollusk and the "manner of its growth" will satisfactorily explain to this naturalist its artistic sculpture and exquisite beauty of blended tints, then, in the name of all that is called science, why does he resort to "sexual selection" to explain similar artistic effects upon a bird's wing, when the feather of a polyplectron could just as readily produce its own artistic designs and patterns by the "nature of the tissues" and "its manner of growth" as could an ocean shell? If the feather of a bird of paradise, for example, could not attain its artistic form and hue by the "nature of the tissues" and "its manner of growth," without the additional agency of artistic choice and intelligent intervention on the part of a being possessed of mental power, as Mr. Darwin has decided, then clearly the "nature of the tissues" or "manner of growth" of an ocean shell needs in addition, the intelligent intervention of an artistic mind.

This single consideration, if there were not another argument to be drawn from the records of science, demonstrates apodeictically the existence and personal intervention of an intelligent and artistic power superior to, and independent of, Nature, and to the same degree of absolute certainty by which we know that a chronometer could not exist and keep time without an original inventor and constructor. Col. Ingersoll, in his lecture on *The Gods*, last page, says:—

"If by any possibility the existence of a power superior to, and independent of, Nature, shall be *demonstrated*, there will then be time enough to *kneel, until then let us stand erect.*"

Robert G. Ingersoll: in the name of science, and upon the binding obligation of your own implied promise, I now demand that you get down upon your knees, and with penitent heart and lips confess the immanence and power of the God of Nature, whose name you have so often and so profanely reviled.

CONCLUSION OF CHAPTER VII.

Professor Haeckel teaches, as the reader has already become aware, that the *moneron* was the "primeval parent of all other organisms," and, being the very simplest of all creatures, that it was the only organic being which could have originated by spontaneous generation or without parental reproduction, because it alone of all organisms is "*composed of one single substance.*" Speaking of the Spontaneous Generation of Monera, he says:—

"Only such *homogeneous* organisms as are yet not differentiated and are *similar* to the *inorganic crystals* in being *homogeneously composed of one single substance* could arise by *spontaneous generation* and could become the *primeval parents of all other organisms.*"—HAECKEL, *History of Creation*, vol. i., p. 345.

Leaving out of the question the idea of a living creature without organs and composed of but "one single substance," so fully exposed in the preceding pages, we shall for the present suppose it to be a fact that the moneron is strictly homogeneous, containing but a single substance, the same as a crystal—a diamond, for example—and it will at once be seen that it overthrows completely Darwin's theory of transmutation of one species into another by natural selection, since almost any logical mind will admit that a being thus without organs and composed of "one single substance" only, formed by spontaneous generation, can no more produce "variations," which require the correlation and interaction of various substances and organs, and which form the foundation for "natural selection" and "survival of the fittest," than can the "one single substance" of the diamond spontaneously vary and evolve itself into the emerald or sapphire.

The only spontaneous variation possible or conceivable in a being or a crystal composed of "one single substance," and without parts or organs to differentiate, supposing such a thing possible with a being, would be to occur in larger or smaller lumps of this single homogeneous substance the same as in the diamond. To suppose such a creature, purely of one substance, capable of taking on organs or additional substances from inorganic matter by *inheritance* or *descent from itself alone* (since it is propagated alone by "*self-division*") would be the climax of absurdity; while if additional substances and heterogeneous organs could be added from *anorgana*, or the crude materials of Nature, without inheritance, then these substances and organs could have been added by the same inorganic laws and forces which produced the being in the act of spontaneous generation! But as Professor Haeckel tells us it was impossible for Nature to produce a being out of anorgana with parts and organs, or with more than "one single substance," then this "homogeneous organism" is forever chained to its "one single substance" and its organless form till some power in addition to the laws acting among the particles of inorganic matter is brought to bear on it. But as there could have been no supernatural agency in the start, and no power of any kind to produce organs or animate more than "one single substance," as Professor Haeckel asserts, hence it follows unavoidably that without supernatural interposition after the act of spontaneous generation the moneron could never have varied,—could never have assumed an organ or taken on an additional substance,—which utterly annihilates Darwin's law of transmutation at the very start, since if, in the process of spontaneous generation there can be no organs and no substances combined to differentiate, there can be no va-

riations after it to produce improvements under the same inorganic laws; and if no variations, then no natural selection and no survival of the fittest, consequently no evolution to higher grades of organism. Besides, Darwin's system teaches throughout, which is constantly reiterated by Haeckel, that "natural selection" can act "*only*" on "*inherited*" variations. I will quote one or two passages, which might be increased to a hundred:—

"Unless favorable variations be *inherited* by some at least of the offspring, *nothing can be affected by natural selection.*"

"Natural selection acts *only* by the preservation and accumulation of small *inherited* modifications."

"Any variation which is *not inherited* is *unimportant* for us."—DARWIN, *Origin of Species*, pp. 9, 75, 80.

Now, as there can be no *inheritance* among monera, since their only mode of propagation is "*self-division*," or by each individual creature cutting itself into two equal parts, each of which becomes a duplicate of its former self, it follows that there can be no "inherited" variations and no transmission of them to descendants; and consequently it follows, as Darwin says, that "*nothing can be affected by natural selection*"; and as neither Darwin nor Haeckel claims any other mode of evolution from lower to higher organisms than "natural selection," it inevitably follows that monera could not have evolved or been transmuted into a higher species! If pigeons, for example, propagated their species by a "*self*-division" of their bodies each into two equal parts, as do monera, there could certainly be no *inheritance* between such equal parts, because inheritance implies *parent* and *offspring*. As neither half of the pigeon could claim to be the *father* or the *offspring*, each being equally and essentially the same identical individual duplicated, it must be clear to every reflecting mind that in case of propagation by "self-division," there can be no offspring, and hence no such thing as inheritance; consequently among the monera (the very foundation for evolution, according to Haeckel), "*nothing*" could have been "affected by natural selection," as Darwin positively declares.

Thus, Haeckel's "scientific" basis of evolution in this marvelous *moneron*, by which a "natural order of development" was to be constructed and no thanks to Darwin's "Creator," has fallen to the ground at his very threshold of "Creation." He can show no possible way to get his homogeneous "parents of all other organisms" to move one hair's breadth in the way of variation from their original organless lumps of "one single substance"; and even if they should vary, such variations could not be made available by natural selection, since all ideas of *inheritance* are necessarily excluded. Does not transmutation from monera, then, clearly break down at the very start?

The above disastrous overthrow of "development by inheritance" at its incipiency would seem to be in harmony with the fact, as Haeckel assures us, that the moneron still continues "the simplest of all imaginable organisms," after millions upon millions of years; still found without the least addition to its "one single substance" the same as at the beginning of the Laurentian period, long before the Carboniferous or Coal age began, at which time he thinks the "conditions" were so "favorable," there being so much carbon in the air that spontaneous generation was "possible" even if it is not now. Notwithstanding the millions of years thus intervening since this "parent of all other organisms" was first ushered into being out of inorganic matter, it still continues destitute of "parts" or "organs" without the slightest advance toward heterogeneous

structure,—still propagates its species by the same "pinching" process, resulting in "self-division;" and, of course, without improvement, since it is still the "simplest of all imaginable organisms."

Is it at all likely, if this moneron were of such a nature as to be capable of varying by adding extraneous ingredients to its "one single substance," or by developing organs in its structureless and "homogeneous" body which might lay the foundation for a higher species, that, after this enormous interval of time since those favorable Carboniferous conditions, it would not show some slight addition of substance, or the smallest sign of developing organs? Is it not an astonishing fact, that, after these hundreds of millions of years, as most evolutionists estimate the interval, not one moneron can be found tending in any degree toward a change from that "one single substance" or that organless body it had when first formed out of inorganic matter by spontaneous generation? Finally, is it possible that at *one time only* and in *one place only* in the history of this earth a single moneron varied slightly, giving rise to a variety of monera which led on through additional variations to other varieties, and finally resulted in a new specific organization? This, as I shall soon show, is virtually taught both by Haeckel and Darwin. If it be so, that at *one* time, in *one* place, and in *one* individual moneron only, such variation occurred leading on to countless varieties graduated to a new species of monera, and this again in thousands of transitional varieties toward another specific structure, is it possible to suppose that not a single descendant of any one of these thousands of improved varieties and species of monera leading toward higher organisms has come down to us, and yet that the original and unimproved species continues throughout this long struggle for existence in countless millions of individuals exactly the same as when first spontaneously generated?

Darwin teaches, as I shall hereafter abundantly show by quotations from his voluminous works, that the improved descendants of any organic species in their gradual development toward a higher grade of structure, must invariably "supplant" and "exterminate" the unimproved or parent form in the struggle for existence, as it is only such exterminating process of the unimproved individuals, through "survival of the fittest," by which "natural selection" can work, and solely through this destruction of the unimproved by which an advance is made from a lower toward a higher grade of organic being. Three or four passages, only, will suffice for the present argument, as follows:—

"Hence we see why all the species in the same region do at least, if we look to long enough intervals of time, become modified, *for otherwise they would become extinct.*"

"New varieties continually take the place of and *supplant* the *parent forms.*"

"New and improved varieties *will inevitably supplant and exterminate the older.*"

"*In all cases* the new and improved forms of life *tend to supplant the old and unimproved forms.*"—DARWIN, *Origin of Species*, pp. 264, 266, 292, 413.

This legitimate tendency of "survival of the fittest" is reiterated by Darwin in a score of different ways. If monera are the "primeval parents of all other organisms," as Haeckel so repeatedly tells us, then according to these citations from this highest authority on Modern Evolution, there ought not to be a moneron in existence, since "new and improved varieties will inevitably *supplant* and *exterminate the older.*" As the monera have not been *supplanted* and *exterminated* by their improved descendants, but are perhaps to-day the most numerous of all living creatures, covering almost the entire bottom of the

ocean, while their supposed improved descendants—the thousands of modified species of monera, which, in the very nature of things, were necessary in gradually approaching higher grades of organism—have not a single representative, living or fossilized, to show that such diverging varieties ever existed, is it not the only logical conclusion that these monera never varied in their structure—never were under the control of Darwin's natural selection—and never produced any improved varieties at all?—and consequently that Prof. Haeckel, in thus recklessly staking his whole cause of evolution on this "homogeneous," organless creature, has deliberately thrown it away, and yielded the entire question of transmutation of species by natural selection?

Is it possible that Professor Haeckel can be right in regard to monera being the "primeval parents of all other organisms" and diverging gradually under natural selection through numerous varieties and specific forms which have not left a single specimen to tell the tale, while monera still exist by countless millions, and that Darwin still tells the truth in the following quotation?—

"From these several considerations I think it *inevitably follows* that as new species in the course of time are formed through natural selection, others will become *rarer* and *rarer* and *finally extinct*."—*Origin of Species*, p. 86.

To suppose that the very *lowest* organism, the *weakest*, the most *defenseless*, the *best adapted* as *food* for others, and consequently the most *unfit for survival*, instead of becoming "rarer and rarer and finally extinct," should still exist in countless millions, while its thousands of supposed varieties which were unavoidably necessary for transmutation to higher species, should have all succumbed without a specimen remaining to indicate such transitional gradations,—with Darwin at the same time repeatedly declaring that if such monera had so varied and become thereby the parents of advancing species, their improved descendants would have "inevitably" *supplanted* and *exterminated* them,—is a pitiable, irrational, and puerile hypothesis, whose improbability can only be equalled by its absurdity, and whose origination can only be accounted for either as a deliberately planned burlesque on Darwin's theory of descent, or else as the freak of a scientific adventurer incompetent to reason logically on any philosophical question.

I ought, perhaps, to have been a little more explicit in regard to the impossibility of natural selection having anything to do with *monera*, or other beings which propagate their kind by a self-division of their bodies, owing to the absence of "inherited" variations. Let us carefully examine the law of transmission in the case of such beings, and see if it does not completely shut out natural selection with its entire paraphernalia of "struggle for existence" and "survival of the fittest," as explained by Darwin, and thus demonstrate the impossibility of transmutation of the lower forms of life into the higher grades of organic structure.

Even supposing it possible for a moneron of but "one single substance" and organless, to vary in its form or substance, or to take on an extraneous organ, such variation could not be perpetuated and transmitted, for the reason that the first self-division of the individual which had thus varied would *halve* this abnormal or accidental peculiarity,—thus at once reducing instead of augmenting it, by dividing it between the two individual or duplicate beings, while each additional subdivision in the bodies of the descendants would reduce the abnormity by a proportional dilu-

tion till it would entirely disappear, thus defying natural selection.

This would be equally as true of a beneficial or serviceable variation as of a merely worthless protuberance or excrescence. It matters not of how much value a spontaneous variation in a *moneron* might prove to be if perpetuated by being accumulated and augmented through natural selection, this law of self-division precludes the possibility of all such interference, for a single divergence occurring among millions of individuals would be beyond the reach of natural selection, since it would commence running out by this diluting tendency of self-division, as stated, without a possible chance for augmentation, and would thus soon become extinct.

It is perfectly evident if monera can or do vary at all, it is but very seldom, as no naturalist has yet seen one with even a spontaneous wart on its little body. Hence, natural selection could not begin to work on such a scarcity of material, even if within its law of operation, before the peculiarity would disappear entirely by continual subdivisions.

Suppose, for example, a single moneron should accidentally vary by developing two perfect *eyes* on some part of its body. The very first self-division would either give one eye to each half, according to the direction in which the line of division should take place, or else give both eyes to one half, which would leave the other half exactly in its normal condition, the same as if no spontaneous variation had occurred. If one half of the moneron should continue to retain both eyes at each self-division, then natural selection could do nothing to extend this improvement to any other individual of the race, as there would be no transmission of the eyes, and consequently no *inheritance* of them, and it must be remembered that "natural selection *acts only* by the accumulation and preservation of small *inherited* modifications," and hence as soon as that individual retaining the two eyes should happen to die there would be an end to that variation, terminating and leaving the race as blind as before, and exactly the same as if no such an accidental pair of eyes had been developed, notwithstanding natural selection looked on, so to speak, a helpless spectator all the while. Even if that individual half should live and retain the two eyes forever, such a fact could never result in the improvement of another individual of the race or make the slightest advance toward a transmutation, since *inheritance* is entirely out of the question.

But if, on the other hand, this abnormity should be equally divided between the two halves at the first segregation, giving one eye to each of the duplicate individuals, then, instead of the descendants from these two halves being benefited by receiving each an eye apiece, the first self-division of either body having one of the eyes would either give the single eye to one half (which would leave it exactly in the position of the first moneron just described which retained the two eyes), or the eye would be wholly destroyed by the line of division passing through it, thus annihilating the improvement at the second stage of descent, since we can not conceive any benefit to the two last-named duplicate monera by having half an eye apiece! And if natural selection could reach the case at all, as we see it can not, it would make sorry progress, since it would then find but the cicatrice of an eye to work on, which would indicate the appearance of an eye less and less at each subsequent self-division.

Thus, by every possible view of the case, unsexual beings, which transmit their descendants by the self-division of their bodies, as did Haeckel's "primeval parents

of all other organisms," necessarily shut out the idea of inheritance as wholly impossible in their mode of descent; and hence, as seen from the very highest authority on the subject, natural selection can do nothing for them nor with them, since any accidental or spontaneous variation which might arise in an individual, however beneficial, would be immediately destroyed by self-division, or being retained by one half only would die with that half and thus come to an end, without the possibility of it being extended to other individuals of the race, much less leading to a transmutation of monera to monkeys.

Expressed syllogistically the argument becomes at once simple and unanswerable, as follows:—

I.—Without natural selection there can be no evolution or transmutation of one species to another, as both Haeckel and Darwin agree.

II.—Without the *inheritance* of spontaneous variations among the members of a species there can be no natural selection, since Darwin repeatedly and in various forms lays down the law that "natural selection *acts only* by the accumulation and preservation of small *inherited* modifications."

III.—As there can be no *inheritance* in the true sense among monera and no transmission of an accidental improvement to descendants, owing to its immediate destruction by self-divisions or its retention wholly by one of the duplicate beings, it follows therefore that monera were beyond the reach of natural selection, and consequently beyond the possibility of transmutation to another species.

IV.—The general conclusion is therefore unavoidable, that Professor Haeckel's basis of evolution has utterly broken down; and as Darwin equally with Haeckel holds that the first simple beings which were "breathed" into by the "Creator," as the foundation for evolution, were without sex and propagated by self-division, his theory of primal transmutation from such unsexual beings has likewise gone by the board.

Clearly, then, by the repeatedly expressed views of both Haeckel and Darwin as to the scope and powers of natural selection in dealing "only" with "inherited" modifications, the spontaneously generated monera of the former and the "few simple beings" of the latter were necessarily beyond the range of Darwin's great transmuting law; consequently Professor Haeckel's brilliant spontaneous inauguration of life and evolution by a natural chain of descent from man down to nothing, forming thus a philosophical connection between Kant's Cosmogony and Lamarck's Theory of Descent, has proved a total and ignominious failure. He must therefore manage in some way to get up another "spontaneous generation" a few steps in advance of monera—beings composed of more than "one single substance," with a structure capable of differentiating and correlating, —not like his lumps of albumen, "without parts or organs"; and even then, if they do not embrace some other mode of transmitting their peculiarities to descendants than self-division of their bodies, he might as well frankly abandon his absurd policy of spontaneity, and acknowledge as does Darwin that an infinite "Creator" was at the bottom of the work, *breathing* into the first organic creatures the breath of life; though it is evident, had Darwin foreseen the utter powerlessness of natural selection in doing anything with creatures which propagate their kind by self-division, for the want of inheritance, he would have taken the precaution to see that his "Creator" should have "breathed" into a class of "beings" not quite so "simple."

But even supposing, for the sake of the

argument, that the self-divisions among monera were in every way equivalent to the sexual transmissions of offspring among higher species, is it possible for an accidental peculiarity, however beneficial, occurring in a single individual, to be so favored by natural selection as to be perpetuated, and thus made to improve the race or species to which such individual belongs? I answer emphatically that even in our higher genera and species of mammals the most marked and useful variation spontaneously occurring, unless under compulsory separation and methodical selection, would be immediately lost and obliterated by promiscuous intercrossing with the normal individuals of the same species, and that no possible influence of natural selection could prevent such obliteration of abnormity or cause it to advance the race one iota in a transmutation of that species toward another.

The direct and natural tendency of an abnormal structure to run out and disappear of itself in a ferine state, or when not continuously cultivated by intelligent selection, is admitted among naturalists generally. This, added to the fact of promiscuous intercrossing in a state of nature, would immediately dilute and then destroy any spontaneous deviation of structure, however useful, before natural selection or survival of the fittest would have time to make the least advance toward improvement.

Suppose, for example, among wild asses, which exist in herds of thousands, a male should be born with a single horn in the middle of the forehead. Although this weapon would be of great service in offense and defense among its fellows in mastering the males and getting possession of the females, as Darwin claims, yet its first offspring would either be hornless by a natural reversion or possess but stunted horns, being one half diluted by the normal female structure. This horn peculiarity in the second generation, would, by reversion and natural dilution, no doubt almost entirely disappear; while in the third generation not a scintilla of the abnormity would probably be seen. This is shown by observation, and corroborated by reason, to be the natural tendency of all abnormities when not restrained by methodical selection and intelligent culture.

I will now proceed to demonstrate this principle to the reader's satisfaction by adducing the evidence of the highest living authority on this subject—Mr. Darwin himself. He says:—

"I saw also that the preservation in a state of nature of *any occasional deviation of structure, such as a monstrosity*, would be a rare event; and that if at first preserved it would generally *be lost by subsequent intercrossing* with ordinary individuals."—*Origin of Species*, p. 71.

"But we have *no evidence* of the appearance, or of the continued procreation under nature, of *abrupt modifications of structure;* and various general reasons *could be assigned against such a belief:* for instance, *without separation a single monstrous variation would almost certainly be soon obliterated by crossing.*"—*Variation of Animals and Plants*, vol. ii., p. 495.

I would now appeal to the reader, and candidly ask him if Darwin has not literally and without any forced construction of his words surrendered the whole theory of natural selection preserving and accumulating small inherited modifications, and thus finally so changing the form and structure of one species as to transmute it into another? To admit that an "abrupt modification," a "single monstrous variation," or an "occasional deviation of structure such as a monstrosity," would be lost by "intercrossing with ordinary individuals" and thus "obliterated," in the very face and eyes of natural selection powerless to prevent it, is an absolute yielding of the whole question which he has labored

so long and so persistently to establish; for if natural selection can not preserve, or save from being "lost," a *marked* "modification," how in the name of natural science and common reason can a small variation be saved from thus being lost under the same conditions?

Is there any essential difference, in the nature of things, between a large variation and a small one which should give the advantage to the small one as to the chances of being perpetuated by natural selection? Common sense would suggest that the advantage should be the other way. Darwin does not pretend at all, in any part of his writings, that there is the least difference essentially in their nature except as to prominence; but right to the contrary, asserting repeatedly that a monstrosity is only a larger grade of variation, yet of the same nature, and with no line separating the large from the small by which to prevent their graduation into each other. Hear him:—

"Monstrosities *can not be separated* by any distinct line *from slighter variations*."—*Origin of Species*, p. 6.

"Monstrosities *graduate so insensibly into mere variations* that it is *impossible to separate them*."—*Animals and Plants*, vol. ii., p. 306.

Here, then, unless language in England means something altogether different from what it is understood to signify in the United States, the whole bottom falls out of natural selection by this truthful and most rational inculcation of Mr. Darwin himself in regard to all accidental variations in a species, whether large or small, being of the same nature; and also by his distinct admission, which every one must acknowledge to be correct, that even the most marked and prominent variations which occur in a species will be obliterated by intercrossing, notwithstanding the presence of natural selection and survival of the fittest!

Not only is there no line separating prominent deviations in a species from slighter variations, thus making monstrosities and small divergencies one and the same thing except as to quantity, but they are proved to be of exactly the same nature by being caused in the same manner and under similar conditions:—

"All such changes of structure, whether *extremely slight* or *strongly marked*, which appear among many individuals living together, may be considered as the indefinite effects of the conditions of life on each individual organism."—*Origin of Species*, p. 6.

Thus, as in the case of monera, where propagation of the race is by self-division, we see in higher grades of organism the same result, and that no variation can be perpetuated where individuals of the species are left free to mingle and intercross; and therefore there is no power in Nature nor in natural selection to transmute one species into another, since neither Darwin, Huxley, nor Haeckel claims such a thing to be possible, only by the rigid preservation for long intervals of time of the spontaneous variations which naturally occur in a species. As such spontaneous variations, whether large or small, will be "lost," as Darwin admits, if left free or without forcible separation and intelligent selection, there has therefore never been a power in Nature capable of causing the transmutation even of a sheep into a goat or of a duck into a goose. It being thus broadly conceded by Darwin that a monstrosity can not be saved by natural selection and made available for transmutation, and then quite as broadly admitted that there is not the least difference between a monstrosity and "lesser variations" except as to size and quantity, what need we of further witness? We might well repeat the words of a very emphatic speaker, and apply them to Mr. Darwin—"Out of thine own mouth will I judge thee."

But a word or two more right here with Mr. Darwin and his favorite theory of natural selection, though this is hardly the proper place to begin the review of his special and peculiar arguments, which I had not intended to touch till the beginning of the next chapter; but as the discussion bears directly on the subject of the transmutation of monera, and since we are now upon one of the very weak points of the theory in the self-stultifying position of this great author in regard to monstrosities and lesser variations, I want to find out from Mr. Darwin, while the subject is fresh in the mind of the reader, what is the matter with natural selection that it can not manage to utilize a distinct or prominent variation and turn it to account in the transmutation of a species when it can utilize small divergencies to such an extent as to convert an oyster into an alligator, a fish into a kangaroo, or a mouse into an elephant?

According to this author's general opinion of natural selection, as expressed in numerous places throughout his various works, it far surpasses man's powers of comprehension, discrimination, and selective judgment; in fact, he insists that it is as far superior to man and his best efforts in improving a species by methodical or intelligent selection "as the works of the Creator are to those of man," or "the works of Nature are to those of art."

Look at the following graphic description of natural selection:—

"If man can by *patience* select variations useful to him, why, under changing and complex conditions of life, should not variations useful to Nature's living products often arise and be preserved or selected? What *limit* can be put to this power, acting during long ages and *rigidly scrutinizing* the whole constitution, structure, and habits, of each creature,—*favoring* the good and *rejecting* the bad? *I can see no limit to this power* in slowly and beautifully *adapting* each form to the most complex relations of life. The theory of natural selection, even if we look no further than this, seems to be in the highest degree probable."

"But natural selection, as we shall hereafter see, is a *power incessantly ready for action*, and is as *immeasurably superior to man's feeble efforts* as the works of Nature are to those of art."

Speaking of the *eye* as the work of natural selection, he says:—

"Selection will *pick out with unerring skill* each improvement. Let this process go on for millions of years . . . and may we not believe that a living optical instrument might thus be formed as superior to one of glass *as the works of the Creator are to those of man?*"—*Origin of Species*, pp. 49, 146, 412.

Yet with all this wonderful superiority of natural selection over man's power in cultivating a species, Darwin admits in another part of his book that man can take a monstrous or half-monstrous form, or any visible improvement or variation in a species, separate the being thus diverging from the normal creatures, and, by methodical selection and the prevention of free intercrossing can soon create a distinct breed. He says:—

"He [the breeder] often *begins his selections by some half-monstrous form*, or at least by some modification prominent enough to catch the eye."—*Origin of Species*, p. 65.

But man can not even do this without great care, great and long experience, a most accurate eye and discriminating judgment. Lacking any of these qualifications, his efforts will prove a failure. Darwin, speaking of methodical selection, says:—

"Not one man in a thousand has accuracy of eye and judgment sufficient to become an eminent breeder. If gifted with these qualities, and he studies his subject for years, and devotes his lifetime to it with indomitable perseverance, he will succeed, and may make great improvements; *if he wants any of these qualities he will assuredly fail.* Few would readily believe in the *natural capacity* and years of practice requisite to become even a skillful pigeon-fancier."—*Origin of Species*, p. 23.

Now, putting these things all together, we have a mass of contradictions which might not at first impress the superficial

reader, but which, when carefully looked into, utterly and hopelessly breaks down natural selection as an efficient means in Nature for the transmutation of species, as claimed by Darwin.

In the first place, natural selection is far superior to man's powers in improving a species by taking advantage of and preserving spontaneous variations.

In the next place, natural selection can do nothing with a monstrosity or a prominent variation, but allows it to die out at once by intercrossing; while man, so vastly inferior,—as far beneath this marvelous law of Darwin as the works of man are beneath those of the Creator,—"*begins his selections by some half-monstrous form*," and so on down in his "feeble efforts" can operate on any deviation of structure visible by the microscope; while natural selection, with its vastly superior powers, not only fails on monstrous and half-monstrous deviations, allowing them to be "lost" for want of man's power of separating them from the common herd, but it also fails in the same manner on all smaller variations for reasons before shown, as they are all of the same nature and caused by the same conditions, with no difference between them (except in quantity, giving the preference by all odds to the *larger divergencies*, if natural selection had a hundredth part the "capacity" of the breeder), since all kinds of variations come under the same law, graduating "insensibly" into each other, with no line separating the large from the small.

Then man, notwithstanding his manifest superiority in saving large and small variations, can do nothing in the work of selection or the improvement of a breed, if he lacks the "*accuracy* of *eye* and *judgment*" and "natural *capacity*,"—he must *study* his subject with *perseverance*,—and "if he lacks any of these qualities he will *assuredly fail*." Yet natural selection, without "eyes," without "judgment," with no "capacity," no "patience," no "perseverance," no sense, and no intellect,—incapable of saving the largest or the smallest variation from being lost by intercrossing,—is described by Darwin as "*rigidly scrutinizing the whole constitution, structure*, and habits of each creature,—*favoring* the good and *rejecting* the bad,"—"will *pick out* with *unerring skill each improvement*,"—so "immeasurably superior to man's feeble efforts" that he "can see no *limit* to this power in slowly and beautifully" transmuting a tadpole into a lion or a moneron into a monkey! Yet it can not preserve from being lost the most palpable variation in a species, which the commonest breeder could easily "pick out," then utilize and convert into a distinct breed.

Such is a hurried glance at the incongruous absurdities into which Darwin is involved by his futile attempts to make this ridiculous law of natural selection take the place and assume the role of a God.

Before concluding this chapter I must refer to an intimation I made some time ago, that, according to the teaching of both Haeckel and Darwin, there can be but one "center of creation" for any species; or, in other words, that the variation which leads to a variety of structure, and thence on through other variations to species, genera, families, orders, and classes, could never, in the very nature of things, occur but at one time and in one place. Let us now see if this is not substantially so:—

"Every animal and vegetable *species* has arisen *only once in the course of time* and *only in one place* on the earth—its so-called 'center of creation'—by natural selection. I share this opinion of Darwin's. . . . For it is quite incredible, or could at least only be an exceedingly rare accident, that all the manifold and complicated circumstances—all the different conditions for the struggle for life, which influ-

ence the origin of a new species by natural selection —should have worked together in exactly the same agreement and combination more than once in the earth's history, or should have been active at the same time at several different points of the earth's surface."—HAECKEL, *History of Creation*, vol. i., p. 352.

"Hence it seems to me, as it has to many other naturalists, that the view of *each species having been produced in one area alone*, and having subsequently migrated from that *area* as far as its powers of migration and subsistence under past and present conditions permitted, *is the most probable.*"—DARWIN, *Origin of Species*, p. 321.

Though Haeckel supposes that in the lower forms of life, such as monera, amœbæ, protista, &c., it might be possible for the same variation to have occurred at different times and in more than one place (which I will show involves all the consequences of the above fatal position), yet when the organism had become sufficiently differentiated to form a heterogeneous structure, the occurrence of a variation which would inaugurate a new species in more than one place and at more than one time he thinks could not happen, considering the infinite chances to the contrary.

Let us now look, for a few moments, at the direct tendency and result of this essential feature of the evolution theory as perfected under natural selection. If the origin of a species could not occur only at one time and in one place, it could only receive its first impulse by a chance or spontaneous variation of *one individual*,—the single, identical being, which actually did so vary at that *time* and *place*, which variation was taken up by its descendants, augmented and accumulated by survival of the fittest and preserved by natural selection till it ran all the way from a variety, faintly marked, to a well-defined specific structure.

This, then, being the law under which a new species must be formed by natural selection, the tenure of man's existence on this earth (if Darwinism be true, and if there be no supervising intelligence above Nature controlling its affairs) has for countless millions of times hung upon the merest thread of contingency,—the merest accident of a certain spontaneous variation occurring in some animal in a certain place and at a certain time, and this contingency repeated with each of the millions of varieties and species living and extinct, through which man's lineal descent can be traced from the time he branched off from the monkey down to the lowest form of life—the moneron.

To begin with the monkey, let us take a moderate survey of man's tenure of being and the infinite chances through which he has passed. At one time and "in only one place on the earth," when no human being existed, a certain monkey—according to all evolutionists—possibly an orang-outang, was born, having a slightly larger brain or some other structural variation pointing faintly toward the future human race. This exact spontaneous variation, whatever it was, had never before occurred and could never occur afterward, counting the chances, since had it occurred before or after, there would have been other races of human beings, which Darwin distinctly asserts could not have been the case. It follows, then, that had this little orang died before maturity (or without transmitting its peculiarity to its offspring) by one of the thousands of accidents to which monkey-life was liable, no human being would ever have lived upon this earth, because no other time nor place nor little monkey would have answered the purpose. Not only so, but had the mother of that little orang died before its birth, or had any one of her long line of ancestors (counted perhaps by millions, since the first monkey was developed from the dog) accidentally died without progeny, it would

have severed the lineal chain, and would have inevitably prevented the existence of the mother, and consequently of the little orang with a high forehead, and hence the earth to-day would hold no organic being higher than the quadrumana! Are evolutionists prepared to accept these millions of contingencies for man's existence on earth, going no farther back than his lineal relationship with monkeys?—and then are they ready to believe that had one of those millions of contingencies occurred, no power above Nature exists to remedy the awful defect?

The same statement may be made concerning the dog genus, and that one final and marvelous spontaneous variation in a single puppy which faintly pointed toward the lemur, and through it toward the higher monkey species. As such a puppy could never have been born, and such a peculiarity could never have occurred "in only one place on the earth," and as no other mother could ever have produced it, consequently, had that particular puppy died before maturity or the mother before its birth, or had any one of the millions of her lineal ancestors, such as jackals, foxes, wolves, hyenas, &c., died without progeny, there never could have been a monkey on this earth any more than an Israelite could now exist, according to evolution, had Abraham died in infancy. Thus each species, through which the line of consanguinity passes, as taught by Darwin, adds other countless millions of contingencies against the existence of the human race. Then, beyond the jackals, wolves, foxes, &c., the same unnumbered millions of contingencies occur in connection with each one of that particular puppy's more remote ancestors, such as marsupials, amphibia, batrachia, reptilia, fishes, crustacea, mollusca, &c., on down toward the moneron, among each one of which the slightest circumstance would have forever prevented the existence of man on the earth. Any single link broken in this inconceivable chain of heredity,—the death of a certain fish before it had spawned in the far-off Devonian age,—the failure of a certain one of its eggs to hatch through which the line of descent had to come,—the accidental crushing of a single oyster or janthina by the falling of a rock in the almost lifeless Laurentian period,—would have severed the chain of man's lineal descent en route from the moneron, and, according to these great teachers of science, would not only have forever prevented man's existence on earth, but would have equally prevented the existence of all other organic beings above that particular fish or mollusk. Man's destiny hinged upon the very contingencies here named, because no other fish and no other mollusk could have had all the environments and surrounding influences to produce the peculiar variations required to lead on the lineal thread which should ultimately develop into the human race.

But I will even go further in this matter of contingencies. I will follow Professor Haeckel back to that *moneron* which some time in the inconceivably remote primary epoch was spontaneously generated by the accidental carbonizing of an accidental grain of albumen which had by accident collected through the interaction of inorganic forces,—that *moneron* which he says is the "primeval parent of all other organisms,"—that *moneron* which was the remote ancestor of some other far-off *moneron* in the Carboniferous age, which accidentally varied and then transmitted its peculiarity, in some manner to mortals unknown, to some other moneron with additional improvements,—that to another and so on till a new and higher species of animals was developed.

It is true Professor Haeckel thinks it possible that more than one spontaneous generation of monera may have occurred in different epochs of the earth's history, but that has nothing to do with that one single *moneron* which was first in the long line of man's ancestors. A hundred thousand individual monera may have spontaneously generated at different ages of the world, and thus have given rise to as many species of monera, but out of all these races *one only can be the primeval race through whose chain of successive self-divisions man's lineal descent runs back to some one individual moneron spontaneously generated!* It is as impossible for two such spontaneously generated primeval monera to be both the progenitors of the line leading to man as for a child to have two actual fathers or two natal mothers. Whatever the other races of monera, which may have been spontaneously generated, did or may have done, *they never did originate a line leading toward a human race, since such a line could occur in its primeval spontaneous start at but one time and in but one place.* Hence, we reach the startling and almost paralyzing fact, that, had there been a little stone, no larger than a penny, lying over the exact spot where that first *moneron*—man's "primeval parent"—was spontaneously generating, no such a marvelous event could have taken place. The race of monera descending from that single head would never have existed,—those peculiar variations which some one of its millions of descendants must have developed, and which led on to higher organisms and through them to still higher, could never have occurred,—and consequently man would never have had an existence on earth, nor would any other living creature higher than these "homogeneous" lumps of albumen!

Yes, this great scientist, who would give us a plausible and simple solution of the mighty problem of man's origin, and a consistent, philosophical, natural exposition of "Creation," by linking Kant's Cosmogony with Darwin's Natural Selection, cemented by spontaneous generation,—who would brush aside from the problem the inconsistencies and superstitious puerilities of miraculous intervention on the part of a mythical God,—who would give us a rational conception of man's important relationship to the universe as the intellectual head of all organic beings,—tells us that had a *bubble* of sea-water *burst* at one time on the margin of some estuary a thousand million years ago (disconnecting or disturbing the atoms of inorganic matter which had fallen by chance together, and which were accidentally evolving from nothing a grain of mucus, which would, if left undisturbed, be spontaneously generated by an accidental breath of carbon into a certain *moneron* which was to be the "primeval parent of all other organisms,") then man would never have lived, and there is no power—no intelligence in the universe—capable of correcting the terrible effects of the noiseless explosion of that fatal bubble! Are evolutionists and spontaneous generationists prepared to accept the legitimate and logical consequences of such an array of contingencies, each one of which suspended the existence of the human race by less than a hair? To accept these numberless millions of chances as having actually existed, on each one of which the destiny of our race was suspended, yet without any one of them having given way or failed to make the connection by which man's existence on earth was secured, is a more stupendous miracle a thousand-fold than was ever believed in by either Christian or Jew.

CHAPTER VIII.

EVOLUTION.—ITS STRONGEST ARGUMENTS EXAMINED.

Arguments stated which Evolutionists regard as unanswerable.—They have never been met or even stated in any review of Darwinism.—This fact thrown scathingly into the teeth of Opponents of the system by Haeckel and other writers.—The author pledges himself to skulk no Fact nor Argument adduced in support of Evolution.—A Fundamental Principle underlying all these Problems to be first established.—An Absolute Scientific Demonstration that the Life and Mental Powers of every living creature constitute an Intangible yet Substantial Organism as real as the Anatomical Structure.—Darwin's Theory of Reversionary Action, as one of his strongest classes of Facts, examined.—A terrible Table of Figures arrayed against him.—The Impossibility of Reversions Positively Demonstrated.—The entire Doctrine of Inheritance misunderstood.—Transmission even from Father to Son through Corporeal Organism an Absolute Impossibility.—With the Failure of Darwin's Idea of Reversions, Evolution necessarily breaks down.—Another Demonstration that the Life and Mind constitute a Substantial Organism within the Corporeal Structure.—Transmission and Inheritance of an Acquired Habit among Animals explained.—Darwin implores an Explanation, however imperfect.—The Great Problems and Facts of Embryology examined.—They are turned against Evolutionists, and their Theory overthrown by them.—Haeckel's Plates, showing the Similar Appearance of all Embryos, prove too much for the Theory.—He destroys Evolution by his efforts to aid it.—Darwin proves that Man descended from Lower Animals by the exact similarity of all Ovules.—This Fact fatally turned against him.—Darwin's Provisional Hypothesis of Pangenesis and Gemmules shown to be Utterly Impracticable and Absurd.—The Author's New Hypothesis, by which the Problems of Embryology, Reversions, Monstrosities, Rudimentary Organs, &c., may be solved.—The Only Attempt at Explanation ever made, except by the Theory of Descent and Transmutation.—The New Hypothesis supported and corroborated by Darwin's Assumptions.—The Author's Hypothesis reasoned out and shown to be a Rational Solution of these hitherto Unexplained Facts of Embryology, Reversions, &c.—Summary of the Argument.

The preceding chapters of this book, though apparently miscellaneous and somewhat disconnected, have, as will be made clear in the future, logically prepared the way for a correct understanding and a practical solution of some of the most profound and intricate problems developed by Darwin's theory of descent.

When the writer declares, as he now does, that the strongest facts and arguments relied on by evolutionists in support of the transmutation of species by natural selection, have never been presented by any reviewer of Darwinism, or even referred to, much less met and refuted, by opponents of the theory, he but states what is well known among evolutionists, and tauntingly flung into the teeth of would-be reviewers by advocates of the system.

Take, for example, the patent facts of *embryology*, such as the intimate resemblance of all vertebrate animals in their early embryonic condition, in which the embryos of the chicken, dog, tortoise, orang-outang, as well as that of man, have equally a caudal appendage or a tail like that of the puppy, while in general form at a very early stage of progress they can not be distinguished from each other; and also the notorious fact of the universal presence

of the gill-arches or branchiæ of the fish in the embryos of all reptiles, birds, and mammals;—take the undisputed fact of *rudimentary organs* which are never developed into practical use, found in many animals, such as the incisors or upper front teeth in the embryos of calves, which disappear before birth; and the same thing in the embryos of the whale tribe, where only whalebone is seen in the adult; also, rudimentary leg-bones in the hinder portions of the body of the whale and of the boa-constrictor, which are never perfected into legs, and can only mean, as evolutionists insist, that these animals came by transmutation from other species having those various organs perfect;—take the undeniable fact of *reversions*, in many species, to the form, color, or structure of others, such as the common dovecote pigeon to the color of the wild-rock pigeon, the horse and mule to the stripes of the zebra or quagga; and the astonishing fact that in a few cases women have been found with supernumerary mammæ in the inguinal region, and also organs normal only to marsupials, such as the double uterus of the kangaroo or opossum,—proving, as Mr. Darwin proclaims, that the human race has descended from these remote mammal ancestors, and that women still retain sufficient marsupial blood in their veins to occasionally cause these reversions! These, in connection with the well-known corroborative facts developed by comparative anatomy, which show that all vertebrate animals, from the lowest fish to man, are built up on the same general plan of structure; and that those nearest related in their anatomical chain or type, such as man and the quadrumana or higher species of the monkey, can scarcely be distinguished from each other; while the paleontologic records show this gradual development from the lower species up toward man by a corresponding gradation in their petrified remains found in the geological strata,—all combining, they tell us, to confirm the theory of descent as taught by Darwin.

I here present a few citations which bear directly on the problems referred to. Prof. Haeckel, who is admitted by Mr. Darwin to be one of the highest authorities on the subject, remarks:—

"All the phenomena of organic development . . . and further, the whole history of *rudimentary organs* are exceedingly important proofs of *the truth of the theory of descent.* For *by it alone can they be explained*, whereas its opponents *can not even offer a shadow of an explanation of them.*"—"I wish especially to draw attention in Plates II. and III., which represent embryos in all stages of development, and in which we are not able to recognize a trace of the full-grown animal. . . . Every one surely knows the *gill-arches of the fish.* . . . Now these *gill-arches* originally *exist exactly the same in man*, in *dogs*, in *fowls*, and in *tortoises*, as well as in all other vertebrate animals."

"Finally, when comparing the embryos on Plates II. and III., we must not fail to give attention again to the *human tail*, an organ which in the original condition man shares with all other vertebrate animals. . . . Now man in the first months of development *possesses a real tail* as well as his nearest kindred, the tailless apes (orang-outang, chimpanzee, gorilla,) and vertebrate animals in general."—"In this intimate connection of ontogeny [resemblance of embryos] and phylogeny [common descent] I see *one of the most important and irrefutable proofs of the theory of descent. No one can explain these phenomena* unless he has recourse to the *laws of inheritance and adaptation; by these alone are they explicable.*"—"The rudimentary little tail of man is an irrefutable proof of the fact *that he is descended from tailed ancestors.*"—HAECKEL, *History of Creation*, vol. i., pp. 289, 307, 308, 310, 314.

I also quote a passage or two from Mr. Darwin, to the same effect:—

"It has been shown that generally the embryos of the most distinct species belonging to the same class are closely similar, but become when fully developed widely dissimilar."

"Man is developed from an ovule about 125th of an inch in diameter, which *differs in no respect* from the ovules of other animals. The embryo itself at a very early period can hardly be distinguished from that of other members of the vertebrate kingdom."

"That most wonderful fact in the whole round of natural history, namely, the similarity of members of the same great class in their embryonic condition," &c. . . . "It is the consideration and explanation of *such facts as these* which has *convinced me* that the theory of *descent with modification* by means of natural selection is in the main true. *These facts have as yet received no explanation* on the theory of independent creations."

[I wonder if Mr. Darwin will become "*convinced*" the other way when all these facts are taken from him!—*Author.*]

"*No other explanation* [than descent from a common progenitor] has *ever been given of the marvelous fact* that the embryos of the man, dog, seal, bat, reptile, &c., can at first hardly be distinguished from each other."—*Descent of Man*, pp. 9, 25.—*Animals and Plants*, vol. i., p. 24.—*Origin of Species*, p. 387.

Now all these things are facts of science admitted by physiologists, naturalists, and anatomists generally; and to ignore them, as heretofore done, in reviewing evolution, and as intimated in the Introduction, is to proclaim their unanswerable character. Is it true, however, that these facts unmistakably point to transmutation from the lower to the higher species?—and is it true that no other possible or conceivable hypothesis can be invented which will rationally solve them? If such be the case, then it is indeed no longer of any use to fight against modern evolution; and Darwin's hypothesis of transmutation by means of natural selection or survival of the fittest must be admitted as a well-grounded scientific theory. If these various facts admit of no explanation, save the one given of them by Darwin and his coadjutors, which will harmonize them with the hypothesis of creation and the consistent order of a system of Nature ordained and operated under the supervision of an infinite and allwise Creator acting with a definite design and purpose, then indeed must man not only have arisen out of the monkey, but must have even developed as the lineal descendant of pouched mammals such as the didelphys or wombat, and through them from an ancient fish-like ancestor such as a ganoid; and thence further on down his descent can be legitimately traced from the mollusk, or from Haeckel's "primeval parent of all other organisms"—the *moneron.*

I now undertake, as evolutionists will think, the impossible task of showing, in this and the succeeding chapter, by the most unequivocal scientific proof and authoritative citations, that Darwin's theory of descent by transmutation fails utterly to give a satisfactory or even a possible solution of these facts of science. I propose still further to give a plausible and rational solution of every one of them by an original hypothesis, independently of and in direct opposition to his theory, which not only will comport with known phenomena and scientific laws, but which Darwin will be forced to admit by a similar hypothesis of his own, having not a tithe of the foundation in reason which mine will have.

Should these leading facts and main supports of this great revolutionary theory, which threatens to engulf religion and reconstruct natural science, be swept away, then inevitably the whole superstructure of modern evolution must tumble at the feet of its builder a shapeless ruin.

Preliminary to entering upon this discussion, or attempting a solution of the problems just enumerated, it is essentially important, as the fundamental basis of all explanations, that I lay down and establish immovably the broad principle toward which much of my reasoning in the previous chapters has directly pointed, namely—that the *life* and *mind* of every sentient being are substantial entities,—that they are as real and literal *substance* as are their flesh and blood, though while the latter are corporeal or physical substances the former are incorporeal, and hence intan-

gible as to our physical senses. The entire three chapters on *Light* and *Sound*, in which I sought to prove those and other forces or so-called modes of motion to be emanations of real and substantial corpuscles, were intended principally to establish the great truth that the life and mind may be none the less substantial because they are beyond the grasp of our sensuous recognition. If those chapters really proved *Sound*, for example, to consist of corpuscular emanations, as I assume the reader now admits, instead of it being a mere undulatory motion of the air or other conducting media, then all difficulty would seem to have vanished from the problem of admitting that life and mind may be substantial entities wherever found, rather than the mere motions of the molecules of the brain combined and operated in a "varied manner," as assumed by Professor Haeckel.

While those arguments paved the way to this conclusion, rendering the assumption of the substantial nature of life and mind probable and every way reasonable, the arguments which are to follow in these chapters will demonstrate, beyond the possibility of doubt, the entire correctness of that view, by showing in numerous instances that no other possible hypothesis will explain many well-known phenomena and scientific facts, and thus a clear foundation will be established for the solution of all the problems raised by Darwin, without resorting to the impossible supposition of descent by transmutation from lower animals.

Reversionary Action.

It matters little which one of the great problems shall be taken up first, as they are all treated in essentially the same manner by Darwin and lead to the same result, namely, that man has descended from the lower animals—even the very lowest—by an unbroken line of blood relationship. Hence, I will come directly to this puzzling question of Reversionary Action, of which, as just remarked, no kind of solution has ever been even attempted except the one given by Darwin of inheritance from ancient ancestors and the retention of a sufficient modicum of their blood and corporeal nature to cause reversions under special or peculiar conditions of life. Speaking of Human reversions to marsupial organism, Mr. Darwin remarks:—

"But the *principle of reversion by which a long lost structure is called back into existence*, might serve as the guide for its full development *even after the lapse of an enormous interval of time.*"—"These several *reversionary structures*, as well as the strictly rudimentary ones, *reveal the descent of man from some lower form in an unmistakable manner.*"—"In one instance a woman (the daughter of another with supernumerary mammæ), had one mamma which yielded milk *developed in the inguinal region.* This latter case, when we remember the *position of the mammæ in some of the lower animals* on both the chest and *inguinal region* is highly remarkable, and leads to the belief *that in all cases* the additional mammæ in women *are due to reversion.*"

"This principle of *reversion is the most wonderful of all the attributes of inheritance.* . . . What can be more wonderful than that characters which have disappeared during scores or hundreds or even *thousands of generations, should suddenly re-appear perfectly developed?* . . . We are led to believe, as formerly explained, that every character which occasionally re-appears *is present in a latent form in each generation.* . . . *In every living creature, we may feel assured, that a host of lost characters lie ready to be evolved*, under proper conditions."—"*Reversion*, in the ordinary sense of the word, comes into action so incessantly, that it *evidently forms an essential part of the general law of inheritance.*"—*Descent of Man*, pp. 39, 43.—*Animals and Plants*, vol. ii., pp. 76, 446, 447, 478.

Before suggesting any hypothesis for the solution of this problem of so-called reversionary action, I wish distinctly to point out to the reader, as before proposed, the utter impossibility of it being caused in the manner claimed for it by Darwin—through a small remnant of the blood or of the physical nature of a distant ancestor retained

in the reverting structure, and then developed into action by some peculiar conditions of life. That the cause of these reversions is the retention of a small fraction of ancestral blood, Mr. Darwin clearly teaches:—

"No doubt it is a very surprising fact that characters should re-appear after having been lost for many, *probably hundreds of generations. . . . After twelve generations the proportion of blood*, to use a common expression, from an ancestor is only 1 in 2,048."—*Origin of Species*, p. 126.

By the law of consanguinity, as here stated by Mr. Darwin, the first descendant would partake one half of the blood or physical nature of the father and one half of that of the mother; or the proportional dilution would be as 1 to 2 for the first generation,—1 to 4 for the second,—1 to 8 for the third,—and so on, making, as Darwin states it, 1 to 2,048 for the twelfth generation, as any one can see by continuously doubling the figures for each succeeding generation.

But Darwin speaks of this dilution being extended through "hundreds" and even "thousands" of generations, and yet retaining sufficient heredity to cause reversions or to produce a monstrous organ in a woman, for example, normal only to her ancient progenitors or ancestral marsupials, at least a million generations distant according to evolution, and which Darwin may well call an "*enormous interval of time.*"

Now, I really wonder if Mr. Darwin ever seriously thought of the almost infinitely minute portion of ancestral blood or corporeal nature which would be thus retained by a descendant, even after heredity had passed through but one hundred generations? I can scarcely believe it possible that he has ever even given it a passing reflection, or he surely would not have dared to venture such a bewildering and overwhelming improbability as reversions through ancestral blood back to the organs of marsupials,—which, if really our ancestors at all, can not be less than millions of years distant, as estimated by moderate evolutionists.

Let us, by means of the following astounding table, carefully calculated, take a glance at the inconceivable dilution of ancestral blood no farther distant than the one hundredth generation of human beings, or extending no farther back from the present time than to the commencement of the Roman Empire:—

12th generation,	1 to	2,048
25th	"	16,777,216
50th	"	526,952,548,730,112
75th	"	17,687,976,686,375,030,226,944
100th,	"	1,116,700,203,157,979,981,456,633,757,926

The figures in the last line, which are almost enough to drive a mathematician wild even to contemplate them, only carry the dilution of ancestral blood forward *one hundred generations!* Yet Mr. Darwin holds that a fraction, as much less than the one here represented as a grain of mustard-seed is smaller than the sun, would be all-sufficient to overpower a woman's entire organization and change her into an opossum, or at least to convert a part of her body into the corresponding part of that ancient ancestor which lived at least a million generations prior! *A million generations!* Can the reader imagine even the length of the line of figures, carried out according to the foregoing printed table, which would represent the millionth dilution of ancestral blood? Such a line, if printed as in this table, would extend, according to actual calculation and measurement, *one thousand seven hundred and fifty feet!* Yet, as taught by Darwin and all evolutionists, such an infinite dilution of blood would be sufficient to cause a woman's body to revert to the structure of a marsupial animal; and that, too, in de-

fiance of her own blood and that of all her human ancestors!

One would think that the overwhelming magnitude of the figures given in this table, though but a drop to the ocean when compared to the immeasurable interval back to the time of marsupials, supposing them to have been really our ancestors, would be sufficient to convince any reasonable mind that some other explanation of such apparent reversions than the actual presence of ancestral blood must be sought. That such an inconceivably diluted fraction of marsupial blood could force upon a woman's organization, in opposition to her own entire organism, a structure only normal to those ancient animals, is a miracle equal to that of spontaneous generation, and as infinitely absurd as this supposed marsupial blood is immeasurably diluted. No wonder Darwin declares that "this principle of reversion is the *most wonderful* of all the attributes of inheritance." It is altogether too wonderful to be true, as we shall soon see by one of the most unequivocal demonstrations ever known in science.

But prior to this, I wish to note the fact that not only must a woman hold within her veins, according to this theory, an effective fraction of marsupial blood which is liable to be developed into reversionary organs at any favorable juncture of conditions, but she must also retain a still larger proportion of the blood of all the subsequent myriads of species through which her lineal descent has brought her since she shed her marsupium! These species and varieties and genera and families, living and extinct, from the time the human line branched off from the kangaroo, Darwin estimates at numberless thousands; and hence a woman should be more liable to reversions to the peculiar structures of the wolf, jackal, hyena, fox, dog, lemur, &c., than to that of the marsupial prototype of these subsequently developed species running along the line of her descent. Yet we do not hear of a single reversion in woman to the organs of any of her nearer relatives in this lineal chain, unless the supernumerary mammæ should be an exception.

I now assert, and particularly invite the attention of Darwin and Huxley, that so far from there being the smallest conceivable fraction of ancestral blood or corporeal substance of any kind running in our veins handed down from marsupials or from human ancestors even a hundred generations back, which, by the remotest possibility, could cause reversions, there is not one particle of blood or other corporeal substance in any man living which existed in the body either of his father or mother; and hence I am now prepared to show, by that unequivocal demonstration just promised, that this whole question of inheritance is completely misapprehended, *and that physiologists who suppose transmitted characters and peculiar diseases or structural deformities to be physical transmissions handed down and continued from generation to generation by atavism as it is taught, or through the means of corporeal blood or organism, are laboring under a universal and monstrous misconception.*

There is no man living who has arrived at maturity who has at this time a single atom of the blood or physical substance remaining in his body which he possessed when he was a child, let alone that of his ancestors, near or remote. Upon this all authorities agree. Ancient philosophers maintained that a complete metamorphosis takes place in our entire bodies at least once in seven years, and that a man twenty-one years old has had his whole substance—blood, bone, muscle, &c.—displaced and substituted by other corporeal

atoms taken up from organic and inorganic nature at least three times since his birth.

I will not ask the reader to take this almost universally understood truth on my bare assertion, but will give authority which evolutionists will hardly question. Prof. Huxley says:—

"So constant and universal is this absorption, waste, and reproduction, that *it may be said with perfect certainty* that there is left in *no one of our bodies at the present moment a millionth part of the matter of which they were originally formed.*"—*Lectures on The Origin of Species*, p. 28.

He also says:—

"Bone once formed *does not remain during life*, but is constantly disappearing and being *replaced in all its parts.*"—*Elementary Physiology*, p. 264.

Dr. Flint remarks:—

"It is known that the *organic principles of the body which form the basis of all tissues and organs*, are continually undergoing change as a condition of existence; that they do not unite with any substance in definite chemical proportions; but their particles, after a certain period of existence, *degenerate into excrementitious substances.*"—*Physiology of Man*, vol. i., p. 474.

Dr. Dunglison adds his testimony, as follows:—

"The human body, from the moment of its formation to the cessation of existence, is undergoing constant decay and renovation—decomposition and composition;—so that at *no two periods* can it be said to have exactly the same constituents. . . . Setting aside the erroneous pathological notions that assign to the blood what properly belongs to cell life in the system of nutrition, how can we suppose a *taint* to continue for years or *even entire generations in a fluid which is perpetually undergoing mutation*, and at any distant interval *can not be presumed to have one of its quondam particles remaining.*"—*Human Physiology*, pp. 73, 450.

I could, were I disposed to occupy the space, extend these citations to any number; but these will suffice to show that physiologists who teach that inherited characters or diseases are conveyed through blood and corporeal structure from one generation to another do so in the face and eyes of the universally admitted fact that not one particle of the body of any man or woman which he or she had in childhood continues to maturity, which shows the utter impossibility of atavism based on corporeal transmissions! Hence, the almost infinite absurdity of Darwin's hypothesis that reversions bring up "long lost organs," through the supposed remnant of the blood of remote ancestors continuing in our veins. How, then, in the name of logic and science, we may crushingly ask Darwin, is he to explain these supposed reversions in women to the organs of marsupials, or refer their "supernumerary mammæ," developed in the inguinal region, to those of the dog or jackal, when about every seven years from that remote period to the present time each individual in the line of descent has changed its entire body, breaking down the lineal bridge a million times and in a million places over which descent has had to travel?

I therefore aver that in view of this unanswerable fact of all the physical ingredients of man's body being displaced and substituted many times during each mature human life, and in view of the table just given showing the inconceivable dilution of ancestral blood after only one hundred generations, if such blood continues at all, it is utterly impossible for any sane mind to believe in Darwin's theory of reversions to marsupial organism. And hence it follows that this great and conclusive fact in support of Darwinism is utterly broken down, and his theory, so far as it is concerned, completely driven to the wall. Is not this an irresistible conclusion? If so, then here is one of its most important representative facts which evolution can not explain, and with which it is entirely inconsistent; and hence the whole theory "falls to the ground," according to the rule

of logic laid down by Professor Huxley himself, as quoted at the foot of page 325, which the reader will turn to and read.

Thus, by the overthrow of this main support of the transmutation of the human race from some ancient marsupial form, Darwinism completely breaks down (it matters not whether I succeed in satisfactorily explaining these so-called "reversions" or not), for Mr. Darwin has in many places in his various works distinctly claimed this problem of reversionary action as among his very strongest arguments in support of the hypothesis of man's descent by transmutation from lower animals, and one of the facts which convinced him of its truth.

Right here, then, comes the scientific demonstration that *life* and *mental powers* are real and substantial entities, or otherwise there is nothing through which the transmission of characters or diseases or peculiarities can find conduction from generation to generation! The mental and vital organism (which exists in addition to the corporeal structure), being incorporeal, is all there is about a man or a lower animal which is not liable to change and substitution, and is, therefore, all there is which possesses an identity of person or being; and hence it is the *intimate connection* existing between this incorporeal organism (which is at the same time substantial and unchangeable) and the corporeal organism (which is material and changeable) which causes atavism, and through which inherited transmission occurs either among the human or lower species.

Can there be a stronger proof furnished on any single scientific proposition than this fact here established that there must be some invisible incorporeal and intangible *substance*, not liable to mutation and substitution, through which inheritance from parent to offspring must be conducted? No other rational conclusion is conceivable, since all corporeal or physical connection is severed between them within seven years after the birth of the child, thus effectually breaking the lineal chain between such parent and the next generation. Without the presence of such an unchangeable and incorporeal organism actually existing in every living creature, no inheritance of parental character or resemblance could continue in a child at farthest longer than seven years after birth; for the moment the physical organism had been substituted by new materials all inherited relationship would cease and all transmitted parental characteristics would vanish.

I repeat it, then, that we have here a direct scientific proof of the position I labored so long to establish by indirection and analogy in the earlier chapters of this work. I there assumed that if so many intangible so-called forces and modes of motion were really and demonstrably substantial entities, though incorporeal, that it was but logical to infer that life, instinct, and spirit were equally substantial. But now for the first time we have the direct scientific proof that there must exist in every sentient being a substantial vital and mental organism, in addition to its corporeal structure, through which inherited transmissions descend from father to child, and by atavism from grandfather to grandchild; and thus gradually I am laying the foundation for the new hypothesis to rationally solve Darwin's problems,—which, as we see, are wholly inexplicable by his own theory of physical descent.

But right here is another argument even more conclusive, if anything, than the preceding, that the *life* and *mind* are the real, intrinsic, and principal substance of every living creature; and by *mind*, in the lower animals, I mean that *instinct* which takes

the place of *reason* in man. It therefore must not be supposed because I place man and the lower animals on a level in regard to each possessing a dual nature, and each having within the corporeal structure a vital and mental organism, that I suppose such lower beings equally entitled to immortality, or life hereafter. A just, and, as I believe, a true distinction will be marked out in a future chapter between man and the lower animals; and what I regard as the only true solution will be given of this greatest of all psychical problems, why man shall live eternally and why an intelligent animal like a dog or a horse can not so live, although like man it possesses a substantial incorporeal vital and mental structure. I therefore merely throw in this explanatory remark, lest I should be misapprehended in my frequent allusions to the vital and mental organisms of lower animals.

I now state but a truism, universally recognized and admitted, when I assert that offspring as a general rule partake equally the likeness, character, and qualities of both father and mother, while I emphatically deny that such transmission of likeness or character is caused by or comes at all or in the slightest degree from the physical bodies or corporeal organisms of such father and mother, but exclusively from the vital and mental organism which pervades and animates the corporeal structure, since it is a fact which physiologists will admit that more than nine hundred and ninety-nine thousandths of the child's physical or corporeal organism *is derived from the mother!* Perhaps it might be safely asserted that the germinal or fecundating impulse really supplies nothing to the building up of the child's body. Some authors so believe; but I do not need the admission. The fact that the child's body is almost wholly derived from the mother's organism, while it partakes corporeally as well as mentally as much of the father's likeness and characteristics as of the mother's is an unanswerable proof that even the infant, without waiting seven years for its substance to be supplanted by new materials, does not inherit its specific structure or family characteristics at all through the corporeal organization of either father or mother, but exclusively from their incorporeal mental and vital being!

It therefore amounts to another absolute scientific demonstration that inheritance of any quality or character, whether among human beings or the lower animals—whether the quality or peculiarity relates to the mental powers or is wholly physical and attaches entirely to the corporeal structure—comes exclusively through and is derived wholly from the intangible and incorporeal vital and mental organism of the two parent forms. Evolutionists can not evade or even weaken the force of this overwhelming conclusion. If physical organism is all there is about us of a substantial nature, as Haeckel, Darwin, and Huxley all teach, and if the mind and life are nothing but a complicated motion of the physical molecules arranged in a "varied manner," having no organic or substantial character, then it would assuredly follow, on absolute scientific principles, that, as the child had derived but a thousandth part of its corporeal structure from the father, it should exhibit but a thousandth part of his likeness or characteristics! But since the father transfers as much of his nature and likeness to the child, through his vital organic structure, as does the mother, though she furnishes about all of the corporeal, my foundation is firmly laid in the immutable mental and vital organism of every living creature, and must hereafter remain an established and

demonstrated fact against which the materialistic waves of evolution will beat in vain!

The great mind of Darwin, when contemplating the astonishing fact that an instinct, and even a cultivated habit, in a dog or horse, though not natural to the species, is inherited by its offspring, which will repeat the habit without being taught, becomes almost paralyzed with bewilderment, and he exclaims—"Even an *imperfect answer* to this question *would be satisfactory.*" But I will quote him in full, and then give him a *perfect* answer:—

"How, again, can we explain to ourselves the inherited effects of the use or disuse of particular organs? The domesticated duck flies less and walks more than the wild duck, and its limb-bones have become in a corresponding manner diminished and increased in comparison with those of the wild duck. A horse is trained to certain paces, and the colt inherits similar consensual movements. The domesticated rabbit becomes tame from close confinement; the dog intelligent from associating with man; the retriever is taught to fetch and carry; and these *mental endowments and bodily powers are all inherited. Nothing in the whole circuit of physiology is more wonderful.* How can the use or disuse of a particular limb *or of the brain* affect a small aggregate of reproductive cells, seated in a distant part of the body, in such a manner that the being developed from these cells *inherits the characters of either one or both parents? Even an imperfect answer to this question would be satisfactory.*"—DARWIN, *Animals and Plants*, vol. ii., p. 445.

Had Darwin's mind ever been so fortunate as to delve down into the great central truth I have just been elaborating, that the life and mental powers of every living creature constitute a perfect incorporeal yet substantial organism, as real as the one composed of blood, bone, and muscle, and that inheritance from the parents by the offspring comes solely through such intangible entity, he never would have so puzzled his brain over this problem of the transmission of an instinct or an acquired habit, and would never have begged for even an "imperfect answer to this question." He here has a *perfect* answer. I wonder if he will have the candor and magnanimity to acknowledge it! If he has no difficulty in understanding how two *fine-wool merinos*, male and female, should transmit their peculiar physical characteristics to the lamb, but accepts it as a simple and natural fact, then, whenever he grasps the true and broad idea that these merino parents transmitted this characteristic of fine wool to their offspring exclusively through their mental and vital structures, and that their merely corporeal organisms had nothing whatever to do with the transmission except as being the physical media through which the peculiarity was conveyed, he will then have not the slightest difficulty in understanding and accepting the equally simple and beautiful fact that the retriever after being taught to fetch and carry, transmits this mental habit to the pup through his own mental and vital organism so effectually that the offspring will practise the same thing without being taught. Without the presence of this substantial mental and vital organism all such facts are wholly and absolutely inexplicable.

Right here, then, at the very threshold of my arguments by which I have proposed to overthrow evolution, and while thus establishing the immovable foundation of my future exposition of the theory, I have incidentally furnished a simple and beautiful solution of one of the most profound problems which Mr. Darwin finds mixed up with the complex subject of inheritance, and one so bewildering that he prays for some solution, he cares not how "imperfect," agreeing in advance to be satisfied with it rather than to depend on the wretched consolation which his own corporeal theory of inherited transmissions affords. No wonder he implores assist-

ance, since no physical theory of inheritance can aid him. I have here given it to him without money and without price. Will he accept it? We shall see.

Let the reader not forget, then, what has been accomplished in the arguments just preceding. It has been shown that while all organic beings are changed in all their parts, and their physical atoms substituted frequently by others during life, thus preventing all corporeal transmission whatever, yet inheritance does take place, absolutely proving the presence in each being of an incorporeal *self*, or substantial organism. It has further been proved that while the father equally transmits his likeness and character to his child the mother furnishes nearly all of its physical organism, showing beyond the power of contradiction that no inheritance comes through corporeal structure, and at the same time demonstrating that each being possesses a substantial organism within the physical, which is incorporeal and intangible. So long as these two annihilating propositions remain unrefuted, just so long will evolution remain with its entire foundation of physical inheritance demolished.

If the physical or corporeal organism is all there is about a living creature concerned in the phenomena of inheritance and the transmission of characters, as held by all evolutionists, then surely it must be clear to the reader, if there is no continuity of corporeal structure from one generation to another, that physical transmissions are impossible in the very nature of things; and hence the whole fabric of inheritance and descent is annihilated. If nothing but corporeal structure constitutes the medium for inherited transmissions, then it must follow, if a lamb has a fine-wool father and a coarse-wool mother, not a thread of its wool would be sufficiently changed from the coarse fiber of its mother to be detected under microscopic power, since but a thousandth part, approximately, of its organic nature could have come from the father. Here, then, by evolutionists basing their theory of descent on transmissions through physical organism alone, thus ignoring entirely any other substantial structure as part of a living creature, the foundation of the hypothesis of natural selection is swept away. Hence, if I were disposed to stop right here and not write another paragraph against evolution, the theory of descent as based on transmission alone through corporeal structure could never recover from the force of this single blow; for what is evolution without inherited transmissions? and how is inheritance possible when the very channel through which it passes is displaced in all its parts and substituted by new ingredients several times during each life? Modern evolution knows no medium through which characters can be transmitted save the physical structure, which I have shown by the best authority has no continuity from one generation to another. Therefore, as inheritance is taken away from the theory, the entire superstructure of evolution falls hopelessly to the ground. No escape is possible except by adopting my view, that within each physical structure there exists also a substantial vital and mental organism.

But is there a rational or supposable hypothesis by which to account for so-called reversions in man to the organs or characters of lower animals, as described by Mr. Darwin? Is there any supposable theory for explaining the gills of fish and the presence of a caudal appendage in the human embryo as well as in those of all vertebrate animals? Is it possible to account for the occurrence of a monstrosity in one species resembling some other specific form, or to explain satisfactorily deformities in children resulting from the mental impressions

of the mother? That such phenomena do not result from physical or corporeal causes, such as inherited transmissions linking species together, I shall regard as already clearly demonstrated so far as "reversions" are concerned. That there is a vital and mental organism within and inclosed by the physical structure of every organic being I shall also consider as equally demonstrated, and beyond the possibility of doubt by an unbiassed mind. And, finally, I shall maintain that to this intangible and incorporeal vital and mental organism we are to look for all the phenomena of inheritance, growth, variation, embryology, &c.

Yet, properly, before presenting the hypothesis which I have invented for the solution of the problem of reversionary action, I ought to examine also the surprising facts of embryology, and show, as I have already intimated, that so far from aiding evolution they are absolutely against the theory, even should I be unable to explain their true cause. These remarkable appearances in the embryos of all vertebrate animals so confidently relied on by Mr. Darwin and all his followers as direct proof of evolution, really, in one sense, are as much reversions, so called, as are the recurrence of supernumerary mammæ, and must therefore come under the same general objections, and be ultimately explained by the same hypothesis. I shall therefore come directly to the discussion of

EMBRYOLOGY.

That the presence of branchiæ and a caudal organ in the human embryo at an early stage of progress can not be caused by human descent and corporeal inheritance from fishes and tortoises has been already scientifically demonstrated, since, as just remarked, these embryonic appearances belong in the same class of phenomena as so-called reversions, and must stand or fall by the same philosophical evidence. If the gills of fishes or the tails of tortoises really do show themselves in the embryos of all mammals, from the mouse up to man, through the law of physical inheritance from those ancient progenitors, as Darwin and all evolution writers maintain, then it would undeniably follow that a small remnant of this ancestral blood and corporeal nature from the fish and tortoise must still remain in the human mother in order to be thus transmitted by her organism to the embryonic structure of the infant. For an evolutionist to even attempt an evasion of this fundamental principle of his theory would be to abandon evolution and the idea of physical descent altogether.

Hence, this entire embryologic argument, of which evolutionists so persistently and triumphantly remind their opponents, falls hopelessly to the ground by the very facts and considerations just brought to bear on the subject of reversions. I need only refer the reader back to that terrible and fatal line of figures showing the almost infinite dilution of ancestral blood after only one hundred generations have passed; that is, supposing the blood or physical nature of an ancestor to descend at all from one generation to another, which was clearly demonstrated could not be the case. If that line of figures should be continuously multiplied till it would represent the number of generations back to the Devonian fish, as estimated by moderate evolutionists, there would be an unbroken string of numerals, as closely printed as in the table, over *one hundred miles long;* and this would represent the dilution of fish-blood in the veins of a mother which impresses the form of *branchiæ* on the embryonic infant! I assert, without intending to impugn any man's honesty, that no sensible evolutionist does or can believe it.

But aside from the impossibility of this

inconceivably diluted atom of ancestral blood affecting such a result in opposition to the mother's organism and in defiance of the blood of all her human ancestors, it remains an incontrovertible fact, as proved, that there is no such a thing as the transmission of physical blood or structure of any kind, even for a single generation, since all the corporeal atoms of every nature composing a child's body are displaced and substituted by new ingredients several times before that child reaches maturity. Hence, as so unanswerably shown, not an atom of ancestral blood or physical structure can reach even as far as to the first grandchild. How, then, in the name of science and common sense, can the prints of gills and tails be conveyed to embryonic infants through the unbroken transmission of blood from the tortoise and fish? To suppose that the reader does not see and appreciate the force of this crushing argument would be to cast a slur upon his intelligence.

It therefore matters nothing, as remarked about reversions, whether I am able or not to offer a plausible explanation of these embryonic problems, or, in fact, any explanation at all, they clearly have nothing to do with evolution. Even if I should now admit them among the unsolvable mysteries of which every page of Nature is so prolific, it would nevertheless remain an established fact that Darwin's theory fails utterly to account for them. If they are never to be explained, still this fact is clearly demonstrated, that they do not and can not come by descent from the tortoise and fish.

It must be remembered as an undisputed fact that *inheritance*, with Darwin, Huxley, Haeckel, and all evolutionists, signifies only the transmission of characters or peculiarities, through the *physical* blood and structure of organic beings, handed down from generation to generation. Not one of these writers has ever had the first glimmer, as their works indicate, of this beautiful and grand idea of an incorporeal yet substantial vital and mental organism existing within and represented by the physical structure. Hence, whatever use such a sublime view of organic life might be to them to help out their broken-down theory of physical inheritance, they have forever estopped themselves from employing it by their utter repudiation of life and mind as anything except the mere motions of commingling organic molecules.

I may also be permitted to add, as cautiously as may be, that the true reason why these great problems raised by Darwin, such as reversions, embryonic resemblance, rudimentary organs, &c., have never before been wrenched from the grasp of evolution and hurled with fatal effect against the theory, is because no reviewer of the theory of descent has seemed to catch this fundamental principle of being, that each living creature has a dual organism or two distinct structures interblended—one corporeal and subject to constant mutation, while the other is incorporeal, not liable to mutation, and hence the only part about every living creature constituting the essential identity of its being. I here assert confidently that no man can answer these fundamental arguments of evolution or solve the otherwise inexplicable mysteries involved in inherited transmissions, if this broad principle of a substantial vital and mental organism be ignored. Hence, Darwin's principal scientific facts have never been met.

Although the arguments just advanced completely take embryology outside the pale of evolution, I do not propose to stop here with these facts, which Mr. Darwin says were among the main reasons which "convinced" him of the truth of evolution,

and which Professor Haeckel, his great German apostle and coadjutor, flings boastfully at all opponents of the theory of descent as beyond their power to jostle, and in which he declares, "*I see one of the most important and irrefutable proofs of the theory of descent. No one can explain these phenomena unless he has recourse to the laws of inheritance and adaptation; by these alone are they explicable.*" (See page 402.)

Then, to show how conclusive is this similar appearance of the human and lower forms in their early embryonic condition, as a proof of evolution by transmutation, Professor Haeckel goes to the expense of producing two elaborate plates representing the embryos of the *man*, *dog*, *chicken*, and *tortoise*, at a correspondingly early and then also at a more advanced stage of growth, in which the *tail* of the tortoise and so-called *gill-arches* of the fish are conspicuously displayed in the human embryo and also in that of the three lower animals, as a proof that man descended from the tortoise and the fish.

But in these plates (as those having a copy of Professor Haeckel's *History of Creation* will see), this learned naturalist overshoots his mark, so to speak, and gives us a complete illustration of that "vaulting ambition which o'erleaps itself." It is really an unfortunate coincidence, that, while the younger series of embryonic pictures makes the "little human tail" and the fish-gills everything the most ardent evolutionist could desire, the embryonic heads of the four different orders are not only a total failure but a fatal blunder, showing such a want of foresight as to utterly overthrow the argument; for while the head of the human embryo is the proper size and exactly in proportion to the size of its body, thus consistently representing the human cranial type from the commencement of life, the head of the tortoise and that of the chicken are enormously out of proportion to the sizes of their bodies, and ridiculously as large as that of the human embryo, if not a trifle larger! Yet every one, however little versed in natural history, knows that the head of a tortoise in proportion to the size of its body is not one quarter as large as that of man. Thus it follows, since the head is of infinitely more importance as a guide to generic classification than the tail, that Professor Haeckel has unwittingly placed his hereditary cart squarely before his embryologic horse, and, by giving the tortoise a human head, has actually reversed evolution, and proved that the reptile descended from man! If these sagacious plates of Haeckel are correct,—which, of course, must be admitted,—then the whole embryologic argument falls to pieces, since the most casual observer must see, who examines these pictures, that while the human form retains its own head in due proportion from the start, the tortoise drops its normal head and adopts that of man! It follows, then, unanswerably, that this "little human tail" which Professor Haeckel keeps so menacingly before his opponents, as he refers to his annihilating plates, never came by descent from the tortoise at all, since the human head which fits so coolly on this embryonic reptile could not have descended from man, if there is any truth in "survival of the fittest." But I refer the reader back to the preceding chapter for an elaborate discussion of the whole question of embryonic development, in which the very facts of the "gill-arches" and the "little tail of man" are denied, and reasons given for the denial, though I have here admitted them as claimed by these scientists, and have endeavored to show, even after such concession, that they do not favor evolution.

Having thus succeeded in depriving evolution of the least claim to or interest in the phenomena of embryology and re-

versionary action, I shall now attempt an explanation of these problems,—which, however imperfect and liable to objection, I am willing to submit to the reader with the belief that they will present more plausibility and show more harmony and consistency with already established facts and scientific laws than this utterly foundationless theory of physical descent.

But in what manner shall I begin to frame the general hypothesis which shall give this new solution of these remarkable phenomena? If it be true, as I claim to have already demonstrated, that there is such a thing as a substantial vital and mental organism constituting the incorporeal but essential entity of every living creature, which I doubt not the attentive reader admits, it then becomes easily supposable that such a substantial though intangible structure should be at least as complex as the corporeal organism, which is merely its physical expression. That such a substantial structure, invisible and intangible yet possessing all the details of parts and organs of the corporeal body, may actually exist within the physical and tangible form of a living creature, constituting its real and essential entity, ought to be deemed not only possible but reasonable, even if I had not already given direct proof of it. In view of the incorporeal substances known to exist in Nature all around us, completely beyond the reach of any of the senses, scientists should not deem it such an incredible thing that a living creature may possess an internal vital organism as well as an external corporeal structure; and this applies particularly to all modern scientific thinkers who believe in a universal and all-pervading yet substantial luminiferous *ether* which can run in waves and circulate freely through the texture of a diamond! That such a vital and mental organism *does* really exist in every human form, essentially related to and intimately blended with such corporeal structure, and through which all the biological phenomena of procreation, growth, development, inheritance, and variation from specific structures take place, I shall again assert has been clearly established in the two preceding arguments, in which were shown that no peculiarity or characteristic of father or mother can by any possibility be transmitted to posterity without the intervention of such an incorporeal organism; and that no father, on any known principle of reasoning, could transfer to his offspring more than about a thousandth part of his likeness or character as compared to that which would be transferred by the mother, were it not for the presence of such invisible vital and mental organization as the exclusive medium of all inherited transmissions.

Here, then, I make my first hypothetic supposition, that, as the physical structure contains not only the different organs of the body but an almost infinite number and variety of separate molecules and units or real organic atoms, so the vital organism within each living creature contains not only the intrinsic life-form of the specific being it inhabits but is a veritable *microcosm* or a little universe of life-forms which include the intrinsic germs of all organic being wherever found. Life itself being a real substance it must be constituted of life-atoms, while its molecules, so to speak, consist of essential life-forms representing every living creature, the same as the molecules of the body consist of the various forms and kinds of organic elements which go to make up the countless and manifold constituents of all bodies; and hence, within the *life-germ* of every organic being, or within this intangible representative kernel of existence, all other

life-forms are essentially represented, so that when the microcosmic germ commences to gather about it the corporeal elements of organic structure, there are present not only the specific structure of the family to which the germ belongs, but the inconceivably minute images and essential life-forms of all other living creatures; and while thus environed with all forms of life, the taking on of an abnormity, from the juxtaposition of unnumbered images of specific beings, would be but the natural result of a collision through some perturbation in the mother caused by one of the accidental conditions of life to which she might be and is at all times exposed, and which might indelibly impress her mental or vital organism.

So far, the reader may say, this seems to be all supposition. Granted; but we shall probably see as we advance in the hypothesis corroborative reasons for regarding it as a rational and even scientific basis of solution for very many phenomena wholly inexplicable on any other supposition.

According to established rules among all scientific investigators, I have a perfect right to frame any scientific hypothesis I may deem expedient, and then try to build up a theory by seeing how far the admitted facts of science and Nature will harmonize with such hypothesis. If, after carefully comparing all such facts with my provisional hypothesis, I shall conclude that more phenomena are explained by it, and the various classes of facts made more harmonious and consistent among themselves than by means of any other known hypothesis, it is logical and fair to claim the result of such investigation as a probable scientific theory. Mr. Darwin says:—

"In scientific investigations it is permitted to *invent any hypothesis*, and if it explains various large and independent classes of facts it rises to the rank of a well-grounded theory."—*Animals and Plants*, vol. i., p. 20.

Having found that the theory of descent by transmutation can not possibly explain these embryonic and reversionary phenomena since the physical means of inheritance necessary to solve such problems are wanting, and since the dilution of ancestral blood required to extend as far back as to the marsupial, tortoise, and fish, must be infinitely absurd, even if ancestral blood passed from one generation to another,—which, as shown, is not the case,—I have therefore invented this hypothesis of substantial but incorporeal *life-germs* as *vital microcosms*, based on the demonstrated fact that the life and mental powers of every living creature constitute a vital and mental organism, which, though incorporeal and intangible, is nevertheless as really substantial as the corporeal blood, bone, and muscle, by which it is physically represented.

Mr. Darwin surely can not take exception to such a *microcosmic* assemblage of vital images representing a miniature universe of living structures. He teaches, as recently quoted, that not only the opossum, kangaroo, didelphys, wombat, and all other marsupial forms and organic structures, are actually present in their physical characters in a woman, but necessarily all subsequent specific characters in the lineal chain of descent from the marsupial down to the present time,—that all these characters lie "dormant" or "latent" in each generation, ready to be awakened into organic structures or reversionary forms by the intervention of some unusual condition of life. I re-quote:—

"We are led to believe, as formerly expressed, that every *character* which occasionally re-appears *is present in a latent form in each generation*. . . . In *every living creature* we may feel assured that a *host of lost characters lie ready to be evolved under proper conditions*." (See page 404.)

No physical "*character*," such as the mammæ of a wolf or tail of a tortoise, can

lie "dormant" for countless generations in organic beings "ready to be evolved," unless the *form* of such organism—I care not how infinitesimally small—is actually present all the time. If "hosts" of such physical organic characters and forms are present "in every living creature," "ready to be evolved under proper conditions," have I supposed anything more surprising or wonderful in the hypothesis that each life-germ is a real living *microcosm*, containing a representation of all vital forms of being? But Darwin goes even further, and represents each *physical* organism, however simple, as a literal corporeal "*microcosm*." I quote his words:—

"We can not fathom the *marvelous complexity* of an *organic being;* but on the *hypothesis* here advanced this complexity is much increased. *Each living creature* must be looked at as a *microcosm*—a *little universe*—formed of a *host of self-propagating organisms*, inconceivably minute, and *as numerous as the stars of heaven.*"—*Animals and Plants*, vol. ii., p. 483.

The "hypothesis" to which Mr. Darwin here alludes is of the utmost importance to his theory of descent, without which, as he evidently understands, or without the principle which it involves, no transmission can possibly take place from one generation to another. He calls it "*pangenesis*," and elaborately explains it at the close of his work on the *Variations of Animals and Plants*. It is based on the supposition that the cell-units of each living creature throw off minute atoms of their own substance, which he terms "*gemmules*," and which, in fact, are "self-propagating organisms," multiplying themselves by "self-division" of their bodies, the same as explained recently in the case of *monera*. The hypothesis, however, is purely imaginary and entirely without any visible or tangible foundation, since "gemmules" never were seen either singly or in mass, probably for the reason that they do not exist at all; and, if they did, no microscope would be sufficiently powerful to visualize them. Hence, the hypothesis is purely guess-work, without any apparent reason or foundation in Nature or science, save the necessity for something to bridge over the millions of physiological breaks which the law of organic mutation and substitution necessarily causes in the lineal chain of descent from remote ancestors, as I have already proved.

In fact, the hypothesis of "pangenesis" and "gemmules" seems to have sprung itself into Mr. Darwin's imagination almost entirely to aid the cause of *reversionary action*, which becomes at once impracticable from the enormous dilution of ancestral blood in a few generations. At the very commencement of the hypothesis he says: "Every one would wish to explain to himself, even in an imperfect manner, *how it is possible for a character possessed by some remote ancestor suddenly to re-appear* in the offspring." (*Animals and Plants*, vol. ii., p. 428.) He surely saw at a glance that the inconceivable dilution of ancestral blood by the law of consanguinity in a short time rendered the possibility of characters being transmitted through such a medium as utterly out of the question.

To meet this manifest impracticability in the transmission of blood or other corporeal substance, even through a few dozen generations, Mr. Darwin must have seen (though he never so much as hints it in any of his works) that something substantial must be invented, differing in its nature from blood or any other ordinary organic substance, which would pass from generation to generation without being lost by dilution or cast off by the universal law of displacement and substitution. He never thinks of adopting the idea which I have so clearly and repeatedly demonstrated, namely, that the mind and life of every creature constitute a substantial but incor-

poreal organism, but supposes that his hypothetic physical "gemmules"—in fact, infinitesimal living creatures, since they are "*self*-propagating organisms" and capable of "*self*-division,"—will answer the purpose, and in some way avoid this law of displacement and substitution and not be liable to the same mutation as other corporeal atoms. Yet, in keeping with the inherent weakness of his whole theory, he stultifies his hypothesis by assuming that these gemmules pass from generation to generation, even from the remotest ancestors, in a "dormant" and consequently in an inactive state, and must therefore be incapable of "self-propagation" by "self-division," and hence, as I will abundantly show, they must turn out to be wholly worthless; for how can such "dormant" atoms descend all the way from an ancient marsupial in a quiescent condition, ready to be aroused to action in the veins of a human mother and thus reproduce marsupial organs, any more than atoms of the original marsupial blood?

Such is a brief view of this great hypothesis, so essential to the very existence of Mr. Darwin's theory of descent, and without which all inherited transmissions are with him a physical impossibility. When it is shown that even with the aid of this hypothesis all inheritance remains still the same physical impossibility, as will soon be demonstrated, the weakness, inefficiency, and utter helplessness of Darwinism, will be pitiably apparent, for what does the theory of descent amount to with the possibility of physical transmissions removed?

I had not intended here to enter into this provisional assumption of "pangenesis" and "gemmules," but had purposed to defer it till the closing chapter of this book; particularly as right here it breaks into the explanation of my own hypothesis of microcosmic life-germs. But as it is the only conceivable hypothesis which Mr. Darwin can suggest by which to bridge over the millions of physiological breaks and chasms which have been proved to occur in the line of corporeal descent, I have determined to meet "pangenesis" here and now, lest some reader may have been misled by it, and might suppose it to militate against the arguments I have previously brought to bear against "reversions," such as the impossibility of physical transmissions, from the well-known law of mutation and substitution, as so recently established. I will first, however, let Mr. Darwin give us his hypothesis in his own words:—

"The hypothesis of Pangenesis as applied to the several great classes of facts just discussed, no doubt is extremely complex . . . namely, that all organic units, besides having the power, as is generally admitted, of growing by self-division, *throw off free and minute atoms* of their contents, that is, *gemmules*. These multiply and aggregate themselves into buds and sexual elements, . . . and they are capable of *transmission in a dormant state to successive generations*. . . . *Reversion depends on the transmission from the forefather to his descendants of dormant gemmules* that occasionally become developed under certain known or unknown conditions."—DARWIN, *Animals and Plants*, vol. ii., pp. 481, 483.

The reader can scarcely fail to observe, by reading this passage attentively, that Mr. Darwin was really troubled in his mind about his *reversionary argument*, which he tells us was among the strong reasons going to convince him of the truth of evolution. He surely must some time or other have figured far enough to see the absolute impossibility of ancestral blood producing such a result, from its almost infinite dilution in a few generations; and he is most assuredly intelligent enough not to be ignorant of the universal teaching of physiology that all corporeal connection, even between succeeding generations, by means of blood or any other physical substance, is constantly being swept away by

the law of growth, displacement, and substitution of corporeal ingredients. Hence, the absolute necessity for something, which, unlike blood or any other known organic matter, would come down through millions of generations without being dislodged from the organic tissues, or otherwise *reversion*, and with it *physical descent* must be given up as purely chimerical.

It will take but a few paragraphs to show the inefficiency of this provisional hypothesis, and to clearly demonstrate, from the language in which "pangenesis" is couched, that it completely stultifies itself, and overthrows the very position it was intended to establish. It will be at once seen that "gemmules" in a "dormant" condition can no more pass from generation to generation in the blood of an animal, and thus help the cause of reversionary action, than can the blood itself or any other senseless, inactive, useless particles of matter, which happen to collect in an animal's system,—which, as I have abundantly proved, pass off by physiological change, and are substituted frequently during each animal's lifetime by other constituents.

It is entirely evident that "*dormant*" gemmules are powerless for transmission from one animal to another, or for any hold on the corporeal texture of an organic being, whatever might have been supposed of the same organisms in a "self-propagating" state,—which, unfortunately for the inventor of the hypothesis, he lacked either the forethought or shrewdness to provide for. The very word "dormant," according to all dictionaries, signifies *inactive*, *asleep*, *quiescent*, &c.; and hence, while in this state, as Mr. Darwin frequently admits, gemmules, if they really exist and are even all he represents them to be, can develop into nothing, since, being inactive, "*self*-propagation" by "*self*-division" is out of the question, and therefore *multiplication*, to keep up the stock or replace those cast off from the animal organism, is clearly impossible!

It must follow, from the above self-evident considerations, that such "dormant," quiescent, sleeping, inactive "gemmules," would be of no more account in a living organism than any useless, cumbersome, excrementitious atoms of matter; and as the hypothesis supposes them to remain in such a "dormant" state during the countless generations of descent till they happen to be aroused and developed into organs by "unknown causes," the intelligence of every reader is sufficient to convince him that such gemmules could not descend at all even through one generation by the inevitable laws of physiology, as already shown.

This law of the constant displacement and substitution of all corporeal ingredients constituting every organic being, as so recently established by high authorities, would therefore as certainly remove "dormant" gemmules as it would displace quiescent or inactive *trichina* in an animal's system; and it is clearly evident that these parasites can only maintain their hold on organic tissue while in an active, propagating, or multiplying condition. Hence, as all considerations go to prove, "dormant" or inactive gemmules could not pass to the succeeding generation, to say nothing about two or three millions, as Mr. Darwin's "pangenesis" requires.

This great author has thus made a mistake, which he will never be able to rectify, in attempting to transmit gemmules in a "dormant" condition through millions of generations, or from that ancient epoch when a woman wore the marsupium of the didelphys down to the present time. I fear that word "dormant" has already proved the death of "pangenesis," since it actually makes such sleeping, inactive,

quiescent, and worthless atoms, no better than any other little specks of bone or lifeless matter,—not even as good as ordinary blood, since this author and inventor does not claim "dormant" gemmules as being nutritious or even digestible. If an opossum were therefore loaded down with them they would only be a burthen to carry, without doing the least particle of good.

I insist upon it, therefore, that Mr. Darwin committed a fatal blunder in employing such a *stupid* word as "dormant," when there were so many wide-awake words in the dictionary! Instead of allowing these little sleepers to curl up in the veins of kangaroos in the far-off Eocene period for a nap of two million years he should rather have started them on their journey alive and kicking, so to speak, and instead of administering such a soporific as "pangenesis," which was enough to put anything to sleep, he should not have allowed them to close their eyes during the entire trip!

It is simply a matter of astonishment that the author of "natural selection" and "survival of the fittest" should show so little sagacity in a matter so vital to his hypothesis. After proving himself capable of inventing such a word as "pangenesis," and especially of originating such a "self-propagating" little imp of an organism as a "gemmule," it is the profoundest kind of a puzzle that he should deliberately put it to sleep and allow it thus to be cast off from the marsupial organism as worthless matter and immediately substituted by new ingredients, thus smashing his "pangenesis," and with it his theory of descent, rather than to keep it awake, self-dividing its little body so rapidly as to prevent all danger of the supply of ancestral marsupial "gemmules" becoming exhausted! But the fatal mistake was made, as has so often been done before by great men, and can not now be recalled.

As "self-propagating" gemmules are necessary, according to this provisional hypothesis, in "each living creature," to give vitality to the organic units of its body, then the organic units of the *gemmule* itself will necessarily require the same kind of "self-propagating organisms," though on a scale almost infinitely reduced, probably as much smaller than these original gemmules as they are smaller than kangaroos; for since the "gemmule" is a veritable "*self*-propagating *organism*," capable of "*self*-division," it must necessarily be a "living creature," and therefore as much entitled to the benefits of another "pangenesis" as was the original kangaroo! It would be really interesting for Mr. Darwin to extend his hypothesis to the organic units of these "gemmules," which he could easily do by inventing another word, and thus calling them *pinnules*, for example; and then again, since these pinnules would likewise be living "self-propagating organisms," he could continue on with the innocent amusement of extending "pangenesis" *ad infinitum*, which would probably be of as much use to the world and to the cause of science as any other portion of this self-contradictory theory of descent.

Since Mr. Darwin insists on his "gemmules" coming all the way down through a million generations in a "dormant" state, and of course *inactive* and incapable of multiplying by "self-division," let us by a little calculation consider the chances of any given original stock of "dormant" gemmules, however enormously large, running out in a given time, and in this summary manner open up the manifest impracticability of marsupial gemmules coming down to the present generation, and still sleeping, as Mr. Darwin maintains, in the veins of human mothers.

We will suppose the *last marsupial* from which the line divaricated leading toward

the human species (for there must have been a *last one*) gave over to the primal parent or head of this line all its gemmules fast asleep, or in a "dormant" state, to be faithfully transmitted down to future generations for the special purpose of producing "reversions," and thus assisting modern evolution, as they seem really to have no other use. I am now willing, in order to make the case as strong for "pangenesis" as possible, to admit that there were in that single opossum, kangaroo, didelphys, or whatever other marsupial, *one hundred millions* of these sleeping gemmules. If Mr. Darwin were here and should request it, I would double the number, or increase it till he should express himself as entirely satisfied. But as he is not here to consult, I will take it for granted that I have met his wishes in placing the number at 100,000,000, which is a liberal population of "self-propagating organisms" to have possession of one small animal's body.

I am now even willing to admit, in order to oblige Mr. Darwin and facilitate pangenesis, that these quiescent or "dormant" gemmules do not come under the universal law of displacement and substitution which controls other useless, innutritious corporeal substances, and which leads to their rejection and to an entire physical metamorphosis of an animal's body every few years. I will concede, to help his "provisional hypothesis," that these 100,000,000 gemmules were of such a nature as not to be superseded and displaced by new ingredients taken up from organic and inorganic nature, but that they became, on their first transfer, a part of the animal's identity of being or of its natural selfhood.

Now, after doing all this to accommodate Mr. Darwin and aid pangenesis, let us see what it amounts to. The very first generation of descent, or the first descendant of this primal head of the line, would take one half of these "dormant" gemmules, leaving the other half in the body of the father, thus giving them 50,000,000 gemmules apiece. Is not this an inevitable conclusion?

It would not do to assume that the father kept them all, giving none to his offspring; for if that was the law, then, as soon as the father should happen to die, it would end the business for the "dormant" gemmules, and wipe out Mr. Darwin's pangenesis. Neither would it do to assume that the father transmitted them all to the son; for if that was the plan of transmission, then at all times during the millions of years which have since succeeded, the entire 100,000,000 "dormant" organisms would have their sleeping apartments within one single animal's body. This is wholly inadmissible, since the accidental death of that one animal which happened at the particular time to be the custodian of this precious stock of ancestral gemmules would in like manner annihilate "pangenesis," since there could now be no dormant marsupial organisms in the blood of human mothers to cause reversions, so essential to the cause of evolution.

Hence, the safe, natural, and scientific mode of transmission, would necessarily be, as stated at the start, that each lineal descendant should receive one half the dormant gemmules possessed by its father. Now, I wonder if Mr. Darwin ever took the trouble to think how long it would take to exhaust any given original stock of "dormant" gemmules, however large? It seems to me if he had even given it a casual thought, he surely would never have dreamt of "pangenesis." Instead of transmitting such quiescent organisms down through a million generations, as is absolutely necessary according to this provisional hypothesis, the *twenty-seventh descendant* in this lineal chain from that last

marsupial *would have but a single dormant gemmule remaining in its body*, while the twenty-eighth descendant would destroy that! The following table, leaving out a few unimportant fractions, shows how rapidly the original stock of 100,000,000 gemmules would become reduced by these continual subdivisions, according to the law of consanguinity; for, it must never be lost sight of, that since these gemmules, according to "pangenesis," are transmitted in a "dormant" state, they are necessarily *inactive*, and hence have no power to propagate themselves by self-division, and thus increase their number on the way:—

1st	generation,	100,000,000	dormant	gemmules.
2d	"	50,000,000	"	"
3d	"	25,000,000	"	"
4th	"	12,500,000	"	"
5th	"	6,250,000	"	"
6th	"	3,125,000	"	"
7th	"	1,562,500	"	"
8th	"	781,250	"	"
9th	"	390,625	"	"
10th	"	195,312	"	"
11th	"	97,656	"	"
12th	"	48,828	"	"
13th	"	24,414	"	"
14th	"	12,207	"	"
15th	"	6,103	"	"
16th	"	3,051	"	"
17th	"	1,525	"	"
18th	"	762	"	"
19th	"	381	"	"
20th	"	190	"	"
21st	"	95	"	"
22d	"	47	"	"
23d	"	23	"	"
24th	"	11	"	"
25th	"	5	"	"
26th	"	2	"	"
27th	"	1	"	"
28th	"	The last dormant gemmule cut in two and destroyed!		

As soon as reduced to a single gemmule, at the twenty-seventh link in the chain of descent, "pangenesis" necessarily explodes, since Mr. Darwin distinctly teaches that a single gemmule can do nothing toward developing a "part" of an animal's structure, but that it requires "a *number* or *mass* of them" to accomplish any result:—

"But *gemmules* differ from Mr. Spencer's physiological units, inasmuch as a certain *number* or *mass* of them are, as we shall see, *requisite for the development* of *each cell or part*."—*Animals and Plants*, vol. ii., p. 450.

Thus ends the great hypothesis of "pangenesis," before even the first variety branching off from the last marsupial in the line has had time to change the color of its hair, let alone become a distinct species; and hence we may bid good-bye to "dormant" gemmules and to Mr. Darwin's provisional pangenesis!

Having made this digression for the purpose of disposing of Mr. Darwin's great hypothesis, I now return to the discussion of my own provisional assumption of an incorporeal vital and mental microcosm, which I have supposed to exist as a little universe of life-forms present in each ovule at the beginning of each individual life, or as soon as the ovule is pervaded by the vital entity or intangible essence of being from both parents.

By turning back to the last passage quoted before the digression, it will be seen that Mr. Darwin assumes a "microcosm" or a "little universe" of corporeal organisms, as present in each living creature, and as "numerous as the stars of heaven." In the quotation just preceding it we are informed that a "host of lost characters" are continually present "in every living creature." Now, if Mr. Darwin has a right to assume a "microcosm," or a "little universe" of "self-propagating organisms" "numerous as the stars of heaven" existing within "each living creature," which includes monera, monads, and the smallest bacteria, barely visible by means of the microscope, thus embracing within one infinitesimal atom tens of thousands of different species represented in their

"dormant gemmules," then surely I have an equal right to avail myself of a rational modification of his assumption, which, however improbable in its corporeal sense as he employs it, becomes a grand and beautiful possibility when applied as I apply it to the substantial and vital essence of being. If Mr. Darwin, therefore, is authority in the discussion of evolution (and he surely will be so regarded by me whenever he favors the overthrow of his own system), I clearly have a right to assume a vital microcosm essentially embraced within every life-germ in which are represented the ideal forms of universal being, since it has been so clearly demonstrated that there is actually a vital and mental organism within each living creature in addition to its physical structure.

My hypothesis, therefore, contemplates no such an improbable idea as a "microcosm" of *physical characters* or *corporeal forms* representing the corporeal organs of countless diverse species, which is the only conception Mr. Darwin has of such a "microcosm." Instead of physical forms my hypothesis only supposes the presence in every life-germ of a microcosm representing the essential but incorporeal forms of the vital and mental entities of being throughout Nature. But as these vital and mental germs of the various living structures can all exist within the same space of one of them, like other incorporeal substances, such as sound, heat, light, magnetism, gravitation, and electricity, without the conflict of space unavoidable with all corporeal bodies, however small, they do not therefore involve the necessary want of room or idea of crowding in a human ovule, for example, which is but about the 125th of an inch in diameter.

If Mr. Darwin, in order to sustain evolution, may rationally suppose a physical "microcosm," and the presence within the smallest animalcule of the physical germs of organs or corporeal characters, "numerous as the stars of heaven," ready to be evolved into fully developed structures, am I not rationally justified in assuming the presence of a vital and incorporeal microcosm in every life-germ by which to explain these otherwise inexplicable facts of science, especially since it has been so clearly shown that physical descent and inheritance are out of the question? Having demonstrated that there is and must be a vital and mental organism, which is wholly intangible and incorporeal, inclosed within each physical structure, and without which no inheritance or transmission of any kind can take place, have I not a right, as a provisional hypothesis, to assume that within the germ of such vital organism a microcosm, representing all life-forms, may exist, with a thousand times more plausibility than Mr. Darwin can assume a similar "little universe" of physical organisms which have come down through countless generations in a "dormant" condition by physical descent?

Assuming, therefore, that such a vital and mental microcosm, embraced within each life-germ at the commencement of every embryonic being, is not an incredible idea, on the principles laid down and hypotheses invented by Mr. Darwin, I now propose to look at the various problems involved, and see how far they can be explained and made to harmonize with the facts of biology, physiology, psychology, and science generally, based on such a supposed microcosm.

Viewing the intangible and incorporeal life-germ of each sentient being as such a microcosmic assemblage as I have described, it is not a surprising result that the embryos of all animals should appear exactly alike at the commencement of the corporeal concentration of organic sub-

stance. Could this incorporeal germ itself be seen in its microcosmic condition,—which, of course, can not be done with mortal and physical eyes,—the absolute presence, in their essential forms, of all animate nature would probably be observed, just as the leaves, buds, blossoms, twigs, boughs, branchlets, bark, trunk, and roots of the perfect tree, may be supposed to exist in their essential and elemental outlines within the life-nucleolus of every acorn; and if the analogy between animal and vegetal life is carried out, as it might be, the seed-germ of a tree would probably present an arboretum or a microcosm of the entire vegetable kingdom.

To say it would be impossible for such a microcosm of animal life to exist in the vital germ of the embryonic being, would be, of course, to repudiate Mr. Darwin's corporeal microcosm of physical organisms as almost infinitely more improbable. If a landscape of mountains, hills, rivers, valleys, trees, villas, &c., extending for leagues, can be photographed upon the retina of a human eye in such a condensed form and yet be perfectly outlined in every feature on such a mere speck of surface, and can then be copied in all its details on the focal point of the optic nerve so almost infinitely reduced in size that the most powerful microscope can trace no impression, yet along this thread such actual landscape, in all its minutiæ, can be conducted to the brain, and there reproduced in its full size by the incorporeal mental impression, it would seem that no conception of an incorporeal microcosm ought to be rejected on the ground of its impossible condensation or want of room.

The earlier the stage of growth at which we view the embryos of various animals, or the less they are developed, the more intimately do they resemble each other, while the farther they are developed toward natal life the more are they differentiated into specific form and outline, under the influence of the specific substantial life-germ. From this state of facts it would follow that when we trace the development backward to the ovule itself the resemblance would be perfect, which, strange to say, is admitted by evolutionists, and claimed by them as an important fact in favor of their theory, but which, as I will show, unwittingly refutes the whole hypothesis.

Mr. Darwin distinctly tells us, as already quoted, that "Man is developed from an ovule about 125th of an inch in diameter, *which differs in no respect from the ovules of other animals.*" This is an anatomical fact which I do not question, so far as the *physical structure* of such ovules is concerned, which, of course, involves the entire extent of this author's conception of their existence. In fact, it is intrinsically and essentially a part of Darwinism not to recognize anything as substantial in connection with any living creature but the physical and tangible organism. But this admission, just quoted, fatally overthrows this erroneous view of organic being, and is the most undeniable acknowledgment of the truth of all I have been urging in regard to a vital and mental organism being inclosed within and physically expressed by the corporeal structure. If the ovules from which the most diverse species are developed, "differ in no respect" from each other, as Mr. Darwin so frankly admits, does it not follow beyond the possibility of doubt that within the ovule of each specific form at the beginning of life, there must exist an invisible, incorporeal (yet substantial) organism, which does truly embrace every outline of the creature into which such specific ovule will ultimately differentiate?

If there is no difference between the

human ovule and that of a lower animal, physically considered, as Mr. Darwin teaches truly, and then if there is no substantial mental and vital organism holding within it the specific form and outline which takes possession of such an ovule and leads on to its proper development, controlling the accumulation and arrangement of corporeal atoms drawn from the mother's organism, then it unavoidably follows that all ovules should develop and differentiate exactly alike, according to evolution; that is, if they could develop at all without such vital organism, which, of course, they can not.

Hence, as in the case of Prof. Haeckel's annihilating "plates," which were to overwhelm the opponents of evolution, but which unfortunately proved that the tortoise descended from man, so Mr. Darwin, in his anxiety to produce a crushing argument in favor of his theory by showing that the human and marsupial ovules "differ in no respect" from each other, has literally destroyed the foundation of evolution by proving that there is no scientific reason within the prevision of his great theory why the ovule of a lioness should not be just as apt to produce a young hyena as a young lion! It therefore inevitably follows that there is no scientific law within reach of evolution and its purely physical system of philosophy which can assign a shadow of a reason, after this admission, why a crocodile should not bring forth a young reindeer, or a cow should not produce kittens, since their ovules "differ in no respect" from each other, and since such a thing as an incorporeal, substantial, organic life-germ, is entirely foreign to that wholly materialistic philosophy.

This important discovery of Mr. Darwin, that the human ovule "differs in no respect from the ovules of other animals," may not after all prove such a godsend to evolution when we shall have traced its legitimate bearing a little further. It becomes, in fact, another scientific demonstration that there is present in the life-germ of every living creature a substantial vital and mental organism, which really contains the specific entity of each being, from which alone the animal form derives its structural outline; and that the substantial is not therefore limited to the visible and tangible, as evolution necessarily inculcates. Without this absolute entity of being existing invisibly and incorporeally, yet substantially, within each ovule, representing, as an individual microcosm, every bone, joint, muscle, ligament, vein, artery, and nerve of the entire anatomy of such specific form, it may be relied upon as a physiological fact that no such a thing as development or differentiation could take place from any ovule.

If Mr. Darwin were asked to give some explanation why an equine ovule differentiates and develops into a colt rather than into a puppy, since the ovule of the horse "differs in no respect" from that of the dog, he would probably reply, as he did when imploring some solution to the problem of inherited instinct and acquired habit in a retriever: "An answer to this question, however imperfect, would be satisfactory." The truth is, these physical philosophers, who believe in nothing substantial but the tangible, haven't the remotest idea how to answer any of these questions or solve any problem relating to inheritance, reproduction, or development; yet they assume to hold the only keys in the theory of descent by which all these mysteries of inherited transmissions are to be unlocked, at the same time pleading for any kind of answer to a question no more profound than any and all others relating to inheritance and development;

for they all involve the same underlying principle of a substantial vital organism in each living creature as the counterpart of its corporeal structure.

No question more profound, or, in fact, more simple, was ever asked relating to the great subject of inheritance, than why a chicken as soon as it leaves its shell, without having seen its mother or any other fowl, will commence running around and hunting grains of food, or why it will even tap against the shell with its beak and break its way out. I have used the remark, no question more *profound* or more *simple*, since they are all alike, and the man who can answer one can answer all, while he who fails on one, however apparently profound or simple, may at once drop the whole subject, as he will assuredly fail on all.

That a young chicken, without being taught by experience, will pick up and swallow a *fly* but cautiously avoid a *bee* of the same size and nearly the same form, while a little child, not having been taught to the contrary, will pick up a poisonous snake as readily as it would take in its hand a piece of ribbon, is a mystery which well may puzzle the brains of materialistic philosophers; for they have no conceivable answer within the range of their physical ideas which sheds a glimmer of light on these problems.

It is a cheap answer to say it is *instinct* which leads the chicken to pursue such and such a course. But what is instinct? Evidently the chicken *knows* in what manner its food will be found, if it gets it. It also knows that the bee is dangerous, and that the fly is not only harmless but nutritious. Young mammals also know, as soon as born, where and how to go in search for the breast; and, as seen with litters of pigs, will range themselves in the most orderly manner at the very first trial. The mother does not tell them, nor give them the least instruction. How, then, have they learned it? That they *know* where to go and how to proceed, by what we term *instinct*, there can be no doubt. Then what is instinct but *knowledge* or *intelligence?*

The answer to this entire problem of animal instinct and human reason, and the exact difference between them, can be given in a couple of paragraphs, which has never, so far as the writer knows, been before accomplished, simply because the true basis of such solution has hitherto been wholly ignored by writers on the subject. Since no intelligent solution can be conceived of without admitting a Creative Will to start with, hence the bewilderment, confusion, and contradictory attempts at explanation, indulged in by evolutionists, as will soon be shown from Mr. Darwin himself; while the weak, half-evolved, and unsatisfactory attempts at solution, by those who admit a Creative Will, result alone from a failure to recognize the dual organism of every sentient being, which I have postulated from the introductory chapter to the present page as the only possible basis of solution for the thousands of mysteries brought to light by physiological research.

Is there, then, a satisfactory and distinct line of demarkation between human intelligence and that knowledge possessed by the lower orders of animals which we usually designate as instinct? And is it further possible to give a clear and satisfactory explanation of the exact *modus operandi* by which that demarkation was first established and by which it is still kept up through the fixed laws and principles of Nature? I will now attempt quite briefly to give this solution, to which I invite the reader's careful attention.

The Creative Will in forming the first pair of fowls, for example, supplied them

from out His own fountain of life and intelligence with such mental powers and such a store of practical knowledge as was necessary to the struggle for existence, with the capacity to increase such intelligence within a certain specific limit by experience and memory. As thus formed, the vital and mental powers of these animals constituted an incorporeal yet substantial organism, the counterpart and invisible essence of their physical and tangible structure, thus constituting as real and true an entity of existence as is the substantial mental and vital nature of God himself, out of which all such entities issue as infinitesimal drops.

With the powers thus described the Creative Will also established the law of procreation, giving the capacity of transferring to offspring not only a duplicate life-germ which should contain the blended vital and mental organism of both parents, but with it He gave them power to transmit *their original and acquired store of parental knowledge.*

With the primal creation of the human pair, the mental powers and a store of practical knowledge were likewise given, but without the capacity of transferring to the child by the laws of generation a *single idea of parental knowledge, either original or acquired.* Instead of the transfer bodily of parental intelligence to the child with the vital and mental organism, as in the case of lower animals, the human parents had received the power from the Creative Will of transferring *an almost unlimited blank capacity of being taught.* While the human pair were denied the power of transferring to the child bodily their originally inspired and acquired knowledge, they were given in lieu of it the gift of speech and the capacity and desire to teach the young, and in this way only to transmit their intelligence from one generation to another. While the lower animals have been deprived of this capacity or desire to teach their young, and in lieu have received the power of transmitting their own knowledge bodily with the physical and vital organism, the young are equally incapable of being instructed by the parents except to a very limited extent by observation and imitation, but depend wholly upon the actual supply of knowledge which is born with them, and which we have, for the want of a better word, called *instinct.*

Here, then, is the real difference between the man and brute,—between human intelligence and animal instinct. The lower animal, having neither the capacity nor desire for teaching or being taught, has received from the Creator instead the power of transferring and receiving from generation to generation, inclosed within the vital and mental organism, the complete stock of ancestral knowledge. A human being, on the contrary, deprived of the capacity of thus transmitting or receiving a single ancestral idea, has been furnished by the Creative Will with the power of transferring to the child or receiving from the parent such a vital and mental entity as includes the full capacity and desire for both teaching and being taught.

And thus we have the distinct line of demarkation defined and clearly drawn between human reason and animal instinct. The former is built up, step by step, through instruction constantly accumulating from higher sources, aided by man's almost unlimited capacity for teaching and being taught, while the latter is the untaught and unlearned aggregate knowledge of the race since its primeval origin, transmitted bodily to offspring with their mental and vital organisms.

Hence, as an illustration of this difference carried into practice, let a pup be

raised to maturity or even old age without seeing the light or hearing a sound, and it would start out into the world when released with nearly the same intelligence and apparent familiarity with objects as ordinary dogs of its breed. But let an infant be thus raised to manhood, and it would come forth to the light a helpless idiot.

Here, then, is a problem which evolution can neither explain nor throw the least ray of light upon. Such a difference existing between two beings sustaining a *near blood relationship to each other*, as we are assured is the case by Darwin and Huxley, is utterly inconceivable, and must be held as absolutely impossible. That man should have descended from animals which receive all their intelligence in a mass at birth, while he, so nearly related and yet so vastly improved in other respects, and so differentiated physically, should not receive a single idea of congenital intelligence, must be regarded as utterly unreasonable and absurd. To ignore the solution I have given, that there was an original line of demarkation between human and lower species drawn by the Creative Will, and to assume, as do evolutionists, that man has actually descended from animals having such wonderful instinct as the dog, is to repudiate every true and consistent idea of development, and reverse the whole theory of evolution. Instead of *evolving* the congenital intelligence or instinct of the dog, and *developing* it to a higher grade of intuitive knowledge, as natural selection professes to accomplish, it has finally and utterly annihilated it in the infant, leaving not even a rudimentary vestige of such instinct remaining.

No one can deny that the instinct of the lower animal is useful, and would have been of service in any and every condition of life. Then why should survival of the fittest (!) completely destroy it in developing man from the dog? Suppose the infant born now had all the instinctive intelligence and physical strength at birth of the dog added to its unlimited capacity for being taught, would not such development be useful to man? No one can doubt it for a single moment. Then how could natural selection destroy such valuable instinct and such important physical strength in the young, as illustrated in the infant, except by reversing the very signification of evolution and survival of the fittest? Natural selection has not only developed (!) the infant to utter helplessness and weakness, and completely deprived it of every instinctive idea, but, according to Mr. Darwin's theory, it has even taken away the natural covering of hair from its body, without which it must instantly perish, even in the most temperate climate, especially at night, but for the acquired knowledge of the mother. Yet this stripping the infant of all natural clothing, which would have always been of service to man even when civilized, depriving it of all strength of body and limb, taking away from it every vestige of instinctive knowledge, all of which its near ancestral young relatives possessed in a high degree, is called by these advanced scientific thinkers *evolution*, *development*, and *survival of the fittest!* Really, if the words designating this theory were intended to correspond with the facts, it should be called *retrogression*, *deterioration*, and *preservation of the weakest!*

As the condition of the infant is in every essential respect the exact opposite of that of all lower animals at birth, showing a deterioration in every physical and mental aspect of its being, it amounts to a simple and clearly defined demonstration that the infant never descended from the dog or any other lower animal. Were there

no other argument against the theory of man's descent from lower forms of being, this alone should annihilate it, since the meaning of every word employed by evolutionists to represent such descent flatly conflicts with the present condition of the infant.

But, further, while we find natural selection reducing man in his normal physical and mental condition, as compared to lower animals, to a more and more defenseless and helpless state, taking from him every vestige of his former instinctive knowledge, and even stripping him of his natural clothing, which survival of the fittest should by all means have preserved and augmented, we see that some other power has had him in hand, entirely above, beyond, and outside of natural selection or survival of the fittest, and though finding him at birth the most defenseless and helpless being in the entire animal kingdom, being in reality less fit to survive than any other, it has so preserved, sustained, and elevated him mentally, and even physically when matured, as to place him as much above the most powerful animal on earth and as much its master as his corporeal frame was its inferior at birth. This power can not be evolution, natural selection, or survival of the fittest. These forces, laws, or powers had him in hand, we are told, and developed him from the dog till they had taken away from him his natural clothing, leaving him naked and liable to perish. They tried to improve him, according to Mr. Darwin, till they had robbed him of all his instinctive knowledge, leaving him insensate and a mental blank at birth. They practiced survival of the fittest on him in developing him from the opossum till he lost all his physical strength and became so helpless and defenseless that he was the most unfit for survival, physically or mentally, at birth, of all living creatures. Will evolutionists tell us, then, what power is this which finds man at the foot of the ladder in physical dependence, lifts him up, and makes him the lord and head of the animal kingdom?

I will now show the contrast between the highly satisfying solution just given of inherited instinct, and the difference between it and human reason, based on a recognition of the Creative Will and the dual organism of every living creature, and that solution which Darwinism has to propose, denying Creative Will or intelligent purpose, and ignoring the substantial nature of the life and mental powers. Read the following "solution" of the same problems to which I have alluded, as expounded by Mr. Darwin:—

"The development of the mammary glands would have been of no service and *could not have been effected through natural selection* unless the young at the same time were able to partake of the secretion. There is no greater difficulty in understanding how young mammals learnt to suck the breast than in understanding how unhatched chickens have *learnt to break the egg-shell by tapping against it* with their specially adapted beaks; or how a few hours after leaving the shell they have learnt to pick up grains of food. In such cases *the most probable solution seems to be that the habit was at first acquired by practice at a more advanced age, and afterwards transmitted to the offspring at an earlier age.*"—*Origin of Species*, p. 190.

This remarkable "solution" (!) of the problem of inherited instinct is certainly worthy of the author of "pangenesis," and is about as brilliant and original a conception as the possible conveyance of "self-propagating gemmules" down through a million generations in a "dormant" condition.

Strange as it may strike the reader, Mr. Darwin here distinctly teaches, as "the most probable solution," that the art of tapping at the egg-shell by the chicken to break its way out, as well as the "habit"

of hunting for grains of food soon after its escape, "*was at first acquired by practice at a more advanced age, and afterwards transmitted to the offspring at an earlier age.*" Now, would Mr. Darwin object to letting us know how that first parent of the first chicken, which acquired the habit of picking up food "by practice" *at an "advanced age,"* in order to transmit it to the offspring, managed to survive its infancy *without picking up food?* For, mark it, that parent was without the knowledge or the "habit," till it had been "acquired" "at a more *advanced age,*" since being the first one it had no parent to "transmit" such habit! Also, while he is explaining this, he should tell us how that parent of the chicken at an "*advanced age*" "acquired by *practice*" the habit of "*tapping*" *at the egg-shell and breaking its way out!* According to Mr. Darwin's theory there was no creation of the parents of the first chicken, and no original supply of intelligence furnished them by the Creative Will to be transferred to the mental and vital organism of the young ones which would teach them how to get out of the shell, and then how to pick up grains of food; but the first parent fowl, being developed by transmutation from some other animal, had to get out of the egg-shell as best it could, since it could not acquire the "habit" of "tapping" to break the shell till by "practice at a more advanced age." When he shall have explained how this original parent-fowl got out of the shell without the habit of "tapping," which it could not possess till at an advanced age by practice, and then how it picked up food to live on while young, I will agree to be satisfied, and not ask him how the first parent chicken *got into the shell without some other fowl to lay the egg*, as that would be too bad. All I will insist on at present is the main solution he attempts to give,—that is, how the original parent-fowl learned to get out of the shell and pick up grains of food without the "habit," which could only be "acquired," as he supposes, at an "advanced age"!

Then, as the reader observes, he applies the same lucid and highly satisfactory "solution" to the young of mammals, and to the important problem as to how they first learned to suck the breast. The thing is as plain as can be, he tells us,—the "habit" of sucking the breast is as simple as for a chicken to learn how to get out of the egg-shell, and was "first acquired by *practice* at a more *advanced age*, and *afterwards transmitted to the offspring*"! Now, leaving out the interesting question as to what the *first* or *original mammal* parent *practiced on* in learning the "habit" of sucking the breast at an "advanced age" so as to be able to transmit it to the offspring, I would seriously request Mr. Darwin to inform us how that first mammal parent grew up from birth to an "advanced age" without the habit of sucking the breast, or without any breast to suck, for that matter, especially since he distinctly teaches that these mammary glands are "*indispensable*" *for the* "*existence*" of young mammals?—

> "The mammary glands are common to the whole class of mammals, and *are indispensable for their existence.*"—*Origin of Species*, p. 189.

Yet he would have his readers believe that the very first or original mammal parent, which had never been created but had been transmuted from a tortoise or some other reptile, grew up from infancy without sucking, though such mammary glands "are *indispensable* for their existence," and that when it had arrived at an "advanced age" it "practiced" the "habit" of sucking, when there was no other mammal in existence, and consequently no breasts to suck, in order to be able to trans-

mit the habit to its future offspring! Was there ever a theory so ridiculously and laughably at sea?

I give this single instance, from the founder of the system himself, as an illustration of the pitiable predicament in which an evolutionist finds himself placed whenever he attempts to account for the simplest phenomena of inheritance, propagation, or transmitted instinct, by the theory of natural selection and organic transmutation. But Mr. Darwin is a great man and has acquired a great name, yet I doubt whether even this prestige will be sufficient to gloss such self-stultifying and monstrous absurdities as these, after they are placed fairly before the public.

How evidently, therefore, does the truth recur to us at each turn of the inquiry that no merely physical view of organism can give any satisfaction in regard to the numberless problems growing out of inherited transmissions? The great truth, in so many ways confirmed since the commencement of this chapter, that within each sentient corporeal structure there exists its exact substantial counterpart in the form of an intangible vital and mental organism, has rationally prepared the way for the provisional hypothesis which I have already partially elaborated. I do not claim that the idea of an incorporeal life-germ as the concentrated nucleolus of being, given off from the vital and mental organisms of both parents and constituting a living microcosm, has been proved, though it clearly does not conflict with any known law or fact of science, while it does beautifully and consistently harmonize with and lucidly explain many phenomena utterly inexplicable by evolution or any other theory, as will now be shown.

That an *individual* vital and mental microcosm exists in and takes possession of the ovule at the start of each individual life, and that such a microcosmic life-germ really though invisibly embraces and contains every substantial organ or part of the specific being into which such ovule is to develop, I regard as an absolute necessity, and abundantly proved, as otherwise, since the physical ovules of all animals are alike, they should all differentiate into one and the same animal form, if they could develop at all. Then, if an individual microcosm can and does exist within each life-germ of being pervading the ovule, and by whose action alone a concentration and orderly arrangement of corporeal atoms are brought to bear and disposed to build up the anatomy of the embryonic creature, is it not reasonable that such an essential germ of being might also embrace a microcosmic assemblage of all intrinsic life-forms? If such an assemblage of life-forms is supposable, then their substantial presence in the primal germ would be as real as the self-propagating organisms assumed in the microcosm of Mr. Darwin, which, though physical and assumed to each occupy a certain amount of space or room, are nevertheless supposed to be as "numerous as the stars of heaven."

Now, it is but a very short step to extend my hypothesis, and suppose that within each microcosm the one specific form of being which represents the family of organisms to which any given life-germ belongs, is the presiding or governing genius of the little assemblage or universe of life-forms, and which must in the very organic nature of things determine or control the developmental operations and the organic process, giving the final direction to the vital forces of the mother's organism, till the ovule, in which the specific forms and characters of the two parents are equally divided, takes the complete outline of the reproduced being.

Should, however, any unusual shock or

perturbation of the mother's vital and mental organism occur in the early periods of gestation, accompanied by any abrupt physical concussion, to which she may be at any time liable, it would not be unreasonable to suppose, from the intimate connection between her and the life-germ, that the one specific controlling form which corresponds to that of the father and mother, juxtaposited and involved with the thousands of other forms constituting the microcosmic assemblage, might come into collision with some other specific representative and thus take from it by contact the impression of some monstrous organ or mental peculiarity, now regarded by evolutionists as *reversions* to distant ancestral structures. If physical shocks can displace and derange corporeal organisms, may not vital and mental perturbations distort the vital organism within the life-germ, causing some abnormity or so-called reversion to become attached to the embryo?

Here, then, I reach the culmination of my provisional hypothesis, that the tails of reptiles, gills of fishes, and other appearances of low organic forms seen in the early embryos of all vertebrate animals, result from the manner of arrangement and the peculiar order of juxtaposition in which the microcosmic forms take their places within the life-germ, which necessarily cause certain forms, organs, or types of specific structure, to stand out in the early embryo more prominently than others,—which, however, are soon displaced and relegated to invisibility by the controlling germ of the parent form, which supplants all other appearances, and leads on the embryo to its final congenital shape and specific outline.

If there is any truth in this microcosmic assemblage of intangible life-forms, which I was rationally invited to assume by Mr. Darwin's much more improbable microcosm of physical organisms, it would not be beyond the limit of probable inference that some sort of specific or generic affinity might exist even among the representative forms constituting this "little universe" of incorporeal being; that is to say, there might exist a more intimate attraction between species nearly allied in the graduated scale of their form and structure than between those vastly unlike in specific or anatomical outline. Thus it might be supposed in reason that the human life-form and that of the quadrumana, being more intimately connected in their creative anatomical graduation than either with any other vertebrate form, would possess a vital affinity in the microcosmic assemblage not existing among more distantly related species. I thus use the word *related* as only embracing that semblance of being resulting alone from creative graduation as to anatomical type.

This supposed affinity would tend to cause either of two such specific forms thus related to take on the appearance of the other more readily than would two more distantly related; though not without marked exceptions to the rule, from the effects of those collisions I have just spoken of caused by the perturbations and shocks of the mother, which, as seen, could easily cause an infant to take some organic deformity resembling the structure of a marsupial or of a wolf. On account of this affinity coming thus from creative graduation, it may readily be supposed that the horse genus would more likely assume the color or stripes of the quagga or zebra by so-called reversions than it would adopt the spots of the leopard. So dovecote pigeons would more naturally, from their affinity, divert to the color of the wild-rock pigeon than to that of the robbin or blackbird, owing to the great similarity in anatomical type.

That such diversions in color take place more frequently as the result of specific crosses, which so astonishes Mr. Darwin, is not a surprising matter if we consider the nature of such a supposed vital microcosm, when the controlling life-form must as nearly as possible represent both species, since it is necessarily that life-form which gives direction to the developing ovule and guides the evolving embryonic structure. So long as the specific mental and vital elements of father and mother, combining to make up the life-germ which is to vitalize the embryo, shall be in harmonious accord, as in the case of true species, so long will the germ thus produced proceed in its normal and orderly way to gradually take possession of and give direction to the ovule; but let this governing life-form be constituted by a whirl of opposing and conflicting life-elements, which shall form a mongrel or hybrid life-germ, as when species or even varieties are intercrossed, and the germ is necessarily thrown into a state of confusion, and naturally might be assumed to come into many partial collisions with the life-forms nearest in anatomical relationship, and therefore most nearly its own affinity, thereby brushing up such shades of color as those noticed in horses and pigeons, and such texture of epidermis as would even cause an abnormal fiber in the hair and feathers.

The sterility of hybrids when intercrossed, as in the case of mules and hinnies, is caused by the same confusion into which the governing life-form is thrown as just noticed at the cross of species, such confusion being augmented by the repeated violation of specific unity, causing such a conflict in the microcosm and such a prolonged whirl of collisions that the controlling life-germ becomes exhausted and aborted. Nature can thus bear one insult, but will not allow of its repetition.

The well-known sterility of most wild animals in confinement, even when food and shelter are all which could be required, is clearly and rationally the result of mental and vital perturbation, the deprivation of freedom so acting on the governing life-germ in the microcosm, through the mental depression of the parents, as to cause a depressing effect even upon the germ, and such a loss of energy as to paralyze its exertions, and thus to neutralize its power over the ovule. The same effect from mental perturbation is seen with different tribes of people when overpowered by a stronger race, which so acts on their love of freedom from encroachment on their national pride as to render them sterile, thus in time leading to their extinction. The life-germ, even when the vital elements of the parents are united, is so depressed by the mental anxiety and conflict of the vital and mental organisms of the father and mother, that it has not the strength and persistence requisite to cause the primal differentiation of the ovule. Nations have been known to commence at once fading out through sterility as soon as overpowered by a stronger race. Our Indians are a startling proof of this, and will soon be among the historic but extinct races of the earth, alone from the cause I have just given. The physical laws of descent are wholly unable to give any solution of the problems here named.

I shall not dwell in detail as to the bearing of my hypothesis on these various phases of embryologic and reversionary phenomena, though the beauty of incorporeal yet substantial life-germs and the mental and vital organisms I have assumed, with an intangible but real microcosm constituted of all specific life-forms, would warrant me in extending the explanation to the solution of every observed phenomenon. While my hypothesis, if its

basis of a vital microcosm be once accepted, explains rationally and clearly all the problems and facts raised by Darwin's theory of descent, his assumptions fall utterly short of giving a satisfactory explanation of even the simplest circumstance connected with inherited transmissions. Take, for example, the cases of dovecote pigeons reverting to the color of the wild-rock pigeon and of the horse to the stripes of the zebra. The settled laws of physiology utterly prohibit and forever bar Darwin's hypothesis of descent by transmutation as a solution of these facts. Yet he relies upon these so-called reversions as invulnerable proof of his theory. Read the following:—

"Now what are we to say to these several facts? We see several distinct species of the horse genus becoming by simple variation striped on the legs like a zebra or striped on the shoulders like an ass. . . . We see this tendency to become striped *most strongly displayed in hybrids* from between several of the most distinct species. . . . Now observe the case of the several breeds of pigeons: they are descended from a pigeon of a bluish color, with certain bars and other marks; and when any breed assumes by simple variation a bluish tint, these bars and other marks invariably re-appear. . . . When the oldest and truest breeds of various colors *are crossed, we see a strong tendency for the blue tint and bars and marks to re-appear in the mongrels.* I have stated that the most *probable hypothesis* to account for the appearance of *very ancient characters*, is, *that there is a tendency in the young of each successive generation to produce the long-lost character*, and that this *tendency* from *unknown causes* sometimes prevails."—"If we admit that these races [of pigeons] have all descended from *C. Livia*, no breeder will doubt that the occasional appearance of blue birds thus characterized is accounted for on the well-known principle of '*throwing back*,' or *reversion*. Why *crossing should give so strong a tendency to reversion we do not with certainty know.*"

"For myself, I venture confidently to look back *thousands on thousands of generations*, and I see an animal striped like a *zebra*, but perhaps otherwise very differently constructed, the *common parent of our domestic horse*, of the *ass*, the *hemionus*, *quagga*, and *zebra*."—DARWIN, *Origin of Species*, p. 130. *Animals and Plants*, vol. i., p. 245.

Mr. Darwin venturing "to look back thousands on thousands of generations" for an explanation of horses becoming striped and pigeons becoming tinted with blue and bars, is not at all surprising. His whole theory is a fearful "venture" of the imagination from beginning to end. Now, I need not add a single paragraph here in order to annihilate this last-named venture as to the reversion of horses back "thousands on thousands of generations," or pigeons for an equal number of generations back to the *C. Livia*. I only refer the reader to that terrible line of figures (page 405) and the accompanying arguments, in which the impossibility of reversions is so clearly demonstrated. No evolutionist can answer those arguments nor that fatal line of figures, and I now make the assertion that no one will even try to answer them. Those arguments and figures apply with equal force against these reversions of the horse and the pigeon to ancient ancestors. To think of questioning the arguments and figures there presented would be to deny the very foundation-law of physiology, namely, that every organic being is continually undergoing mutation and substitution in all its parts and material atoms and that at no distant date can it possess a particle of its former corporeal substance.

If, therefore, the explanation of these so-called reversions given by my provisional hypothesis is not the true one, we are surely in the dark, and without any explanation at all; for while mine remains a possible solution, Mr. Darwin's is absolutely demonstrated to be impossible.

That my hypothesis can furnish a rational or even possible solution of these otherwise inexplicable problems of embryology and so-called reversionary action, depends entirely on the correctness of the two positions before argued: firstly, if there

is in every living creature an incorporeal vital and mental organism as the counterpart of the physical; and secondly, whether each life-germ or nucleolus of such intangible organism may be rationally supposed to represent a vital microcosm or assemblage of universal life-forms. The first position—the existence of a substantial vital and mental organism in each living creature, as real as its anatomical structure—has been proved beyond the possibility of a scientific doubt; while the second position—the actual presence of a microcosm or a little universe of vital organisms within each life-germ—I may insist on as fully warranted by the assumption of Mr. Darwin in claiming the presence of a microcosm of physical "self-propagating organisms" "numerous as the stars of heaven" within "each living creature," however infinitesimally small. Whatever may be thought of my provisional hypothesis of a microcosmic assemblage of life-forms as present in each embryonic life-germ, considered by itself, I am perfectly willing to let it go on record by the side of the corporeal microcosm of Mr. Darwin, and challenge comparison. If the ovules of different animals are really alike physically, as all evolutionists teach, then it follows as a necessity that invisibly within each ovule there must exist the perfect life-form of the specific organism into which the ovule differentiates; and if one life-form can so exist in all its parts, it is but a rational extension of this fact to include the vital and representative microcosm I have supposed.

The various explanations I have given of phenomena which are wholly inexplicable on the hypothesis of physical descent by transmutation, and the harmonious blending of various facts of science when viewed as the outgrowth of the demonstrated vital and mental though incorporeal organism of each living creature, would seem to be sufficient to give a reasonable probability to my supposition of a vital microcosm and the various solutions I deduce therefrom. That the future line of argument and reasoning to be adopted in explaining other phenomena, such as rudimentary organs, will tend to confirm this view, and further demonstrate the absolute certainty of an incorporeal yet substantial mental and vital organism in every living creature, will be abundantly apparent to the reader as we proceed.

SUMMARY OF THE ARGUMENT.

I will now in a few briefly condensed paragraphs run over the arguments of this chapter, and see in what position they apparently leave evolution.

1. As a permanent basis for all explanations of the problems raised by Darwin, it has been shown from several considerations that the external or corporeal structure of any organic being is but a tithe of its real and substantial existence,—that the life and mental powers of each living creature constitute an incorporeal yet substantial organism as real as is its anatomical structure, and of which its physical form is but the external type or visible expression. Hence, it follows that to this substantial vital and mental organism we must really refer all the varied biological and vital phenomena witnessed in Nature.

2. This hypothesis of a mental and vital organism, so sweeping and revolutionary in its character, was demonstrated scientifically by two direct proofs. The first one consisted in the fact, as shown from high authorities, that there can be no such a thing as transmission of inherited characters from generation to generation through physical organism, since all the corporeal constituents of a living creature are necessarily displaced and substituted

by new materials about once in seven years, more or less, thus breaking down the bridge of physical inheritance and making it absolutely impossible for transmissions to take place at all through corporeal blood and structure. Hence, as was thus shown, it must follow that *atavism* as well as the transmission of characters from parents to children must proceed alone through the intangible vital and mental structure of each specific being, *or it could not take place at all.* The second direct proof of such a substantial entity of being was drawn from the fact, that, while a child resembles its father as much as it does its mother, yet *only about a thousandth part of its corporeal organism can come from its father*, showing unequivocally that the child's inherited characters both of body and mind are derived exclusively from the incorporeal vital and mental organisms of both parents, while their physical structures are only the visible conducting media through which the transmissions take place, just as a wire is the corporeal medium through which a message reaches us, while electricity is the incorporeal but substantial agent by which the transmission is effected.

3. It is a patent fact that no evolutionist has ever intimated such a possibility as a dual organism constituting each living creature, and hence the manifest perplexity and bewilderment exhibited by Mr. Darwin throughout his writings in regard to the transmission of an instinct or an acquired habit, as in the case of the retriever, which, being taught to fetch and carry, transmits the same mental habit to the pup, which will immediately fetch and carry without being taught. Mr. Darwin frankly admits it an inexplicable mystery on his theory of descent through *physical structure* (which is, of course, all he recognizes, and all of which he has ever formed even the remotest conception,) while he implores the reader for even an "*imperfect*" answer to this question. Yet my hypothesis gives at once a satisfactory and perfect answer. The reader must agree with Mr. Darwin that no answer can be given on the basis of physical organism, and hence the only solution is on the demonstrated hypothesis that the retriever transmits his mental habit to the pup, as all other mental and bodily characters are transmitted, through his intangible and substantial vital and mental organism, which constitutes the essential portion of every living creature.

4. Mr. Darwin's great argument, based on reversionary action through the retention of a small fraction of remote ancestral blood, has been examined, and his supposed reversions in human beings to the organic structure of ancient marsupials have been shown to be absurdly impossible by a table of figures which must overwhelm any sane mind with the magnitude and enormity of the fallacy. I shall only here refer the reader back to that table (page 223) as sufficiently crushing to overthrow a theory having a million times more probability to sustain it. But, in addition to that table and its fatal effects, I produced a clear demonstration that no reversion could take place even two generations back, according to Mr. Darwin's theory of physical descent. This demonstration was accomplished by applying the conclusive argument just summarized, that the corporeal ingredients in every mature human being now living have been supplanted and substituted many times since birth by entirely new materials gathered from organic and inorganic nature. Hence, this great and powerful argument based on reversions is thus wrenched summarily from the hands of evolution, while the astounding fact is brought to the surface that the true theory and cause of inherited transmissions *have never been understood by physi-*

ologists! Does this seem egotistical? If so, I can't help it; for just as certain as an invisible vital and mental organism inclosed within and represented by the physical structure, in all animals, from the highest to the lowest, is necessary to the transmission of characters from parents to offspring (which is here distinctly assumed for the first time), just so certain has the whole science of physiology been floundering in the dark upon this subject from the very dawn of science up to the present time. The future will tell whether I am justified in this sweeping assertion or not. I firmly believe it, and hence fearlessly proclaim it to the world.

5. Embryology has also been taken up and treated in the same summary manner. The tails of reptiles and gills or pharyngeal arches of the fish, seen in the early embryos of all vertebrate animals, are regarded as forming one of the strongest, if not the very strongest, arguments known in support of evolution. I have shown that these phenomena come within the same class of facts as those of reversionary action, depending on a remnant of ancestral blood if from physical descent; and hence that the same arguments which so signally disposed of reversions, including that fatal line of figures, would bear with equal force against this embryonic argument, and demonstrate that the appearance of tails and branchiæ in human embryos can not by any possibility be traced back to ancestral tortoise and fish. Thus, by a single consideration this hitherto invincible argument is swept away.

6. But not resting with the overthrow of the argument, the tables have been effectually turned against its inventors; and from their own plates, illustrating the similarity of all vertebrate embryos, it has been shown that the *tortoise must have descended from man*, if there is any truth in the mode of reasoning adopted by evolutionists,—since Professor Haeckel's ingenious engravings, while carefully placing a tortoise-tail on the human embryo, have unwittingly put a human head on the embryonic tortoise! Thus, by all the logic of evolution we may publish to the scientific world that this chelonian testudo is a veritable and lineal descendant, through unnumbered species of emys and fresh-water snapping-turtles, of that most completely differentiated order of mammals called *man!* No doubt this wonderful instance of retrograde transmutation and development backward originally took the idea of his cataphractic carapace from the impenetrable skull of some ancient evolutionist! By this important discovery in examining Haeckel's plates, having a tortoise-tail attached to the human embryo and a human head placed on that of the tortoise, the embryological argument becomes just as much stronger against evolution than for it as the head of an animal is more important than its tail as a classificatory guide.

7. The constantly reiterated fact that the *ovules* of all vertebrate animals, from man down, are exactly alike, and which, as Mr. Darwin repeats it, "differ in no respect" from each other, has also been examined and shown to completely overthrow evolution, based as it is and as it must be on physical descent alone; for since corporeal germs or ovules are exactly the same in all animals, and since there is no such a thing recognized or dreamt of by evolutionists as a substantial incorporeal vital germ controlling organic development, it follows inevitably that a cat would be just as liable to produce a raccoon or a rabbit as to bring forth a creature having feline organism! The very fact that the *ovules* of all animals are alike physically utterly annihilates Mr. Darwin's

theory of corporeal descent, since by no physical laws could such similar ovules differentiate into diverse specific forms, such as alligator and elephant, kangaroo and reindeer. It therefore becomes manifestly a scientific demonstration in favor of my hypothesis that within each corporeal germ or ovule there must exist, at the commencement of each individual life, through the vital union of the two parents, a real *life-germ* embodying their united mental and vital organism, which alone can give direction to the corporeal *ovule* and determine the specific form of the embryo which it shall produce. Little, indeed, did evolutionists think when laboriously prosecuting their anatomical researches to authenticate the unanswerable scientific fact, and bring it to bear in fortifying evolution, that "man is developed from an ovule . . . *which differs in no respect from the ovules of other animals*," that in so doing they were weaving the web which should ultimately become the winding-sheet of evolution.

8. Darwin's provisional hypothesis called "Pangenesis"—a desperate effort to invent something to bridge over the physical hiatus between generations, and something which will take the place of destructively diluted ancestral blood and make corporeal transmissions and reversions possible—has been briefly examined, and shown to be wholly worthless. The "gemmules," which his hypothesis supposes to descend from generation to generation, are admitted to be "dormant" while thus descending, or until roused into action by some "unknown conditions"; and hence they are no better and no more liable to be transmitted from age to age than other corporeal atoms of matter, which are displaced and substituted many times during the life of a human being. This is Mr. Darwin's only attempt to span the bridgeless chasms which each generation must accumulate for physical descent. The attempt has proved a signal failure. Without these "gemmules" there is no physical atom, as the best authorities establish, which can continue unsubstituted by other ingredients, and Darwin is too shrewd a scientist not to have known it. Hence the invention of gemmules to supply this deficiency. Yet, strange to say, by making them descend in a "dormant" condition he completely stultifies his own intention, and tears down the temple with one hand which he is trying to erect with the other; for a "dormant" gemmule, if such a thing has an existence, being useless for nutrition or unconvertible into blood, would be wholly worthless in the body of any animal, and would at once be cast off by this law of change and substitution as waste or excrementitious matter. Being "dormant," they are of course *inactive*, and incapable of procreation by self-division till that period in the far distant future when some "unknown conditions" rouse them into action. Hence, they are no more efficient as bridge-materials to span the myriads of chasms in physical inheritance than so much lifeless bone or dirt. Darwin's great project of Pangenesis, therefore, turns out to be an inglorious and pitiable abortion, and may be quietly relegated to the silent limbo of self-stultified and exploded speculations.

9. Finally, I have undertaken to frame an hypothesis by which to account for reversionary action and the phenomena of embryology. It is based on the demonstrated existence of an incorporeal mental and vital organism in each living creature. With what success this hypothesis meets and explains the various facts involved in these questions, the reader shall judge. At all events, such an incorporeal microcosm of ideal forms of being as I have supposed

to exist within every *life-germ* is fully warranted by Mr. Darwin's physical microcosm, based entirely on the assumed presence of corporeal "self-propagating organisms" concentrated in "each living creature," "numerous as the stars of heaven." Such a microcosm as he supposes, with countless *physical* organisms existing in a single flea or midge, would be surely quite improbable, from their infinite tendency to crowding and want of space, whilst my hypothesis supposes a microcosm of unnumbered incorporeal organisms and vital forms, which involve no more idea of crowding or want of room than the memory of a thousand separate events would physically jostle each other in the brain. That the microcosm which I have thus supposed is at least as plausible as that assumed by Mr. Darwin, there surely can be no doubt. Whether such an hypothesis will satisfy the reader or not, one thing remains fixed and settled beyond all question, namely, that these reversionary and embryological facts and phenomena have no relation whatever to the physical descent of human beings from marsupials, reptiles, and fishes; and their employment hereafter in support of evolution should be regarded as an unwarrantable attempt to impose upon the credulity of the world.

CHAPTER IX.

EVOLUTION.—ITS STRONGEST ARGUMENTS EXAMINED.—(Continued.)

Rudimentary Organs.—The most Startling Instances of such Structures adduced by Darwin and Haeckel, such as Upper Front Teeth in the Embryonic Calf and Whale, and Aborted Leg-Bones in the Whale and Boa-Constrictor.—These Rudiments claimed by all Evolutionists as Positive Proof that such beings descended from Ancestors having these Organs in a Perfect State.—The Author proposes in the Conclusion of this Chapter to give a Scientific Explanation of these Rudiments, which has never before been attempted.—A Definition of Science by Huxley and Spencer.—The Miraculous Creation of a Species demonstrated to be Scientific if shown to be more Probable than Transmutation.—Such a Demonstration Absolutely Furnished by the Testimony of Darwin and all his followers.—The Law of Evolution explained and the word defined by Darwin, Huxley, and Spencer.—Rudimentary Organs, as the Result of Physical Transmutation from Ancestors having the Organs perfect, an Utter Impossibility from the Terminology employed.—The Infinite Absurdity of the Assumption pointed out.—The Theory of Evolution turned fatally against itself, and the Bovine Genus demonstrated to have been Miraculously Created by the Necessary Positions of Evolutionists.—The Probability shown from Evolution itself that beneath the Lowest Silurian Deposits there exist Fossil Remains of Fishes, Reptiles, Birds, Mammals, and even Men.—Rudimentary Organs shown to be the most Conclusive Evidence of the Fallacy of Darwin's Whole Theory.—A Suggestion to Darwin and Haeckel how to easily dispense with their Annoying Difficulty of Creation and Spontaneous Generation, according to the logic of Evolution.—Each one of the cases referred to by Darwin and Haeckel taken away from Evolution by piecemeal.—The Utter Impossibility of a Cow losing her Teeth or of a Whale or Boa-Constrictor losing its Legs demonstrated.—The want of Shrewdness and Business Tact in Evolutionists shown.—They literally throw away their Strongest Arguments by a Childish Mistake.—Eyeless Cave-Rats and Fishes clearly accounted for.—They are no help to Evolution.—The Scientific Hypothesis finally explained by which to account for Rudimentary Organs.—Darwin's Confessed and Demonstrated Ignorance of the Cause of Variations proved from Numerous Passages.—The Reason only Attributable to his Monistic and Purely Physical Views of Organic Beings.—The Cause of all Variations Simply and Rationally Explained.—Numerous Circumstances adduced preparatory to my Hypothesis.—The Facts on which it is based demonstrated by the Highest Authorities on Scientific Breeding.—Several Astounding Facts cited.—Jacob's Experiments with Laban's Cattle Corroborated.—It has taken Scientists thousands of years to catch up with the Bible.—The Hypothesis Conclusively Applied to the cases in hand.—The True Reason Why the Brute can not be Immortal.—Summary of the Argument.

RUDIMENTARY ORGANS.

In the preceding chapter I have endeavored to dispose of two among the strongest arguments relied on in support of evolution, namely, the problems of reversionary action and those relating to embryology. I propose in the present chapter to consider the questions, even more important if anything, growing out of rudimentary organs, as they are called, which Darwin, Haeckel, and all advocates of evolution, regard as completely inexplicable save as the remaining indications of the normal organic structure of remote ancestors. In fact, these writers tell us, as in the arguments based on reversions and embryology, that no attempt at a scientific explanation of rudimentary organs has ever been made by an opponent of the theory of descent, and that any such

attempt, should it ever be made, would be folly in the extreme, unless such explanation should in some form recognize the only key to the mystery—the law of descent by transmutation. It is true that a few writers have assumed such rudimentary structures as purposely designed by the Creator to complete the scheme of Nature for the sake of symmetry; but, as Mr. Darwin remarks, "this is not an explanation, merely a re-statement of the fact." At all events, it does not pretend to be a scientific explanation.

I now undertake, not to merely re-state the fact, but to furnish the most unequivocal proof in the first place that the theory of descent does not and can not, in the nature of things, afford a shadow of explanation of the existence of rudimentary structures as the remnants of ancestral organs. I propose further to show that the system of evolution under natural selection necessarily and absolutely *prohibits* such an explanation as these writers give, and will adduce the clearest demonstration from the highest authorities—Darwin, Haeckel, Huxley, and Spencer,—that any attempt to trace rudimentary organs back to their normal existence in remote ancestral forms must be utterly fallacious and absurd, actually and literally overthrowing the whole superstructure of Darwinism; after which I will furnish a clear and comprehensive solution of the entire problem (not a provisional hypothesis, as in the preceding chapter,) based on purely scientific principles, confirmed by the evidence of numerous recorded facts; so that Prof. Haeckel, notwithstanding his boastful challenge to any writer to offer a "shadow of explanation" of rudimentary organs, will see to his amazement that there is at least one writer sufficiently foolhardy to step single-handed into the arena and accept his challenge.

Prior, however, to entering on this investigation, let us see what Mr. Darwin and Professor Haeckel have to say about rudimentary organs and their unanswerable bearing on evolution. The following citations will present the case in its strongest light:—

"The boa-constrictor has rudiments of hind-limbs and of a pelvis, and if it be said that these bones have been retained 'to complete the scheme of Nature,' why, as Prof. Weismann asks, have they not been retained by other snakes, which do not possess even a vestige of these bones?"

"What can be more curious than the presence of teeth in fœtal whales, which, when grown up, have not a tooth in their heads; or the teeth which never cut through the gums *in the upper jaws of unborn calves?*"—"It is an important fact that rudimentary organs, such as teeth in the upper jaws of *whales*, and *ruminants can often be detected in the embryo, but afterwards wholly disappear.*"—"The *calf*, for instance, *has inherited teeth*, which never cut through the gums of the upper jaw, *from an early progenitor having well-developed teeth.*"—DARWIN, *Origin of Species*, pp. 397, 399, 400, 420.

"But some serpents, viz., the giant serpents (Boa Python), have still in the hinder portion of the body some useless little bones, *which are the remains of lost hind-legs.* In like manner the mammals of the whale tribe (Cetacea), which have only fore-legs fully developed (breast-fins), have further back in their body another pair of utterly superfluous bones, which are remnants of undeveloped hind-legs. The same thing occurs in *many genuine fishes, in which the hind-legs have in like manner been lost.*"

"In the embryos of many ruminating animals—among others, in our common cattle—fore-teeth, or incisors, are placed in the mid-bone of the upper jaw, which never fully develop, and therefore serve no purpose. The embryos of many whales, which afterwards possess the well-known whalebone instead of teeth, yet have, before they are born and while they take no nourishment, teeth in their jaws, which set of teeth never comes into use. . . . *No biological phenomenon* has perhaps ever placed zoologists or botanists in greater embarrassment *than these rudimentary or abortive organs.* . . . Now it is precisely this widely spread and mysterious phenomenon of rudimentary organs, *in regard to which all other attempts at explanation fail, which is perfectly explained, and indeed in the simplest and clearest way, by Darwin's Theory of Inheritance and Adaptation.* . . . I have here spoken somewhat

fully of the phenomena of rudimentary organs, *because they are of the utmost general importance*, and because they lead us to the great general and fundamental questions in philosophy and natural science, *for the solution of which the Theory of Descent has now become the indispensable guide.*"—HAECKEL, *History of Creation*, vol. i., pp. 12–17.

It seems to me extremely strange, in reading these passages, that the scientific facts here presented, which no one disputes, have not been wrenched from the theory of descent and turned against evolutionists with fatal effect in some one of the numerous publications which have appeared in opposition to Mr. Darwin's hypothesis of transmutation during the eighteen years since the first publication of *The Origin of Species*. If they can neither be explained by natural laws nor shown in any way to conflict with the system of evolution under natural selection, I can not see how writers can consistently go on and oppose the theory of Mr. Darwin with such palpable and startling facts staring them in the face. But, on the other hand, if this most invulnerable bulwark of evolution shall really turn out when assaulted to be nothing better than a paper fort, there will be little left of Darwinism capable of inspiring the confidence even of the most ultra evolutionist, or of exciting the fears of its most timid opponents.

I am aware that the intimations here made of a purpose not only to turn all these facts fatally against the theory of Mr. Darwin, but to explain them scientifically in opposition to evolution, while no writer has ever attempted either an explanation or a rebuttal of them by scientific laws, appears to be presumptuous in the highest degree, while to thus assault the entire army of evolution in its strongest fortified position, with its heaviest guns pointing directly at me, must appear to many almost like courting annihilation. But having just run the risk of facing other evolutionary guns of almost equal caliber, and having found them when tested charged with blank cartridges, I shall undertake this task with little trepidation or alarm as to the result. If I have in any degree verified my pledges in regard to the two preceding "unanswerable" classes of facts—reversions and embryology—I have a right to expect the unbiassed attention of the reader while I enter upon this the most profound and formidable of all evolutionary arguments.

As the subject of rudimentary organs will have to be approached by a kind of sapping and mining process in order to expose the untenableness of the position, and ultimately to bring about, as I trust, an unconditional surrender of the works, it will require a little preparatory engineering and reconnoitering, and possibly the establishment of a few points of observation, not directly related, apparently, to the matter in hand,—yet the bearing of which will become self-evident as the work advances.

As a matter of course, all opposition to Darwin's theory of man's descent from the lowest forms of life by means of transmutation under natural selection must assume the miraculous formation of the parents of each species by the direct intervention of an infinite Creator. It is not to be expected, however, and never has been, that we should prove or *demonstrate* the miraculous creation of a species, as evolutionists are expected, and as they claim, to demonstrate its origin by natural selection. All that opponents of evolution have to do is to rest upon the received doctrine of creation, which has borne sway among the masses of mankind for thousands of years; and if any scientific theory, such as that of evolution, shall come up in opposition and assume another origin for specific forms than the received mode, it belongs to the advocates of such theory to assume also

the *onus probandi*, and give reasonable proof of such hypothesis, while the adherents to the old doctrine have only to look on as spectators and occasionally show the defects of the new assumption, and point out wherein such supposed origin is less reasonable or probable, all things considered, than the old mode. Though this is really all there is required of us, yet it would be a somewhat remarkable and unexpected state of facts if I should actually demonstrate the miraculous formation of one of our highly organized species of quadrupeds, using the very positions assumed by evolutionists to confirm such demonstration! This, startling as it may seem, will soon be so clearly established that no evolutionist can assail it, unless he abandons his own theory to do it. For the present, I shall assume the miraculous creation of all specific forms as the rational, probable, and only consistent hypothesis of the origin of species.

Necessarily, evolutionists deny this as *unscientific*, and therefore *irrational*. But they can not deny the formation of the first living species, from which all others have evolved, as a *scientific fact*, either as the result of a miraculous intervention on the part of God, acting with a definite design and purpose, or else as a spontaneous act of blind, mindless, senseless, lifeless laws of Nature, acting necessarily without design, purpose, or intelligence. There are unavoidably but these two ways for such beginning. From the exhaustive discussion of Spontaneous Generation in a recent chapter, I believe the reader will justify the assumption that no such a thing as spontaneous generation, or the formation of a *living*, *thinking* being, without prior *life*, *thought*, and *purpose*, is a possibility in Nature. Hence, the first living species, however lowly and simple, must have been created by the miraculous intervention of a supernatural power, as admitted by Mr. Darwin. I shall therefore take his view for granted, as the only possible way of producing the first species of living creatures.

Now, as everything connected with the theory of evolution, from its start to its consummation, as claimed by all evolution writers, must be regarded as a scientific process under Nature, it is thus clearly demonstrated at the very start of the argument that the miraculous creation of at least one species *must be admitted as a fact of science*. (This, however, is not the miraculous creation I propose soon to demonstrate.) Then, if one miraculous interposition on the part of God may be regarded as a settled scientific fact, on the ground of its necessary occurrence in order to start evolution, may not two separate miracles on the part of the same All-wise Creator be likewise facts of science, if a rational probability exists for their necessity? And if two, may not all species have been miraculously inaugurated, and still each separate creation be a fact of science?

The great and reiterated cry of evolution writers seems to be, "Science! Science! Science!" Give us science, they say, instead of miracles or special acts of power; yet they are logically and unavoidably compelled to admit the miraculous creation of at least one species to be scientific, in order to have anything to begin evolution with! Is it any less tax on *infinite* power and wisdom to create one species by a direct miracle than two?—than five?—than a thousand?—than a hundred thousand different species? Would it be any more of a strain on Omnipotent Power and Omniscient Wisdom to design and construct an elephant than to form an oyster?

What is "science," of which these writers so persistently remind us when treating on evolution? It is nothing in the world but

knowledge,—that degree of knowledge relating to any question which forms the most reasonable basis for reflection and faith. If the existence of a God be more reasonable from all the sources of our information than Atheism, then the former becomes a scientific thesis. Herbert Spencer asks:—

"What is science? To see the absurdity of the prejudice against it, we need only remark that science is simply a higher development of common *knowledge;* and that if science is repudiated, all *knowledge* must be repudiated along with it."—*First Principles*, p. 18.

Huxley inculcates the same true idea of science:—

"*Knowledge* upon many subjects grows to be more and more perfect; and when it becomes to be so accurate and sure that it is capable of being proved to persons of suitable intelligence, it is called *science.* The *science* of any subject is the highest and *most exact knowledge upon that subject.*"—*Elementary Pysiology*, p. 11.

With these lucid definitions of "science," does it not conclusively follow, that, since one miracle is demonstrated to be scientific, a thousand miracles would be equally scientific if the weight of evidence or the most "accurate" knowledge we could acquire went in their favor rather than against them? No evolutionist will hereafter assert that a miracle or the miraculous formation of species is not recognized as among scientific facts. The miraculous creation of one species being forced upon them as scientific, if it shall be shown that it is more probable and reasonable to assume that all species were started in the same monistic manner rather than to suppose an entire change of God's plan of operation after having begun by miracle, then undeniably the miraculous formation of every separate species becomes the true science on the subject of the origin of species. It must therefore strike every candid and thoughtful reader as simply absurd in the highest degree for a scientist like Mr. Darwin to speak slightingly against the miraculous creation of different species as unreasonable and unscientific, when he is obliged to admit that the leading and fundamental fact of science on which his whole transmutation theory is founded is the miraculous creation of the first few simple beings as the start for evolution! Let it therefore rest right here as a settled principle of philosophy and science that miracles, like all other facts in question, depend alone on the weight of evidence; and that if a miracle be shown to be a probable necessity for explaining the phenomena of Nature, it is as much a fact of science as the growth of an oak from an acorn or the birth of an animal after the parents exist, and that the whole question as to miraculous or non-miraculous creations of the separate species, like ordinary propositions, hinges entirely on the amount of testimony brought to bear, thus determining the probabilities in the case.

Thus, having clearly shown that the miraculous production of a species is as strictly a scientific fact as the falling of an apple or as any other ordinary event occurring under the laws of Nature, provided it is proved that such miraculous commencement of specific forms best explains the various phenomena involved, and is more consistent with collateral facts of science than any other assumption, I will now leave this branch of the subject for the present, to be resumed after a while, and at once try to find out the true signification of *evolution* as applied to the origin and development of species.

When I state that evolution, according to all authorities on the subject, distinctly implies development from the crude to the refined, from the imperfect to the perfect, from the lowly organic beings to the higher grades of organisms, from the indefinite to

the definite form, from the simple structure to the complex arrangement of parts, and from the homogeneous to the heterogeneous, I but state what the best writers and those best qualified to comprehend the true meaning of such terminology will at once admit. Hence, no evolution under natural selection, such as I am now investigating, can go *backward* or *downward*. Retrogression or deterioration under evolution is an evident absurdity on its very face, and hence a contradiction in terms. Mr. Darwin says:—

"As natural selection works solely for and by the good of each being *all corporeal* and *mental endowments* will tend to *progress* toward *perfection*." —*Origin of Species*, p. 428.

Professor Huxley entertains the same idea of evolution—that it is in all cases to improve the being operated on or to make it better, while any spontaneous variation which may happen in Nature tending to deteriorate the species or the individual or to make it worse, will lead to the extermination of such species or such being by the very operation of the law itself. He says:—

"It seems impossible that any variation which may arise in a species in Nature should not tend in some way or other to be a little *better* or *worse* than the previous stock; if it is a little better it will have an advantage over and tend to *extirpate the latter* in this crush and struggle; and if it is a little *worse it will itself be extirpated*."—*Lectures on the Origin of Species*, p. 123.

Mr. Darwin corroborates this completely in more than a dozen different places in his *Origin of Species* and other works. I will quote but a single passage:—

"The continued production of new forms through natural selection, which *implies that each new variety has some advantage over others*, almost inevitably leads to the *extermination of the older or less improved forms*."—*Animals and Plants*, vol. i., p. 18.

But to settle all doubt as to the tendency and operation of evolution, according to its intrinsic signification being development upward not downward, from the uniorganism to the multiplication of parts, from the indefinite to the definite structure, from the *simple* to the *complex*, and from the *homogeneous* to the *heterogeneous*, I quote from the great modern philosopher and definer of general laws—Herbert Spencer, one of the very highest authorities among evolutionists:—

"From the remotest part which science can fathom up to the novelties of yesterday, *an essential trait of evolution has been the transformation of the homogeneous into the heterogeneous*. . . . At the same time that evolution is a *change from the homogeneous* to the *heterogeneous* it is a *change* from the *indefinite* to the *definite*. Along with an advancement *from simplicity to complexity* there is an advance from confusion to order. . . . *Development, no matter of what kind*, exhibits not only a multiplication of unlike parts, but an increase in the distinctness with which these parts are marked off from one another." —HERBERT SPENCER, *First Principles*, pp. 359, 362.

From this necessary and unavoidable meaning of evolution it will now be seen at once that the idea of rudimentary organs having been aborted or atrophied by descent from ancestral species which had those organs in a perfect condition is an impossibility as well as a gross absurdity, since it would be exactly the reverse of evolution, and an absolute change from the heterogeneous back into the homogeneous. Take, for example, the boa-constrictor, which, Mr. Darwin's theory informs us, once had legs in a perfect condition, and that by evolution (!) under natural selection and development (!) by *survival of the fittest* (!) the species finally lost its legs, leaving the atrophied leg-bones in the body beneath the skin; and that ever since it has been obliged to convey its ponderous form along the ground by the most unmechanical and unphilosophical class of movements known in the animal kingdom.

It thus flatly contradicts reason as well as the true meaning of evolution, as it is a retrogression or a going backward instead

of an evolution or a "*progress* toward *perfection*," as just quoted from Mr. Darwin himself. It is a clear transformation from the complex back to the simple,—from the heterogeneous back to the homogeneous,—from a "multiplication" of parts to the absence of parts,—exactly the reverse of the law and definition of evolution and all development, as laid down by Herbert Spencer. Besides, it is practically an almost laughable absurdity, since, according to Mr. Darwin and his theory of evolution, this boa-constrictor was first developed by natural selection through almost countless slight successive modifications from some legless fish or mollusk till it possessed the quadrupedal advantages of legs and feet; and then, by as many spontaneous variations also carefully accumulated and preserved by this "scrutinizing" process called natural selection, its feet and legs have been finally aborted and taken from it, for no apparent purpose under the heavens except to leave "little bones" under the skin to aid evolutionists in proving descent by transmutation!

No one can believe for a moment that these legs were not useful or of advantage to this creature for locomotion,—as much so as are the legs of the alligator, if not even more so, since alligators live in the water and scarcely need them. If legs had not been of great service to the boa why should natural selection have wrought through almost numberless generations to develop them from some legless species below it? Even if they had not been of any essential importance, we have volumes of evidence all through Nature showing that the most useless and absolutely worthless structures are among the best preserved under this "scrutinizing" law of natural selection. Look at the tails of tortoises, foxes, dogs, wolves, panthers, lions, tigers, &c., some of them actually injurious, such as the bushy tails of foxes when running from danger or pursuing prey in a snow or rain storm. Yet these absolutely useless and superflous tails continue unaborted and in all their perfection under this discriminating law of natural selection, which Mr. Darwin declares will destroy an organ if it should become superfluous:—

"Thus, as I believe, natural selection will tend in the long run to *reduce any part of the organization* as soon as it becomes, through changed habits, *superfluous*."—*Origin of Species*, p. 118.

The hump of the camel is one of the most remarkable instances of superfluity and uselessness in organs known in the animal kingdom. It is not, as some have supposed, a part of the osseous structure, and therefore useful on the mechanical principle of the arch in giving strength to the camel, thus enabling it to carry heavy burdens. Besides, what did natural selection know about the camel being a pack-animal when its humps were developed a million years before man existed on earth, according to evolution? Thus we have a living proof that Mr. Darwin's great "scrutinizing" law of natural selection not only developed the utterly useless and "superfluous" humps on the camel, which no naturalist pretends ever had or could have had any use, but it refuses to "reduce" them! Yet this same natural selection, after working a million years to develop legs on the boa-constrictor, which are universally known to be of service to an animal, takes the particular pains to "reduce" them, and leave the evidence of such reduction in the shape of a few "little bones" in the hinder part of its body!

More, still, the hump of the camel is not only useless but it is worse than useless,—it is absolutely *injurious*, being a burden to carry around, and necessarily consuming nutrition to aid in its growth and to replace

its lost substance, which is continually passing off by the physiological laws of wear and deterioration. Mr. Darwin teaches, as one of the fundamental tendencies and offices of natural selection, the "destruction" or atrophy of every organ which is in any degree "injurious." He says:—

"On the other hand we may feel sure that *any variation* in the *least degree injurious* would be *rigidly destroyed*. [Why has it not "rigidly" destroyed the camel's hump?] This *preservation* of *favorable* individual differences and variations and the *destruction of those which are injurious* I have called natural selection or survival of the fittest."—*Origin of Species*, p. 63.

Hence, we are driven to the conclusion that no more absurd principle or law than natural selection was ever promulgated to the world, since it carefully preserves the useless tails of mammals while its particular business is to "reduce" them, and scrutinizingly builds up and protects the injurious humps of camels which its office is to *destroy*, while at the same time it takes away the most necessary and even essential legs of a quadruped, according to Mr. Darwin, after working a million years to produce them! Was there ever a more contradictory, incongruous, or ridiculous theory, propounded by a sane naturalist? While the hump of the camel is conspicuously useless and hence injurious, it could not, Mr. Darwin tells us in more than twenty places, have been produced by natural selection, which *only acts on useful variations*. I will quote here but two passages. He says:—

"Natural selection *acts exclusively* by the preservation and accumulation of *variations which are beneficial*."

"Natural selection *acts only* by the preservation and accumulation of small inherited modifications, *each profitable to the preserved being*."—*Origin of Species*, pp. 75, 97.

Now, how simple a process it proves to be to "break down" this theory of natural selection at every turn of the investigation, even with the assistance of Mr. Darwin, so built up is it of inconsistent and contradictory elements. Its author admits that his theory would "absolutely break down" if a single organ could be found which could not have been produced by the accumulation of slight modifications through natural selection. He says:—

"If it could be demonstrated that any complex organ existed which could not possibly have been formed by numerous successive slight modifications [natural selection] *my theory would absolutely break down*."—*Origin of Species*, p. 146.

How simple, therefore, it is to "break down" and utterly overthrow Darwinism, when I can easily point out a thousand organs of different species, such as the useless and injurious humps of camels, which could not possibly have been thus produced by *natural selection*, since it acts "only" and "exclusively" on "profitable" or "beneficial" variations! An ordinary scientific student might safely take a contract to hopelessly "break down" the theory of evolution fifty times a day for a full week, using nothing in the operation but Mr. Darwin's *Origin of Species*, *Descent of Man*, and *Variations of Animals and Plants;* and if he should be permitted to add Professor Haeckel's *History of Creation* and *General Morphology*, he would be safe in extending the contract for a month. But as I shall refer to numerous additional instances of this kind in other places, in which, according to his own admission, his theory of natural selection must "absolutely break down," I leave the present unanswerable demonstration for the reader's reflection.

Now, as the boa-constrictor, with its aborted leg-bones beneath the skin, resembles all other serpents except in size, is it not rational and logical to suppose if it was developed from a quadruped that all the other families of snakes came in the same

manner? If so, why is it that in the hundreds of species of snakes, large and small, not one can be found except this boa-constrictor having these rudimentary leg-bones hidden beneath the skin? Mr. Darwin distinctly admits, as quoted at the commencement of the chapter, that these rudimentary leg-bones are confined exclusively to the boa family, and makes this thrust to ridicule the idea that this snake should have been thus created for symmetry and to maintain the harmony of Nature, when no other serpent, large or small, has been provided with this mark of symmetry? However trenchant this weapon may appear used against those who hold to this "symmetry" solution, I fear Mr. Darwin will find it a little sword which cuts both ways before he is through with it.

If snakes descended from quadrupeds, no evolutionist can assign a particle of reason, in science or philosophy, why the boa-constrictor should be the only one which retains this connecting link between the form of the serpent and that of the quadrupedal ancestors. As the smaller snakes have necessarily more recently branched off from such ancestral form, they have had less time to retrograde, and therefore by all means should have much more clearly defined rudiments of legs than their older cousin the boa! To say that one snake developed (!) downward from the quadruped and that all the other species of snakes, appearing exactly the same except in size, developed upward from the fish, would be an absurdity too preposterous to palm off on an ignoramus as a zoological joke. It is clearly evident, therefore, that many of the smaller snakes should not only have rudimentary leg-bones the same as the boa, but some of the later developments from quadrupeds should have legs partly useful or in various transitional stages of retrogression,—some, in fact, but just commencing to be aborted, others in a more advanced stage of atrophy, and so on down to the boa's "little bones"!

The ordinary intuition of a scientific student, if not blinded by the insane hypotheses of evolution, such as these rudimentary arguments, would at once lead him to scout the idea that one snake only retrograded from quadrupeds while all the others developed from the fish. He would logically come to the conclusion that any other explanation, however unsatisfactory, would be preferable to this utterly self-stultifying assumption, which makes the retrogression of the boa contradict every possible conception or definition of evolution, such as development, progression, or survival of the fittest. My hypothesis fully and satisfactorily explains these rudiments of legs in the boa alone, while this boasted theory of evolution—the only key to unlock the mystery of rudimentary organs—does not pretend to give even the shadow of a reason why the giant boa should alone of all the snakes show rudiments of legs.

The same thing is true of the whale tribe, which alone of all the fish-mammals have these rudimentary leg-bones beneath the skin, while the dugong, grampus, lamantin, manatus, porpoise, dolphin, &c., all fish-mammals, are destitute of such rudiments. Mr. Darwin remarks:—

"One of the most remarkable peculiarities in the existing dugong and lamantin is the entire absence of hind limbs, *without even a rudiment being left.*" —*Origin of Species*, p. 302.

When it is understood that evolutionists hold that whales and all fish-mammals were alike degraded from land quadrupeds and hoofed animals to their present deteriorated condition, we can comprehend Mr. Darwin's remark above—"*without even a rudiment being left.*" Professor Haeckel says:—

"It is probable that the remarkable legion of *whales* (Cetacea) *originated out of hoofed animals,*

which accustomed themselves exclusively to an aquatic life, *and thereby became transformed into the shape of fish.*"—*History of Creation*, v. ii., p. 251.

Evolutionists seem to claim the right to teach anything, however absurd, in order to explain the difficulties met with in defending evolution, and then expect people to quit thinking, and passively subscribe to it as "science." Thus, with all the apparent nonchalance imaginable, they would have us believe that natural selection spent a hundred million years in evolving a fish into a bull, horse, elk, or some other "hoofed animal," and then spent another hundred million years in degrading it back "into the shape of a fish," leaving only the rudimentary leg-bones and incisors found in the embryo to prove its remarkable history! Yet they take no account of the fact that such *retrogression* from the land quadruped back into the fish is the very opposite of evolution—a transformation from the "complex" and "heterogeneous" back into the "simple" and "homogeneous." If this going backward from a hoofed animal down to the fish is not the very opposite of all ideas of evolution, then the development of the horse out of a fish in the first place, as all writers on the subject teach, can not be evolution at all, thus overthrowing the whole Darwinian theory at a blow! Will some one of these revolutionary evolutionists tell us which one is the evolution?—the going upward or the going downward?—the going forward into the "complex," or the returning backward into the "simple"?—the becoming "heterogeneous" by a hundred million years of variations and "progress" from the mollusk through the fish toward the hoofed animal, or the change to the "homogeneous" through the fish back again toward the mollusk? Assuredly both can not be *evolution!* Again, I ask, which of these is the evolution and the development?

If a hoofed animal can by evolution be degraded into a fish, may not the fish be degraded into a mollusk, and it still be called "development"? Does my evolutionary friend reply that the whale, dugong, lamantin, &c., are not fishes but *mammals*, and that there is no evidence that a quadruped could be degraded into a real fish? But Professor Haeckel says, as recently quoted: "The same thing occurs in *many genuine fishes, in which the hind legs have in like manner been lost.*" If, therefore, "genuine fishes" can be transformed by *development* and *evolution* from a complex highly organized quadruped, what hinders them from continuing on in this downward course of *development* to those "primeval parents of all other organisms"—the original *moneron?* If this is possible (and it surely is, if there is any truth in this kind of back-action evolution and development taught by Darwin and Haeckel), then how do evolutionists know that the primal miraculously created *larva* of Darwin and spontaneously generated *moneron* of Haeckel, were not actually developed from ancient fishes and hoofed animals which lived in the pre-Laurentian period, but whose paleontologic remains have never yet been discovered, or by age have disappeared from the geologic record?

If species can develop downward as well as upward, backward as well as forward, as we see by this accommodating kind of evolution taught by these great naturalists, —if a quadruped can change into a fish and a fish into a mollusk, and so on down, —then there may be deposits far below the lowest Silurian strata containing paleontologic remains of fishes, reptiles, birds, mammals, and even monkeys and men,—which, by this novel kind of evolution, in the course of ages developed downward finally into the moneron and larva, when Darwin's present system of evolution com-

mences! When this pre-Silurian deposit shall have been found, if not too old, Mr. Darwin will be astonished to find petrifactions of hoofed animals which had changed into fish, and finally into "those few simple beings," where his *evolution the other way* first began. He has by no means a sure thing on the geologic record, if his logic about rudimentary organs is worth a sou. At the same time I see no difficulty in him and Haeckel, by carrying out their logic legitimately, staving off the annoying problems of creation and spontaneous generation indefinitely, by simply assuming the earth to be eternal! It would then only require them to keep up this battledore and shuttlecock play of evolution developing a species first upward and then downward, first forward and then backward; first putting legs on an animal, making it a cow; then taking them off, making it a fish; and it would not require half as much stretch of fancy to suppose this see-saw evolution going on from eternity, after the logic is once admitted, as for a living creature to *make itself* by coming into existence through spontaneous generation, as supposed by Professor Haeckel.

Further, if Mr. Darwin's theory be true, the dugong and lamantin have been evidently much more recently degraded from hoofed animals to the life of the fish than have the whale species proper. This is proved from the fact that the whale is vastly larger; and, in the second place, that while the whale is carniverous, having changed its mode of living entirely, the dugong and lamantin continue herbiverous, or subsist on herbage along the shores. Now, would not ordinary reason and respectable science teach us that the more recently transformed herbiverous dugong and lamantin should still have rudimentary legs and embryonic incisors, if such rudiments originated as evolution teaches? Mr. Darwin, as just quoted, expresses surprise that not even a rudiment of legs is "left" in these herbiverous fish-mammals! He never thinks of the possible fact that they never had any legs, that the whale and boa-constrictor never had any either, and that this whole theory of degradation from hoofed animals is a bald fiction! It is a complete mystery to him, unless the whale got its rudimentary legs by being degraded from the ox or some other hoofed beast; and if it was so degraded, then the other fish-mammals (dugong and lamantin) must have been also. But the puzzle then comes up in Mr. Darwin's mind, why do they not show the same rudiments as the much more anciently developed whale? In fact, the whole matter of rudimentary organs, which evolution boasts of making as clear as crystal through descent by transmutation, turns out to be a confounded muddle which even Darwin himself does not pretend to understand. No evolutionist, in fact, can form the slightest idea why the older species of whales, degraded from hoofed animals, should retain rudimentary leg-bones, while the more recent degradation in dugongs, which have not had time to change their habits but still eat grass, have not a vestige of the former legs and incisors of their ancestors! My hypothesis, which will be soon introduced, will explain it fully, without resorting to any such scientific nonsense as working a hundred million years to convert a fish into a horse and then a hundred million years longer to convert the same horse back into a fish!

But Darwin and Haeckel also refer, in the passages quoted, to our common bovine ruminants, such as the cow, which are devoid of upper front teeth, and make a strong point on these rudimentary incisors found in the embryonic calf which disappear at or before birth. They ask, triumphantly

what could possibly cause these rudimentary teeth in the front upper jaw of the embryo where teeth are entirely absent in the adult, unless the cow is the lineal descendant of some ancient species of hoofed quadrupeds which had a full set of incisors above and below?

This, at first sight, seems a real puzzle; and it has hitherto turned out to be such a genuine scientific conundrum that the whole world, judging from its silence, has given it up. No one pretends to assign any kind of a natural or scientific reason, plausible or improbable, save the one here given by evolution, namely, descent from an ancient species of animals having teeth complete. Does this answer meet the case? I will now show, from several weighty considerations, that this phenomenon has and can have nothing whatever to do with descent by transmutation from ancestors with teeth complete, after which I will gradually but surely develop the hypothesis which will scientifically and rationally explain it and all the other rudimentary problems under discussion.

As we saw in the argument on reversionary action, in the preceding chapter, that no development of a long-lost structure is even claimed by Mr. Darwin to occur in descendants only through a small remnant of ancestral blood or corporeal substance remaining in the reverting organism, I need only remind the reader that the arguments in that case are clearly applicable to these rudimentary embryonic teeth in calves, since they are as much *reversions*, in every sense of the word, as they are rudimentary organs, if they are the reproduction of long-lost ancestral characters, as claimed.

The reader will distinctly remember, from the table there given, that the enormous dilution of ancestral blood after only *one hundred* generations, if such blood continues at all from one generation to another, was sufficient to prove the utter impossibility of such reversions being caused, as evolutionists assume, through physical descent from other organic and ancestral forms. He will also remember that a final scientific demonstration was given, showing the absolute impossibility of reversions being caused by physical descent at all,—since, if any corporeal atoms, such as blood, do descend with the child from the parents, such physical substance is utterly obliterated and substituted by new materials in a few years after birth, thus cutting off all physical connection between children and parents even before such offspring arrive at maturity; and as evolutionists (and I may add physiologists) do not believe in or recognize any other substantial organism existing within or forming the identity of a living creature, save the corporeal blood and structure, it was declared and is still declared an unequivocal scientific demonstration that no such thing as a reversion could take place, according to evolution, even as far back as to the second link in the ancestral chain.

This, therefore, demonstrably proves that the teeth in the embryonic calf can not be produced by physical descent from some ancient ancestor of the cow having teeth complete, since she can not by any possibility retain an atom of such ancestral blood or corporeal structure.

I might safely leave these rudimentary problems here as completely wrenched from the grasp of evolution, but I propose to go further. If the cow or the bovine genus ever had upper incisors, what could have possibly caused their loss? Not the fact of such incisors having become useless, for their absence has caused many a bovine animal to lose its life by being unable thereby to bite off heavy twigs in browsing, to gnaw the bark from saplings, or to crop the stunted grass, which a sheep,

with full incisors, would grow fat upon. Such incisors, if they ever existed in that species or in their lineal progenitors, could not have been lost by natural selection, because Mr. Darwin teaches, in a score of places, in the most unequivocal language, that natural selection can only act for the good of each species, as the very phrase "survival of the fittest" implies. I will quote here a few additional passages, which will give, however, but a specimen of his teaching on this point. He says:—

"Natural selection acts through one form *having some advantage over other forms in the struggle for existence.*"

"Natural selection acts exclusively through the preservation of *profitable modifications of structure.*"

"If any one varies ever so little either in habits or structure, *and thus gains an advantage over* some other inhabitant of the same country, *it will seize on the place of that inhabitant.*"

"Natural selection acts exclusively by the preservation of *variations which are advantageous.*"

"Only those variations which are in *some way profitable* will be *preserved* or *naturally selected.*"

"Several writers have misapprehended or objected to the term natural selection. Some have even imagined that natural selection *induces variability*, whereas it implies only the preservation of *such variations as arise and are beneficial to the being* under its conditions of life."

"This preservation of *favorable individual differences and variations* and the *destruction of those which are injurious* [like a toothless upper jaw] I have called natural selection or the *survival of the fittest.*"

"Natural selection acts by *life* and *death*,—by the *survival* of the *fittest*, and by the *destruction* of the *less well-fitted individuals.*"

"Individuals having any advantage, however slight, over others, would have the best chance of *surviving* and of propagating their kind. On the other hand we may feel sure that *any variation in the least degree injurious* [such as a toothless upper jaw in a calf occurring in a species with full sets of incisors] *would be rigidly destroyed.*"—DARWIN, *Origin of Species*, pp. 63, 90, 96, 143, 156. *Animals and Plants*, vol. i., pp. 18, 19.

Now, as natural selection can act only for the good of a species, and as survival of the fittest will invariably preserve the best-adapted offspring which may arise in a species, while those which chance to vary unfavorably will be "*rigidly destroyed*," the common intelligence of every reader will show him that had an ancient calf been born without upper teeth when the whole bovine tribe had complete upper and lower incisors, natural selection and survival of the fittest would at once have rejected such a defective specimen as unfit to survive, the same as if it had been born with but three legs; and instead of having become the founder and head of a new genus, which, from superiority, would lead to the extermination of the parents with their full sets of teeth, such an unfortunate abnormity would have been rejected at once, and left to die under the pitiless contempt of Darwin's great law of natural selection and survival of the fittest; and the toothless jawbone, instead of becoming the ruling genus, would never have again been heard of unless a similar freak of Nature should have happened to occur,—which would, of course, have shared a similar fate.

It must therefore strike every reader, as the only admissible view to take, that such a monstrosity and comparatively helpless deformity as a *toothless calf*, when the whole tribe to which it belonged had full sets of teeth above and below, would have perished before arriving at maturity or being able to transmit its peculiarity, as among the unfit to survive, if Mr. Darwin's theory contains the least bit of truth in regard to the powers of "natural selection" and "survival of the fittest." May I not therefore assert, without the slightest fear of its ever being successfully contradicted, that such a deformity could not have been preserved under survival of the fittest, occurring, as it must have done, as a manifest deterioration of the race, if there is a grain of meaning in the universal definition of natural selection given by evolutionists?

Hence, as here is one clear instance of a species which natural selection and survival of the fittest could not have possibly produced, since they work exactly in the opposite direction, evolution is not only overthrown by its own argument, but we have an undeniable demonstration of at least one highly organized species having been produced by miraculous creation! As quoted a few pages back, Mr. Darwin himself agrees that if it can be shown that any "complex organ" exists which could not have been produced by natural selection through the accumulation of slight modifications, it would absolutely break down his theory, as such an organ must necessarily have come by special or miraculous creation! Since, therefore, evolutionists admit, in this rudimentary argument, that the bovine genus, with all its "complex organs," could only have sprung from a completely toothed race of animals, and as I have conclusively demonstrated that it could not have so descended by survival of the fittest, it clearly demonstrates its miraculous origin! Was there ever any thing clearer or more logical than this?

The reader has thus found that my pledge, made a little while ago, to demonstrate the origin of at least one highly organized species by miraculous creation turns out to be no scientific joke, but a clear and unanswerable demonstration, according to this rudimentary position of evolutionists.

I have thus not only broken down Mr. Darwin's theory by "demonstrating" that there is *one* "complex organ" (the extent of his stipulation) which could not "possibly" have been "formed" by natural selection, but that there is a whole animal with all its organs, and an entire genus of these animals, now existing, which, if there is the least consistency in his definitions, could not "possibly" have been formed by evolution or natural selection, because evolution, Mr. Spencer tells us, can only develop from the simple to the complex and from the homogeneous to the heterogeneous, while natural selection can only preserve the fittest. I appeal to the intelligence of my readers if Mr. Darwin's theory does not therefore "*absolutely break down*," according to his own explicit agreement? But as I shall have occasion to recur to this in a future chapter, with even more fatal effects, if anything, I will leave it for the present just where it is, with the theory of modern evolution again fallen to the ground, by this unfortunate but clear stipulation of its author and chief exponent.

It will be remembered, as I showed at the beginning of this chapter, that if the miraculous creation of a species better corresponded with all the facts, phenomena, and circumstances involved, than any other hypothesis brought to bear on the question, then the miraculous view of the case would be inevitably the scientific view. No man can dispute this position, if he pays the least regard to the true signification of the word "science," as given by Professor Huxley and Mr. Spencer. Further, as it is clearly established by unquestioned authorities (Darwin, Huxley, and Spencer,) that all "evolution," without exception, and all "development," must "tend to *progress* toward *perfection*," is from the *homogeneous* to the *heterogeneous*, from the *simple* to the *complex*, from the *few parts* to the *multiplicity of parts*,—it becomes a clear demonstration, as just intimated, that the cow could never have lost her upper teeth by evolution or development, since the destruction of such organs is exactly the reverse of evolution in every possible meaning of development, natural selection, or survival of the fittest! While

evolution is toward the *multiplicity of parts* or heterogeneity, the destruction of these six or eight teeth would have been directly toward uniorganism or homogeneity. While the loss of these incisors is directly toward the indefinite, all evolution and development, Spencer says, is exactly the other way, or toward the definite. While the destruction or the taking away from the cow of a number of her important and distinct organs is a direct move from the complex toward the simple, all evolution, says this greatest authority, and all development, is right the other way, or from the simple to the complex. So self-evident a truism, and one so well understood and defined, can not and will not be called in question by any candid reader.

Then, it becomes settled to actual demonstration that as natural selection, survival of the fittest, evolution, development, or whatever word you please to employ, could not have produced this specific structure from a genus having perfect teeth, since they all operate exactly in the opposite direction, I have therefore redeemed my promise and demonstrated scientifically, and by the testimony of evolutionists themselves, that the bovine genus originated by miraculous creation! Advocates of evolution have no conceivable way of evading this dilemma, except to abandon their position and frankly admit that this cow did not descend from a species having full sets of teeth above and below, and in so doing they hopelessly give up the rudimentary argument; for, if these incisors found in the embryonic calf do not come through descent by transmutation, then the bottom falls out of the theory of modern evolution, since the whole explanation of Darwin and Haeckel is a self-confessed scientific fallacy. Which horn of this inevitable dilemma they will accept remains for evolutionists to determine. There is surely no escape from both, since it is either the miraculous origin of the species or the abandonment of the rudimentary problem!

But I ask no admissions, nor concessions, nor compromises, on the part of evolution, to aid the complete overthrow of this rudimentary argument, and to turn it fatally against every principle involved in Mr. Darwin's law of natural selection. The self-annihilation of so monstrous an absurdity as that the bovine genus lost its upper teeth by development (!) from ancestors having complete sets of teeth in both jaws, becomes apparent as soon as the case is stated, and the more such a scientific and logical incongruity is turned over and looked at the more laughably absurd it becomes. That *evolution*—which means "progress toward perfection," development from the homogeneous to the heterogeneous, and survival of the fittest,—should, as seen in the case of the boa-constrictor and whale, work a million years to produce perfect incisors in the ancestor of the cow, and then turn round and work another million years to take them away and leave the naked gums, is not only destitute of consistency, but is simply ridiculous; and the inculcation of such an absurdity could only be regarded as a genuine travesty on science, had we not the most conclusive evidence that it is seriously advanced by evolutionists as among their very strongest arguments. Accordingly, it turns out to be, with these sage naturalists, all *evolution*, let it go which way it will. It is all *development*, whether it takes a species forward toward the complex and heterogeneous, or backward toward the simple and homogeneous. It is all "progress toward perfection," whether it elevates or degrades the species, whether it gives it an organ or takes it away, without the least regard to its utility or necessity; whether it retrogrades an animal

down toward the mollusk or advances it up toward the quadrumana, it becomes equally "survival of the fittest." Thus, evolution can mean up or down, forward or backward, anything or nothing, whichever will for the time being best subserve the interests of this contradictory system.

If natural selection, or any other known or unknown influence, should take away the cow's *lower* teeth (if it would only leave rudiments in the embryonic calf which might seem to favor evolution), it would be seized upon by these writers and proclaimed as a proof of *development*, without the slightest regard as to what "development" signifies. If some unknown cause should partly abort the cow's lower jaw and take away one half of it, leaving her so she could barely eat grass, it would still be a clear case of *evolution;* and, on the same basis of reasoning, if the cow should finally become acephalous by losing her whole head, if she could only manage somehow to live, it would demonstrate "survival of the fittest," provided a rudimentary head should be found in some embryonic calf!

The truth is, had evolutionists been half as shrewd as they have tried to be, or as they have received credit for being, they would have foreseen this unenviable self-stultification of their theory, and would have cautiously steered clear of the rudimentary argument altogether, and thus have kept out of this inevitable trap of their own setting, which has so clearly arrayed evolution against itself. It seems almost ludicrous that they should thus stake their cause on rudimentary organs, when the moment the trap is sprung on them they are not only caught by the miraculous creation of the bovine genus, which Mr. Darwin says "absolutely" breaks down his theory, but it reverses and turns topsy-turvy everything in the shape of evolution, natural selection, and survival of the fittest, leaving the entire system of development an absurd mass of contradictions, all for the sake of a few rudimentary teeth in an embryonic calf!

Had this author of modern evolution possessed with his other knowledge a little ordinary business talent and shrewdness, he would have given special attention to the bovine genus, particularly on account of this apparently monstrous defect of a toothless upper jaw; and, instead of stultifying and absolutely overthrowing the theory of descent, by proving, as he tried to do, that the species had retrograded from ancestors having perfect teeth, and thus *developed backward* by becoming *toothless*, he should never so much as have hinted "rudimentary organs," and thus let slip one of his best arguments, but should have gone to work in a quiet way to prove that these embryonic teeth in the calf were a direct proof of evolution, development, and approaching transmutation.

It would have been easy to assume that the cow had descended from some toothless race of animals, since which she had developed her molars and her lower incisors, and would, in the course of time, no doubt possess complete sets of teeth above as well as below; and, as a proof of such a prospective transmutation, could have triumphantly referred to the embryonic incisors in the upper jaw of the calf, showing that the cow was still in the hands of natural selection, and that by survival of the fittest the teeth thus foreshadowed in the embryo would in time become fully developed! Instead of this brilliant piece of evolutionary engineering and transmutation tactics, this deliberate blunderer failed to see the point of advantage he might make, but fastened upon the embryonic incisors in the upper jaw of the calf as rudimentary organs, and as a direct proof that the whole evolution hypothesis was an

absurdity, since the cow must have *retrograded* from ancestors having complete sets of teeth, thus innocently overthrowing the very idea of evolution, development, or survival of the fittest, as an ordinary schoolboy might have told him,—since such deterioration necessarily signifies exactly the opposite of this terminology.

How beautifully and irresistibly also could he have utilized the little leg-bones in the body of the boa-constrictor as a proof that quadrupeds had developed from legless reptiles, and would no doubt do so again! For here is the largest and reasonably the oldest serpent, he could have logically urged, just beginning to show signs of developing hind legs,—which, by survival of the fittest, would in time come through the skin and differentiate into feet and toes! It is difficult at present, even with a good deal of reflection, to see just how such an argument would have to be met. But, instead of taking advantage of such a fortunate circumstance, Mr. Darwin unaccountably throws away the opportunity, proclaims these little leg-bones in the giant boa as aborted or "rudimentary organs," thus using them as conclusive proof that this serpent had once been a quadruped, and that its legs, which could never have been otherwise than useful, had been atrophied and taken away by *evolution*, *development*, and *survival of the fittest!*—while at the same time declaring those words to mean exactly the opposite!

Is it not clearly evident and natural, if all quadrupeds have been developed from legless reptiles and fishes, as evolution teaches, that some instances of partly developed legs should be found in some of these legless species? That such a commencement of legs in the form of "little bones" beneath the skin can not be found even once among the countless species of legless fishes and reptiles would seem to be a direct proof that no such development of quadrupedal species from legless animals ever took place. We are forced to this conclusion by evolutionists themselves; for the moment they find in the boa-constrictor little leg-bones beneath the skin indicating such incipient evolution, instead of shrewdly claiming them as the important connecting link, and the prophecy of transmutation,—the orderly progression toward future legs,—these writers demonstrate their own assinine descent by coolly rejecting the most important proof of transmutation ever found in natural history, by assuming these little bones to be the remnants of lost legs which had once been perfectly differentiated,—thus turning the whole system of development, evolution, natural selection, and survival of the fittest, against itself.

The same thing is equally true of the little leg-bones found in the hinder portion of the body of the whale, and of the teeth found in the Cetacean embryo. How provokingly could Professor Haeckel have gratified his inclination had he possessed even the sagacity of his near relative the chimpanzee; and how triumphantly he could have challenged his opponents to "show a shadow of explanation" of these direct proofs that the whale was gradually approaching quadrupedal form and the anatomy of hoofed animals! But he lacked the business shrewdness to comprehend the situation. He could have argued with a plausibility which he has never begun to show in any of his writings, that the dugong, lamantin, porpoise, and dolphin, though having made sufficient advances from the common fish under natural selection to become *mammals*, and some of them to become *herbiverous* in habit, yet being younger in order of development from genuine fishes than the whale, they had, as Mr. Darwin says, not a vestige of leg-bones

in their bodies; whereas the whale being of earlier origin, or having earlier developed into a mammal, had made greater progress toward quadrupedal anatomy, and consequently had already developed permanent leg-bones in the hinder portions of the body, and even already showed the teeth of hoofed animals beginning to develop in the embryo! I assert that no argument half so plausible or puzzling in favor of the theory of development as this would have been, can be found anywhere in the writings of Mr. Darwin or any other advocate of evolution. In fact, the very strongest argument ever produced is as nothing compared to this. Yet, astonishing as it seems, these writers have all lacked the genius necessary to the emergencies of their difficult position; and, instead of utilizing these little leg-bones and embryonic teeth in the whale as a proof of progressive development toward higher mammiferous forms of being, they have quietly assisted evolution in becoming a scientific *felo de se*. They have, as before shown, assumed the suicidal position that after evolution had wrought through millions of years to develop a hoofed quadruped from the fish, the mollusk, and the polyp, or sponge, it had taken the back track, and had already reduced it to the form of a fish, and was in a fair way of retrograding it still lower to an actual fish, then to an oyster, and finally back to a mammoth *moneron!*

The true way to meet evolution, the reader will see, is to show exactly what it is doing for itself, and how successfully its advocates are succeeding in overturning their arguments in favor of the theory as fast as they can build them up. There can be no clearer proof furnished in refutation of any theory than its own utter want of consistency, especially when it is compelled, in order to account for a phenomenon, to stultify and repudiate its own terminology and reverse the entire catalogue of its own established definitions to meet emergencies.

Had Mr. Darwin consulted the writer when he was about developing his rudimentary argument on the bovine toothless upper jaw, for example, and the embryonic incisors found in the calf, he would surely have been persuaded to change his tactics if he had the least regard for his own definitions of evolution, development, natural selection, or survival of the fittest. I would have modestly suggested that the cow was a peculiar instance of "lateral development," if not from the original comb-medusa at least a lineal descendant of the soft-shell crab, with her horns probably derived in passing through the form of the original toothless catfish. There would then be no difficulty in securing her connection with the order of hoofed quadrupeds by supposing the line to pass through some primeval edentate species of mammal which must have been completely toothless, since its descendants are almost destitute of teeth to the present day, while some ancient sloth could easily be shown to have had hoofs by one of Prof. Haeckel's "monographs." How naturally and consistently with the progressive meaning of "development" and "evolution" would these facts present themselves to the reader, and how clearly would they harmonize with the present condition of the cow's teeth, so unlike those of all other animals; and what a splendid assumption in favor of Darwinism that the cow has probably developed her lower teeth complete, and her molars in the upper jaw, since she branched off from the edentata, and must no doubt in a short time—say a couple of million years—have also a full set of upper incisors, as is clearly indicated by the presence of such teeth in the embryonic calf! But instead of such a "systematic survey," which

would have kept clear of teeth all the way up except as they were gradually and consistently developed, Mr. Darwin, like a scientific lunatic, reversed the "monograph," gave the cow a full set of teeth by natural selection preserving from age to age "numerous slight successive modifications," and then put some kind of an unheard-of back-action process of evolution to work at her jaw taking them away!

I have before shown, I think to the satisfaction of the reader, that upper front teeth would have always been useful and would even now be of great service to the cow; and that therefore natural selection, which acts only for the good of a species, could not have aborted them. I now wish to say that there is only one way in Nature by which any organ which once was useful can possibly become aborted or atrophied, unless by some accidental physical injury (which would be confined to the individual thus injured), and that is by the owner of such organ *ceasing entirely and absolutely* to use it for a long interval of time. If the same conditions, which might thus entirely prevent the use of the organ, should extend to all the offspring, the atrophy would be inherited, and become more and more marked each generation, till at length the function might cease, if even the form of the organ itself should remain. By the same law an organ will increase in capacity and strength by extra use if exercised within temperate restrictions. It is this law of absolute disuse which has made cave-rats and fishes sightless, though the atrophied organ is still present, showing that such rats and fishes once had perfect eyes, but by being confined within these regions of rayless darkness for many generations, through, at present, unknown causes, and having no use for the organs of vision, they finally lost their function. This may also and doubtless does apply to the wings of certain birds, which, from being so situated for many generations as not to be required to fly, the wings have become finally so far aborted as not to be available for flight. Other cases may come under this head. But the cow's teeth can never rank in this class, nor can any other organ while used at all. She has always been compelled to use her teeth, and that constantly, if she ever had them, or she would have starved, since she could not have used her mouth at all without using her teeth. Thus, the only possible means or conditions for the degeneracy and loss of these incisors have always been absent, and are found to be inapplicable in the very nature of the case to that class of organs; and hence, no argument based on atrophy from disuse has the least application to the cow, while all arguments and considerations conspire to show that she never descended from a perfectly toothed species, but must have originated by special creation, according to the very mode of reasoning by which evolutionists have sought to prove the contrary!

I have thus redeemed my first pledge, given at the opening of this chapter, in which I promised to show by unanswerable arguments that rudimentary organs, so far from supporting evolution or proving descent by transmutation, were absolutely and directly opposed to such an hypothesis. It has been shown, clearly I trust, that the very meaning of "evolution" and "development," according to all authority and all ideas of fitness, is distinctly opposed to the destruction of any useful organ, *or any organ whatever while used in the slightest degree*, since it would be a retrograde movement. Had there been, for example, the least glimmer of light in the deep recesses of the Kentucky Mammoth Cave, the rats and fishes confined there, instead of becoming sightless, would have had

their visual sense improved and their eyes developed to suit these almost rayless regions.

The unprehensile tails of all animals are about the least useful organs which we can suppose to exist, yet from the remotest epoch of mammal life on this earth their almost infinitesimal amount of employment (wagging) has been sufficient to prevent their loss or even reduction by atrophy. Is it at all supposable, then, that the fully differentiated legs of a quadruped, constantly and unavoidably in use, such as those of a whale, would become completely aborted by the animal having accustomed itself to an "aquatic life," and thus have changed a hoofed quadruped into a fish, as these writers teach? The thing must be absurd on its face, if the almost useless tails of animals can thus retain their full perfection since the very dawn of mammal life. Besides, no aquatic habit could make any animal suspend the use of its legs and feet, as witness the hippopotamus, beaver, otter, muskrat, alligator, &c. All such animals use their legs and feet to swim with, and to walk and run with when on shore. The legs and feet of all these creatures named are as perfect now as those of any exclusively land animals, though accustomed to an "aquatic life" since perhaps their first formation. Even supposing it possible for a hoofed animal to assume the custom of going into the water for food, no man can for one moment suppose it to cease using its legs. They would rather be used with greater exertion for the purpose of swimming, and really receive a double share of exercise, as they would be the only means of locomotion either on the land or in the water. Hence, the wholly foundationless assumption that because a quadruped becomes accustomed to an aquatic life it must cease using its legs, ultimately lose them, and be changed into a fish!

I shall regard, therefore, the Darwinian hypothesis, that rudimentary organs are the aborted remains of the same organs in a normal and useful form in some remote ancestors, caused by evolution or development, as wholly exploded by the arguments and considerations here presented.

This brings me to the second part of the discussion; and that is, to frame an hypothesis which will explain the true cause of these so-called rudimentary organs. Is it possible to give a scientific reason for the occurrence of teeth in the front upper jaws of embryos of the bovine and whale tribes? Can there be any rational scientific reason given why boa-constrictors and whales should have leg-bones in an undeveloped condition beneath the skin if such bones do not come by inheritance from remote ancestors which had legs thus indicated, fully developed? I answer, emphatically, there can be such a reason given, and that I will now proceed to develop the hypothesis by which it will be clearly established. But as much preparatory discussion, inquiry, and collection of facts, may be necessary before coming to the direct proof and the record which will form the culmination of the hypothesis, I will have to be indulged for a few pages in such preparatory and preliminary work.

Though the hypothesis is new, its cornerstone is nevertheless the same broad and already demonstrated principle so often illustrated in the preceding chapter, and on which my provisional hypothesis was based for the explanation of the problems of embryology and reversionary action, namely, the physiological and psychical fact that within each living creature, in addition to the corporeal structure composed of blood, bone, muscle, &c., there exists its counterpart—an incorporeal vital and mental organism constituting the real and essential being; and that this interior vital

and invisible organism, though wholly intangible, is as truly *substantial* and *entitative* as are the grossest atoms of which the physical frame is composed.

I flatter myself that the reader who has carefully read the arguments in the preceding chapter by which such an incorporeal vital and mental organism was demonstrated, already admits the truth of that position. I will here repeat that it is only by such an inter-related and co-ordinated organism, existing within and vitalizing the corporeal structure, that any of the phenomena of inheritance, propagation, variation, development, growth, reproduction of parts and healing of wounds, can take place in a living creature, whether such creature be high or low in the scale of being.

A single phenomenon may here be named in addition to those to which I have already referred, completely corroborating this hypothesis of a vital and mental organism residing within each physical structure as its counterpart and visible expression, while the wonderful fact of sensation will be thus seen to depend wholly on this essential entity, which constitutes the real identity of every living creature.

I refer to the remarkable fact that amputated limbs of animals have been frequently known to reproduce themselves from the stump by a process of mysterious vital action hitherto regarded by physiologists as wholly inexplicable. It is simply impossible, on the physical or purely monistic view of organic beings, to tell why the segments of a polyp will each reproduce a perfect being, or why the leg of a salamander when cut off will be reproduced with the foot and toes in every respect perfect. Cases are recorded in which a supernumerary finger has been amputated from a child's hand, which, in time, would be reproduced, with the nail and joints complete. Who can give an explanation of these astonishing phenomena based on the purely physical hypothesis of organic being? Why should not a toe have been developed in the place of the child's finger, or another tail in the place of the salamander's amputated leg? No physical view of organism can give the least information on this problem, while I undertake to say that the view here maintained of a vital substantial organism, co-existing within the corporeal as its exact counterpart, is a solution at once conclusive, and as simple as it is satisfactory.

According to this hypothesis, there is a vital, intangible, but substantial *salamander*, in perfect form and outline, embraced within the physical structure of that reptile. This invisible organism, so far as its vital characteristics are concerned, consists of the pure substance of life itself, and by means of its correlation in all its parts with the corresponding parts of the corporeal body, thus constituting an exact organic homologue, all the phenomena of growth, sensation, reproduction of parts, and healing of wounds, must, as stated, necessarily result. To the mental eye, the reproduction of the salamander's corporeal leg, under the control and direction of the vital leg, is plainly visible.

Could we with our physical eyes see what really exists, namely, the essential leg of that animal still connected with its body, perfect in all its parts—cuticle, joints, muscles, bones, ligaments, nerves, veins, and arteries,—after the physical leg is amputated and destroyed, we would see at once how the corporeal atoms from the body of the salamander through its circulation are built out from the stump into a new leg by following the exact but substantial outline of the vital structure; and how they are thus deposited one by one, each atom in due order, within the exact part to which it belongs, till the whole leg, to the ends

of its very toes, is perfected,—just as a honey-bee builds up its wonderful cell by depositing atom by atom the wax in its exact place to form the ideal geometrical outline.

Without such a vital and substantial leg really remaining connected with this complete vital organism, there would be no guide or outline for the atoms to follow; and it is utterly inconceivable as to how the form of the new leg is preserved by unconscious laws of Nature, except by the direct intervention of a creative mind. Physiologists are obliged, therefore, either to accept my hypothesis as a scientific explanation of the phenomena attending the reproduction of a limb or to have recourse to miraculous intervention, since there is no other conceivable solution.

The same is true of the healing of an ordinary wound. However deep may be a cut in the flesh, the vital or intangible flesh, so to speak, remains uncut, and the work of healing is but the deposition of organic molecules within this vital substance till the wound is filled up.

There is not the least difference between the reproduction of a part, the healing of a wound, and the development of the embryonic being from the ovule. The vital and substantial germ of the embryo must be present before any development can commence. Professor Paget corroborates this when he says:—

"The powers of development from the embryo *are identical* with those exercised for the restoration from injuries."—*Lectures on Pathology*, 1853, p. 152.

Yet, should you ask this great scientist by what means the organic atoms are guided to each particular part, even to the maintenance of their exact shades of color, in the restoration of a salamander's leg, he would be utterly lost, and unable to enlighten you,—since, in common with the entire profession, he has no conception of this dual organic structure of each living creature, so absolutely essential to the solution of the problem.

The reproduction of a part when amputated must depend upon the nature and density of the life-substance constituting the vital organism of the part. But few animals, as observation proves, are able thus to reproduce a lost limb; and but few children would possess that density of vital substance in the hand which would be sufficiently compact to conduct the organic atoms with that force necessary to restore an amputated finger. Yet certain worms have such an intensified life-essence—the *nais*, for example—that they can be cut into many pieces, and each part retain sufficient life-substance to lead to the reproduction of the whole being.

This is explained on the same principle as that a given mass of normal atmosphere may be subdivided into a dozen equal parts and passed into as many different vacuums, each the size of the original mass. It is plain that each vacuum would be *filled* with air, though of but one twelfth its normal density. So a *nais*, if subdivided into a dozen sections, instead of its dense vital organism being cut up into corresponding sections, it would be subdivided by dilution or reduction of density, each segment retaining the complete vital form and outline of the worm, though in a rarefied condition. Still, although thus diluted, the vital form of this creature connected with each section of its physical structure is sufficiently dense to form the conducting medium of the corporeal atoms which are thus guided along the line of the organism, each one taking its place till the corporeal being is perfectly reproduced. No physiologist, anatomist, or naturalist, I again insist, can propose even the shadow of an explanation of this overwhelming problem based on the monistic view of

organic forms of being,—holding, as they all do, that there is nothing substantial but the tangible in a living creature.

It is well known that no two persons are exactly alike as to the facility with which a wound will heal. With some a scarless cicatrice will form almost immediately, while with others a cut with difficulty heals at all. This is generally attributed to the purity or impurity of the blood. Though this may be a partial cause of the difference, it is but a scintilla of the true reason. When physiologists and pathologists shall come to fully comprehend the grand idea involved in the duality of man's organic nature, the science of medicine will have made a long stride in advance of the present standard of scientific knowledge.

I add but one other corroborative class of phenomena to confirm the truth of my hypothesis, on which so much depends, that every living creature possesses a dual organism—a substantial vital and physical structure. This class of phenomena consists in the well known fact that when a human arm or leg is amputated the sufferer distinctly and for a long time afterward feels pains and itching sensations in the fingers or toes of the lost limb. I had an abundant, though unpleasant, opportunity to witness a demonstration of this fact in the case of my own brother, who lost his leg by accident. For months after the amputation he would complain of the terrible itching sensation in his toes, and would even at times involuntarily attempt to place his hand on the lost foot. Little did I think then (over forty years ago) that his actual foot was there to all intents and purposes as much as before the corporeal flesh had disappeared!

This experience is not confined to human sufferers. A dog which had lost its leg has been frequently seen to attempt to lick its absent foot, showing that the true source of all sensation is the vital and mental organism, and that upon this foundation alone are based all the issues of life and all biological phenomena. The destruction of the flesh does not therefore necessarily put an end to the actual identity of the being, the difference between the human and the lower forms of life alone remaining to complete the solution of this beautiful and interesting problem, which I will attempt to give prior to the close of this chapter.

I now return to consider the evidence which will lead directly to the explanation of rudimentary organs, though these digressions are absolutely needful to unfold the many complicated questions involved.

The variations which continually occur in the young of all species of animals, from the human race down, are only explicable by the actual presence of this incorporeal organism as the regnant element in every living creature. There are no two human beings, and there never were two, exactly alike at birth. The same is true of all lower animals. The shepherd knows each one of his thousand sheep by its countenance, while to a stranger they all look alike, owing solely to a want of familiarity with their appearance.

Variation in all organic beings has a law which superinduces it as fixed as that governing the movements of a planet in its orbit; yet to those who only look upon living creatures as merely corporeal beings, with the vital and mental powers as the insubstantial results of certain molecular motions, and thus ignore the dual substantial nature of each organism, the phenomena of variations, monstrosities, inherited transmissions, &c., are a perplexing riddle which casts an impenetrable shadow of the deepest gloom over the smallest biological fact. Such corporeal philosophers have

never broken through the egg-shell of Nature. The movement of a worm confounds them. The growth of a hair or the projection of one of the pseudopodia on the surface of a moneron utterly annihilates their corporeal philosophy. As an illustration of the bewilderment which results from ignoring this intrinsic and essential part of every organic being, look at this confused and heterogeneous mass of contradictory ideas in regard to the probable causes of variations among the offspring of different animals entertained by as great and careful a student of Nature as Mr. Darwin:—

"Our ignorance of the laws of variation is profound. Not in one case out of a hundred can we pretend to assign any reason why this or that form has varied."

"With respect to the *exciting causes* we can only say as when speaking of so-called *spontaneous variations*, that they relate *much more closely* to the *constitution* of the *varying organism* than to the *nature* of the *conditions to which it has been subjected*."

"All such changes of structure, whether extremely slight or strongly marked, which appear among many individuals living together, may be considered as the indefinite *effects of the conditions of life* on each individual organism."

"On the whole Knight's view, that *excess of food* is one of the most *potent causes of variability*, appears, as far as I can judge, *probable*."

"*We know not* what produces the *numberless slight differences* between the individuals of each species, for *reversion* only carries the problem a few steps backward; but each peculiarity must have had its efficient cause."

"These facts are important, from showing, as remarked in a former chapter, that each trifling variation is governed by law, and is determined in a *much higher degree* by the *nature of the organization* than by the *nature of the conditions* to which the varying being has been exposed."

"Domesticated animals *vary* more than those in a state of nature, and this is apparently due to the *diversified and changing nature of the conditions* to which they have been subjected."

"Of all the *causes* which *induce* variability *excess of food*, whether or not changed in nature, *is probably the most powerful*."

"We are profoundly ignorant of the *cause* of each sudden and apparently *spontaneous variation*. . . . What first *caused these slight differences can not be explained any more than why one man has a long nose and another a short one*."

"Variability often depends, as I have attempted to show, on the reproductive organs *being injuriously affected by changed conditions*."—DARWIN, *Origin of Species*, pp. 6, 131.—*Descent of Man*, pp. 28, 61, 62.—*Animals and Plants*, vol. i., pp. 250, 265; vol. ii., pp. 310, 311, 421, 471.

There can be no better exhibit than this of the real state of confusion existing in the minds of all naturalists and physiologists who take into view only the *physical* structure of a living creature when trying to account for this universally admitted fact that no two living creatures are in all respects alike at birth. The truth is, and future physiology will be compelled to recognize it, that the true and only causes of these so-called spontaneous variations in the offspring of all species, are the constantly varying mental and vital perturbations of the mother as the results of the diversified shocks and impressions of one kind and another made upon her mind, and ultimately their re-action from the incorporeal structure of the mother upon the corporeal organism of the embryonic being.

The world is full of facts confirming and illustrating this great truth, though they have never been comprehended even by the physiological profession, simply because these great minds apparently were unable to grasp the dual nature of a living creature or to understand that the vital and mental organism was as truly and really substantial as was the blood, bone, or muscle.

Had Mr. Darwin recognized this law of mental perturbations as the true and sole cause of spontaneous variations in the young of animal species, he would not have been led into the manifest self-con-

tradictions on the subject, of which his writings are full, and of which I have quoted but a sample.

Among these mysterious phenomena of spontaneous variations he names the well known fact that domestic species are much more liable to variations and monstrosities than wild species. How beautifully this is explained by mental perturbations of the mother acting on the vital, mental, and corporeal organism of the embryonic being! Domestic species being under the control of man, and being forced constantly to obey his behests, receive innumerable shocks of body and mind which wild animals are wholly free from. As every coercion of an animal against its will causes a mental perturbation, it is plain to see why domesticated animals are more liable to divergencies of structure than wild ones.

I shall here treat first briefly of human offspring, and the manifest causes which lead to their universal variation from each other, and adduce complete reasons for the truth of the position here assumed, that monstrosities and all minor congenital variations, even to the diversity of features, must be traced to the mental impression received by the mother from some shock of more or less intensity during some impressible period of gestation.

There is, perhaps, not a single reader of this book who is not cognizant of some circumstance which will corroborate this assertion. I have now in my mind six distinct cases which have come under my own personal observation, where the infant was deformed either in mind or body by a shock causing a mental impression on the mother, which she distinctly remembered, not only after the birth of the child, but thought of at the time of the perturbation, even with alarm at its possible consequences,—while no doubt such alarm, adding to the mental impression, helped to bring about the result.

Can physiologists begin to give a reason, based on the idea that corporeal organism is the only substantial element involved in a mother's being, why the mere sight at a distance of a monstrous or deformed object, can, through the incorporeal sense of vision, without physical contact, convey such monstrous form and mark its physical impress on the embryo? There surely can be only her mental impression to do it; and if the incorporeal sense of vision taking hold of the monstrous object and the mind of the mother be not substantial entities, however much attenuated, then the impress of that deformity was conveyed through absolutely *nothing* to the embryonic structure, which is a clear absurdity.

I lay down the position, without the fear of it ever being successfully met, that no substantial effect can be produced on any object without an absolute substance of some kind connecting the cause with the effect. This belief is what led me to assume, in an early chapter of this book, that gravitation must of necessity be a *substance* instead of a so-called almost meaningless *force*, since it acts upon physical objects at a distance and causes physical effects. I argued the same of magnetic currents, which pass through imporous bodies and seize and manipulate bars of iron. I was thus led to embrace all the forces and so-called modes of motion, such as sound, electricity, heat, and light, within the scope of this broad principle that whatever is, exists, or can be thought of, or which forms the basis of a concept, is substantial,—which carried me unavoidably to this most important, as I conceive it, principle of philosophy, that life and mind are substantial entities as really and truly as are the most ponderable physical objects, while every step I take in

this physiological and psychical inquiry but confirms my earliest impressions on the subject.

The reader may ask if I regard *motion* as *substance*. I answer, No. It is the name by which we designate the act of a substance changing places. If mind is the result of the motions of molecules in the brain, as scientists teach, then what does this "result" of such molecular movement consist in? If the *motion* itself among the molecules of the brain is the all of mind, then the mind is really and absolutely *nothing* of which thought can conceive, since motion is nothing before an object begins to move, while it is the same *nothing* after the object has moved and stands at rest; and hence, as it is impossible for anything to be produced from nothing, all motions are therefore strictly nonentities, and consequently *mind* is literally *nothing*. The old Undulatory Theory teaches, for example, that *sound* is conveyed by means of air-waves. But what is that thing called *sound* which is "conveyed"? Sound must be a something or it could not be conveyed by air-waves or by anything else. Sound can not be the motion of the air, for then every rapid movement of the air would be heard. In like manner mind is not the motion of molecules of the brain nor any other motion of any other corporeal atoms, but the substantial atoms themselves of an incorporeal mental organism, as absolute in its existence or entity as is that of the physical brain, which is but the visible expression of its invisible throne.

A single case will beautifully illustrate the view of leading physiologists on these questions of abnormal variations in children, and the utter confusion resulting from a want of recognition of this inner organism, which I maintain constitutes the essential nature of every living creature. Mr. Carpenter, perhaps one of the greatest of physiological writers, makes the following statement:—

"Numerous cases were recorded a few years since, in which *malformations* in the infant appeared distinctly traceable to *strong impressions made on the mind of the mother some months previously to parturition*."—*Human Physiology*, p. 991.

While this author records the facts, he nevertheless expresses himself as entirely unable to comprehend how it is possible for such an impression to reach and deform the embryo, since there is no *system of nerves* connecting the mother and the child, but supposes it must be possible for it to be accomplished through the circulation of the blood, though of even this he is in doubt!

Here, then, after recording these cases of monstrosity as having taken place through the *mental impression* of the mother, this great author at once ignores the mind itself as the connecting cause—takes not the slightest notice of the living, thinking part of the mother, as a substantial entity, and the vastly more important portion of her dual organism, which might link the mother and child, but goes at once in search of some physical system of umbilic nerves connecting them; and because he can not find such a system, he is thrown into bewildering confusion, for which the circulation of the blood of the mother affords but a poor relief, since how did this mental impression fasten itself upon the blood? Now, all this goes to show us the inexplicable mystery in which physiological phenomena are involved, in the minds of the greatest authors, by a non-recognition of the sublime fundamental truth I have been trying to impress upon the reader. It demonstrates the fact that the mind itself and the vital incorporeal essence of the mother, which pervade her entire structure as a super-material substance, the same as incorporeal electricity might be supposed to

pervade her, are the true and only means by which the impression of the monstrous, frightful object, though even seen at a distance, was conveyed to the plastic form of the embryonic being. I verily believe that until this great underlying truth shall be duly comprehended and recognized, physiologists, with all their laborious and histologic researches, even with the most powerful microscopes to aid them, will never penetrate even the cuticle of science as regards the true causes of physiological phenomena.

By this hitherto unrecognized principle —and, as I believe, by it alone—that each living creature is formed of a dual substance and organism, half corporeal and half incorporeal,—will all the biological and physiological mysteries involved in the animal economy be ultimately solved. In the light of this elementary truth we can see at once why no two children appear or can appear alike, because it is utterly impossible for any mother to pass during gestation through the same number, kind, and intensity of mental shocks and vital perturbations. The law of chances mathematically forbids it. Applying this principle to the lower animals (and I will prove positively after a little that they are controlled by the same law), it becomes at once plain why no two sheep, out of the almost countless millions now on earth are alike, and why in a thousand million births no two lambs could look alike, even if the ewes were fed on exactly the same kind of food and subjected as nearly as possible to the same environments, since the same vital and mental impressions could not be experienced by any two mothers in all respects alike; though the nearer the mental and vital shocks or perturbations could come to *nil* the nearer any particular lamb would be an exact cross, partaking equally the resemblance of father and mother, while lambs so produced from the same parents from year to year, with the least possible mental and vital perturbations, would no doubt in time come the nearest to perfect resemblance of each other possible to attain in Nature.

How clearly this is illustrated by the well known fact that human *twins* look so much more alike than children of separate births, even by the same parents. They have, as a matter of course, during gestation, received alike the good as well as the ill effects of the same mental perturbations and vital shocks of the mother, and precisely at the same times, which have tended in some cases to produce such perfect resemblance between them as almost to make them indistinguishable. It is perhaps safe to venture the belief, that, but for the differently transmitted impressions from the father upon the two life-germs, which, as I have before assumed, must control the developing embryo, twins would be absolutely and in all cases so much alike as to be indistinguishable.

How beautifully this well known resemblance in twins, which receive necessarily the same impressions at the same time through the mental and vital perturbations of the mother, would have helped Mr. Darwin, had he but thought of it in his great confusion on the question as to what causes variations in children or in the young of the lower animals. He would then not have been apt to teach, as he now does (see page 463), first, that it is owing to the "nature of the *conditions* to which they have been subjected," and then owing "much more closely to the *constitution* of the *varying organism* than to the *nature* of the *conditions* to which it has been subjected"; first, that "*excess of food* is one of the most *potent causes of variability*," and then that "we *know not what produces the numberless slight differences* between the

individuals of each species"; first, that "each trifling variation is *governed* by law, and is *determined* in a *much higher degree by the nature of the organization* than by the *nature of the conditions*," and then that "all such changes of structure . . . *may be considered* as the indefinite effects of the *conditions of life on each individual* organism"; and finally, that "we are *profoundly ignorant* of the cause of each sudden and apparently spontaneous variation"! Surely the attentive reader of Mr. Darwin's works did not require this last sentence. The entire system of modern evolution by natural selection is based by this great author on this very matter of the spontaneous variations among species. If, then, he is "profoundly ignorant," as he confessess himself, on the very foundation of his system, which no one can doubt from the foregoing quotations, how can he be so well informed about the system itself as to assume to overthrow all previous science on the subject? If a mechanic confesses himself "profoundly ignorant" about the foundation of a building, we would hardly be apt to employ him to build us a house. Could Mr. Darwin have laid aside his purely physical ideas of animal organism and inherited transmissions, and have grasped this beautiful thought that mind and life are substantial entities, there would have been no such irreconcilable contradictions in his teaching as to the cause of variations, but rather he might then have boldly enunciated a consistent, clearly defined law and principle, as the basis on which natural selection could build its superstructure of evolution,—unless, as no doubt would have been the case, a true conception of the foundation on which he has built would have prevented him building altogether.

That the mental impression of the mother does actually fasten upon the child through her incorporeal vital organism, whether such impression be in the form of a sudden shock or of a lasting memory, is proved by the well authenticated fact that many times children by a second husband resemble the first much more nearly than they do their real father, alone through the vivid memory of the mother and her appreciation of the long dead but cherished first love. Mr. Darwin admits this, but actually insists, from his purely corporeal ideas of organic beings, that this fact results from the physical impression left upon the mother's organization by the first husband, which will be utterly exploded when I come to apply these facts directly to the hypothesis for which I am now preparing, though the fact is equally well authenticated that many a mother, through the cherished memory of an early love, and who died before marriage, has given to her future children the likeness of the lost one, with whom she had sustained only mental relationship.

No one who has given attention to this subject doubts but that children are frequently marked and even deformed by the longing desire of the mother for some particular object which deeply impressed her thoughts. I could give a list of more than a score of such marks, which have fallen under my own observation, where well defined pictures of fruits, fishes, and other objects, have been imprinted upon various parts of the bodies of children, recognized by the mothers, and the very times and circumstances recollected which produced them. I shall not, however, waste the reader's time in relating instances of this character, supposing that facts so numerous and well known are familiar to almost every one.

Before making the application of these physiological facts to the direct problem in hand, and before showing, as I propose

soon to do, that every circumstance related as occurring among human mothers and offspring are equally liable to take place with lower animals, I wish to briefly carry out an idea suggested in the preceding chapter (page 408, last paragraph), which I promised to elaborate before the close of the volume; and that is, to point out the true philosophical difference between the human vital and mental organism and that of lower animals, as relates to their probable chances for immortality or life beyond the present tangible existence. Although the solution I shall here give is entirely new, so far as I have ever seen published, yet it is so completely in harmony with the tenor of this work as relates to the true law of inheritance and transmission, that the book would be incomplete without the explanation I will now attempt.

There is no person who has arrived at an age of reflection or who has ever philosophized on the vast problem of a future life, or who has pondered on that unspeakable something called the immortality of the soul, who has not been confronted with the puzzling inquiry—"If I am to live after my body dies, why shall not my faithful, intelligent, and confiding dog, live also?" "If the mental powers and vital essence of such an animal, with its memory and loving devotion, can be annihilated or can sink into nonentity at death, what philosophical proof or probable evidence can be adduced to show that man shall live after the death of the body, and retain his personal and conscious identity?"

I am aware that thousands of different books and tens of thousands of sermons have touched upon this problem, and have essayed to give some sort of an answer to these inquiries, though not one of which, as I believe, has been entirely satisfactory to its author. Probably without an exception such solutions have been given from a theological standpoint, employing for the basis of explication the dicta of divine revelation. However clearly such data may establish the line of demarkation between men and the "brutes that perish," or however distinctly they may suggest such a bridgeless hiatus between "the spirit of a man that goeth upward, and the spirit of a beast that goeth downward to the earth," the mind of every writer reverts intuitively to the field of philosophical and scientific research, and anxiously asks for some confirmatory fact or phenomenon which may rationally be construed in the same direction. Are there any such reasonable circumstances to be drawn from the great storehouse of Nature, which, by fair application or explication, may shed light on this cryptic problem? I undertake to give a solution based solely on reason and established facts of science, leaving the theological view exactly where it stands, to be used if need be to re-enforce the explanation I am about to give, or perhaps rather to be re-enforced by it.

In the preceding chapter I undertook to solve the problem (with what success the reader knows) as to the exact scientific difference between *animal instinct* and *human knowledge*. I showed that both were equally knowledge or intelligence, and that both equally depended upon and grew out of a *mental organism* received by offspring at birth as an incorporeal yet substantial legacy transmitted from the parents; and that while the parents among the lower animals had received from the Creative Will originally the power of transferring not only their mental and vital organism, but with it their own practical knowledge, human parents could not transmit a scintilla of their own knowledge, but in lieu of it were given the capability of transferring an unlimited blank capacity for *being taught*, and then in turn *teaching*

their own offspring, neither of which the brute possesses.

These distinctions, fundamentally existing between the human and lower species, I insist, are not mere hypothetical guesses, but are based necessarily on the principles of science as viewed by enlightened reason, since I have abundantly shown from the most demonstrative scientific evidence that there must be within each corporeal organism a substantial entity of being composed of the life and mental powers, and corresponding in every outline with the physical or anatomical structure, or otherwise no such thing as inheritance or the transmission of peculiarities, characters, or diseases, could ever occur between parents and offspring. Neither could such a thing as the healing of a wound or the reproduction of an amputated part occur, as recently illustrated, without the presence of such intangible but substantial organism within every living creature. I challenge the scientific world, and especially the physiological profession, to overthrow that position, as based on the various considerations brought to bear in the preceding chapter (pages 408, 409).

It must not be charged here, because I have based the assumed original stock of knowledge of the primal parents of all animal species on the endowment of the Creative Will, that I start out with a *theological* assumption. It is not theological, but purely philosophical and scientific. I have shown in this chapter that the miraculous creation of a primeval species, if the weight of evidence sustains it, is as much a scientific fact as the development of a tree from an acorn. It hence must follow that the absolute and intelligent existence of such a Creative Will as could form a primal species becomes necessarily a scientific truth, since the reasons are numerous and cogent going to show that by no possibility in philosophy or science could the first specific organisms come into being without such miraculous creation, even if evolution should be admitted as a sufficient cause for all subsequent species. If, however, the first specific forms are thus shown to be necessarily and demonstrably the work of an intelligent Creative Will, and then if evolutionists should fail to give satisfactory evidence that God changed His plan for the origination of subsequent species (as they seem in a fair way of doing), it becomes a demonstrated scientific fact that the primal parents of every organic species were equally the product of the same intelligent Creative Will. It therefore follows, assuming the evolution theory to have signally failed, of which the reader no doubt has by this time become convinced, that I justly and logically base the creation of the primal parents of all the different species, and their endowment with the original stock of knowledge needful to their varied struggles for existence, on the great fundamental scientific truth that such a Creative Will really and absolutely exists.

All this being scientifically and logically premised and deduced, I am now brought face to face with the problem. The first question necessarily arising in attempting a solution is this: If each living creature at birth has a vital and mental organism pervading its physical structure, and as really substantial as the corporeal anatomy, of what is such interior organism composed and whence was it originally derived? It is a universal axiom of science that "from nothing, nothing comes." As this incorporeal organism has been demonstrated to be an entity—a real counterpart of the physical structure, since it is only through it that inheritance can take place and transmissions can occur,—it must, therefore, be a part of some actual substance which had a previous existence; and as

the existence of a God has been scientifically demonstrated, who was capable of producing living organisms out of inorganic matter, such a God therefore must be a substantial and intelligent entity. Just as certain as that our material organism necessarily had to come from a source or fountain of pre-existing matter, just so sure must this mental and vital organism pervading every living creature *have come from a source or fountain of pre-existing mind and life.*

Thus the way is logically made clear for the assumption that the vital and mental organism of each living creature consists of a mere drop from out the fountain of God's own infinite vital and mental substance. To the primal and miraculously created parents of each species the Creative Will must then have transferred an infinitesimal drop of His own being, constituting not only the real entities of these primal parents, but the perpetual specific germ for transmitting the same entity to offspring, and the only part of an organic being not liable to displacement and substitution, as so clearly shown in the preceding chapter, while the primordial stock of knowledge given to the parents of each species, necessary to their primitive conditions of life, was also but a drop out of His own infinite intelligence.

And here, accidentally, we again come back to the starting point—the real, intrinsic, and essential difference between the vital and mental organisms of the human and lower forms of being. From the hints already given, the thoughtful reader must have caught a glimpse of an infinite chasm yawning between the man and even his faithful dog; though its expansion, embracing an eternity of existence and development, may not have been fully comprehended by him thus far. He has only to note the essential constituent element of difference in the vital and mental entities on each side of this hiatus, and it will flash upon him at once as the grandest of biological conceptions. Here it is, in a condensed form. While the lower animals receive at birth their specific stores of knowledge suited to their environment (without the capacity of teaching or being taught, except to a very limited specific extent), thus adapting them exclusively to this single state of existence, the human being receives no knowledge at birth,—not a single idea of inherited intelligence,—but, as before observed, an unlimited blank capacity for being taught, having an interior organism capable of being cultivated and expanded to eternity! This alone constitutes a wall as broad as the earth and as high as the heavens between the man and the brute.

But, as a necessary psychological corollary and scientific outgrowth of this sublime demarkation, lower animals can not have the slightest conception of a future life, since their vital and mental organisms, as well as their specific stores of inherited knowledge, are only suited to and limited within a temporary existence. Hence, a future life of conscious activity, being unanticipated, undesired, and wholly unconceived of, by lower species, would be of not the least advantage even to the most cultivated orang-outang, and would be unappreciated by such creatures even if they had it, since it would be but an eternal sameness without the eternal advances in culture necessary to make it otherwise, of which their very organic natures are wholly insusceptible.

The greatest and most important difference between man and the lower animal, even including the higher apes,—that difference which may be properly called the distinguishing characteristic,—consists in the fact that no animal below man has

or can have a conception of life after death, from the very nature of their instinctive knowledge and the manner of its reception. Whatever other differences may exist, and they are numberless and startling, this is incomparably the most intrinsic and universal.

All this limitation to earthly objects, however, is exactly the reverse with man. With his unlimited blank capacity at birth for receiving instruction, he immediately acquires with his ordinary and rudimental intelligence, even if not specially taught it, a conception of living on forever; and not only such a conception of a future existence, but a desire for and appreciation of such an endless opportunity of acquiring knowledge. There is no reasonable or scientific ground for supposing that a longing anticipation of and a universal aspiration for a life beyond death could have been thus made an indestructible part of man's mental organism were there no such a possibility as a future life in the divine economy of the universe. This blank capacity for unlimited cultivation and eternal advancement in knowledge becomes the guarantee of man's immortality,—while the lower animal, having no such a capacity as a title-deed to a future life, gives back at death the mental and vital drop of its essential entity, which, instead of being annihilated or in any sense lost or blotted out, exists forever,—not as an identity of being, but falls back and is re-absorbed into the great and infinite fountain of life and intelligence from which it originally came as a spark of being,—the same as a drop of water which rises from the sea in the form of vapory mist, and after being carried by clouds to distant lands and caused to descend in rain to water the soil, serving thereby its temporary use, percolates to the river, through whose channel it at last finds its way back to the original fountain whence it came, where, by illiquation, it forever loses its identity in the bosom of the mother ocean, without an atom of its substance being annihilated.

Even the infant, at birth, or before it has a conscious thought, is thus the heir by title-deed to immortal life, though its actual knowledge is not the millionth part that of the pig or puppy of the same age. It starts, thus, a blank as to intelligence; but, having the infinite endorsement of its father and mother, which involves the undeveloped capability of analyzing the stars and weighing the planets, it holds wrapped up in its vital and mental organism the ego of an indestructible personal identity; and should it thus die untaught, and even unconscious of its own being, its *magna charta* of selfhood will be its passport to the primary college of the angels, and thence to the university over whose entrance is written in letters of life—The Garden of Eternal Progress.

Here, then, in this purely scientific conception brought to the surface, that the life of every organic being is but an infinitesimal drop from out the vital fountain of God's existence as truly as the raindrop is but a speck of the ocean, we see a complete solution of the infinite problem of the origin of life, which evolutionists and materialistic philosophers have abandoned as an inexplicable mystery. Mr. Darwin, with his purely physical conception of organic life, may well say:—

> "In what manner the *mental powers* were first developed in the lower organisms is as *hopeless an inquiry as how life itself first originated.* These are problems for the *distant future*, if they are ever to be solved by man."—*Descent of Man*, p. 66.

Yes, the "distant future." Yet it has not been so very distant, after all; for here the whole problem is solved. By demonstrating the miraculous creation of the

first species as necessarily a fact of science, and with it the necessary scientific truth of God's existence, He becomes the author of life and mental powers; and, as organic life is a substantial entity and could only come from a pre-existing fountain of life, hence the solution is clear that the life and mental powers of every organic creature originated primordially as infinitesimal atoms of God's own self-existent vital and mental being; and thus it becomes as naturally and consistently a scientific solution of the origin of life as that the existence of God is an unavoidable scientific truth growing out of the demonstrated fact of the primordial miraculous creation of the species. How teleologically sublime and beautiful, therefore, are these solutions, which the great revolutionary theory of descent abandons as a hopeless mystery, thus leaving the world in utter darkness!

After this digression and attempted explanation of one of the most important problems of life, I return to the consideration of rudimentary organs. I have intimated that all physiological phenomena, such as the marking of offspring by the imagination or mental impressions occurring among human mothers to which I have alluded, are equally observable and liable to occur among our domesticated and wild species of animals; while the most unquestioned proof exists, and in great abundance, among our scientific breeders and fanciers, that such abnormities as I have been discussing are no less common among lower animals than among human beings.

I shall refer to just as few cases as possible to barely sustain my position and complete the chain of evidence preparatory to the final hypothesis which shall solve the problem of rudimentary organs. A brief citation from Mr. Darwin himself will appropriately introduce this class of evidence:—

"In the case often quoted from Lord Morton, a nearly purely bred Arabian chestnut mare bore a *hybrid* to a *quagga;* she was subsequently sent to Sir Gore Ouseley, and produced two colts by a black Arabian horse. These colts were partially dun-colored, and were *striped on the legs* more plainly than the real hybrid, or *even than the quagga.* . . . But what makes the case still more striking is that *the hair of the mane* in these colts *resembled that of the quagga*, being *short, stiff*, and *upright.* Hence, *there can be no doubt* that the quagga *affected* the *character* of the *offspring subsequently begot by the black Arabian horse.*—*Animals and Plants*, vol. i., p. 484.

This single passage from Mr. Darwin's works would be all the evidence I would need to prove my position, that this Arabian mare marked her subsequent colts through her imagination or her mental impression retained from her recollection of the striped appearance of that quagga and her hybrid colt, were it not for one important fact, and that is, Mr. Darwin distinctly avows, immediately following this quotation, that it was the *physical* impression produced on the mare's corporeal organism by the quagga, which she retained in her circulation and which counteracted the corporeal influence of the *black Arabian horse!* Now, I take direct issue with Mr. Darwin on this question of scientific fact, and not only declare that he is mistaken, but will prove it by the very witness to whom he refers in this connection for corroboration.

This purely physical view taken by Mr. Darwin is manifestly the only view of the case he can take; for, to admit that the imagination or memory of that mare could not only change the color of her future foals to that of the quagga, which had so impressed her recollection, but could actually change in like manner the corporeal texture of the mane, making it "stiff and upright," would be to at once admit the

mind of that animal as a substantial entity, since nothing but substance can produce a corporeal result. But, as before remarked, such an idea as an incorporeal vital and mental organism as the counterpart of the physical structure of an animal never found a resting-place for one moment in his thoughts; or, if it had, he probably would never have been heard of as the founder of Darwinism.

Before adducing Mr. Darwin's own witness, I will merely hint that an almost conclusive reason why this supposition of a *physical* impression left by the quagga on the mare's organism can not be true, is the already demonstrated fact that a constant change and substitution was going on among the corporeal atoms constituting the mare's body after her relationship with the quagga. Is it possible, in view of this fact, that, years after such relationship, so much of that, at first, infinitesimal impression could remain in the physical circulation as to counteract and neutralize the organic influence of the sire of her foals? I believe that any mind competent to draw a logical conclusion on any philosophical question, if it can but once grasp the conception of a mental and vital organism, as supposed by my hypothesis, will repudiate the physical interpretation given by Mr. Darwin as wholly out of the question.

But I now propose to take the case entirely away from him by direct evidence. One of the witnesses to whom he refers at the foot of the page from which I last quoted as having recorded similar remarkable instances of offspring being marked, is Alexander Walker, on *Intermarriage*. I have turned to this author, and to my surprise find that he records the same case here quoted from Mr. Darwin about the quagga, and almost in the very same words, after which he utterly repudiates Mr. Darwin's physical view of the problem, and concludes in these words:—

"As, however, there *are ample proofs* of the power of the *mother's imagination among quadrupeds*, especially over color, *this explanation is very improbable*."—ALEX. WALKER, *Intermarriage*, p. 241

He then goes on to relate, in the same connection, a number or authentic circumstances well known among breeders, which go to prove the power of the brute-mother's imagination or mental impression to mark offspring, independently of all physical contact. One case particularly he relates which occurred on the farm of Mr. Mustard, of Angus, in which a neighbor's *ox* broke into his field and ran for some time with one of his cows before she was taken to the male. This ox was *spotted* and *horned*, while all the stock of Mr. Mustard were pure red and without horns. Yet this black and white ox made such an impression on the mind of the cow that her future calf was marked with black and white spots and had horns like those of the *ox!* Mr. Walker adds:—

"The ox was white, with black spots, and horned. Mr. Mustard had not a horned beast in his possession, nor one with any white on it. Nevertheless, the produce of the following spring *was a black and white calf with horns*."

What now becomes of Mr. Darwin's physical theory in regard to the quagga? Here is not only the color, but one of the most distinctly prominent corporeal structures—the horns—produced as the result alone of mental impression or imagination. I could adduce other authorities equally conclusive, but shall consider the fact established even to the satisfaction of Mr. Darwin, since he invited my attention to Mr. Walker as good authority on this question.

I may add, however, that we have here a beautiful illustration and corroboration of the scriptural account of the plan

adopted by Jacob to obtain an adequate compensation from his father-in-law Laban, by causing his cattle to bring forth offspring "ringstraked, speckled, and spotted," which were to constitute Jacob's share of the stock, according to contract. This has been supposed to be miraculous or a direct interposition on the part of the Lord to favor Jacob, since he modestly attributes it to divine assistance, as we may safely do with all our creditable deeds. But the truth is, it was a scientific process of breeding discovered, or at least carried into practice, by this rustic herdman, which it has taken our scientists thousands of years to find out, and which they are only just now beginning to understand.

Though the details of this process are not given, it is quite easy to imagine them. The account simply tells us that he "pilled" rods, and placed them in the troughs as the cattle came up to drink, which caused them to conceive with the result named. It is well understood that most of our domestic animals, especially those of the bovine genus, are mortally afraid of snakes. It would require but ordinary ingenuity to conceal these imitation serpents at the bottom of the clear water in the trough, and, while the animals were drinking, with their eyes intently fixed on the water, to spring the trap and cause the mimic reptiles to leap forth from their lurking-place and seize the brutes by their noses. I can imagine the entire operation, and the form of the trap employed for the purpose, as vividly as if I had been one of Jacob's assistant herdmen; and I am willing to guarantee that any breeder who may test it, according to the plan here suggested, will obtain essentially the same result by which the young patriarch got even with his avaricious father-in-law. (See Gen., chap. xxx., v. 37.)

What, therefore, can be said to these things? Without admitting the fact that the mental impression alone of the brute-mother can permanently mark and deform her offspring independently of any physical connection whatever, and that this is effected through the vital and mental organism, as I have assumed, then here is a class of facts well authenticated which will have to go wholly unexplained. Mr. Darwin's monistic view of physical organism, with mind but an insubstantial nonentity, leaves this whole class of phenomena without a ray of light. My view of a dual organism constituting each living, sentient creature, makes the entire problem one of the simplest and most easily explained phenomena in Nature. Can the theory be a true one which can not explain them at all? Is the theory a false one which makes them as clear as crystal?

I am now prepared for the hypothesis by which these so-called rudimentary organs may be rationally and logically as well as scientifically accounted for, which the reader has, no doubt, ere this, clearly anticipated. It is, that such abnormities are the direct result of the mental impressions of mothers, re-enforced and accumulated through countless generations, caused by the want of or necessity for such organic structures. For example, if the mental anxiety of the cow referred to by Alexander Walker to retain the company of that spotted ox should so act on her vital and mental organism as not only to convey the spots to her future calf but also to produce the physical abnormity of horns in her offspring, and that, too, by only a single impression, is it not every way reasonable that the want of and almost absolute necessity for incisors, for hundreds and even thousands of generations and many times involving great physical suffering and almost starvation, should so act on that particular portion of the embryonic

being as to result in attaching at least partly formed teeth, for which so many thousands of mothers have felt the need? Whales, which are without teeth and provided only with whalebone in their stead, it is easy to imagine, have been thousands upon thousands of times so situated that they have felt the necessity for teeth to assist the mastication and comminution of substances for food which would otherwise prohibit deglutition. By the same law as that which acted on the bovine embryo, cetacean mothers have impressed upon their young, through unnumbered generations, the rudimental forms of teeth through their own want of such organs, till imperfect structures have at last become developed in the embryos at the most impressible period of gestation. There is surely nothing more incredible in this fact than that the desire of the cow should convey the horns and the color of that spotted ox alone through her mental want, and attach them permanently to her calf! It is not at all unreasonable to suppose that the cow actually coveted the spots and horns of that ox, and desired them for ornament and use, and thus impressed them on her offspring, just as a human mother's desire for a certain kind of fruit has been known to print it distinctly upon the child. So the want of teeth and their necessity for ages in the toothless bovine animals and whales might reasonably have so impressed the minds of these brute-mothers as to produce teeth in their embryos.

The same is also true of the rudiments of legs in the hinder portion of the whale's body. For countless generations, whales, from the extreme circumstances of ponderous bulk and shallow water when foraging along the shores, have been liable to be caught behind sand-drifts or within a delta on the ebbing of the tide, and thus have been many times compelled to exert all their strength to regain the open sea. An incident of this kind occurred recently on the coast of Long Island, but a short distance from New York, where two whales became stranded behind a sand-bank and were killed by a company of sailors. One of these men, relating to me the circumstance, said that all these creatures needed was a pair of legs behind and they would have easily made their way over the bar; and I was struck by the remark that they seemed to exert their strength and move their bodies while struggling, as if using "*invisible legs*." This alone proves that if the whale had ever possessed legs they never could have become aborted from disuse, while it seems infinitely more probable that the necessity for and want of some such organs as legs, flippers, or fins, on the hinder portion of the body in emergencies like the one described, would, during thousands of generations, so impress the embryos as to have finally produced these rudimental bones. Again I assert there is nothing more marvelous or incredible in this than that a mare should by simple memory and desire reproduce the stripes and stiff upright mane of the quagga in her future foals after years of separation, or than the conveyance of spots and horns by the cow to her subsequent calf, alone by her want and vivid mental impressions.

I account for the rudiments of legs and of a pelvis in the body of the boa-constrictor in the same way and by the same scientific hypothesis. It being the largest of serpents, there would naturally many times be situations in which it would be difficult for so ponderous a snake to make headway over the ground, especially if a little ascending, and this constant necessity for some protruding organ of the body to seize the ground and prevent slippage acting on

the minds of these subtle and intelligent animals for thousands of generations would be most likely to so work on the life-germs of the young as to actually cause these rudiments of legs; while the correlation of parts and co-ordination of structural arrangement would necessarily frame also the rudimental pelvis, since no hind-legs could be supported except by such sustaining framework.

It is a singular fact that while my hypothesis rationally explains these great examples of rudimentary organs especially cited by Mr. Darwin, Professor Haeckel, and all writers on evolution, it as clearly accounts for the fact of the absence of such rudiments in smaller species of the same families. For example, while the boa has these rudimentary leg-bones, it appears evident that this particular species would be the most liable of all the serpent family to pass through such experiences and situations as would impress the mind, and superinduce in the embryos such abnormities. The same is true of the whale tribe, since it is the largest of all the fishes or fish-mammals. No other fish would ever be so liable to situations which would be likely to impress the mind in the direction of such rudiments, as already explained.

And right here the vast superiority of this explanation over that of Mr. Darwin looms distinctly into view. According to my hypothesis, a large serpent would often stand in need of some such organs as legs, and such a desire, I maintain, acting for ages on the young, could finally superinduce these rudiments; while all the smaller species of snakes, having no necessity for such organs, from their lightness and the ease with which they can get over the ground, would necessarily never lead to the possession of such desire or such rudiments!

It is a triumphant fact that the anatomy of these various species of snakes corroborates my hypothesis fully. But how is it with Mr. Darwin's? The facts are clearly against him; for, if snakes have descended from quadrupeds, as he maintains, from the rudiments of legs found in one of them, then all snakes should contain alike rudimentary legs, but more especially and distinctly should they be seen in the smaller snakes, since all reason and analogy would go to show that they are a later degeneracy from quadrupeds than the boa! Mr. Darwin in a tantalizing way refers to those who maintain that rudimentary organs were retained by the Creator for the sake of symmetry, and asks why the Creator did not keep up the *symmetry in the smaller snakes, since not one of them has the vestige of a rudimentary leg.* But he never thought how this ironical blow would rebound against his own hypothesis! I now ask him, if snakes have descended from quadrupeds, why is it that only the largest and oldest serpents, which have had an abundance of time to outgrow their former structure, retain rudimentary legs, while the smaller species of snakes have not a vestige of such rudiments remaining, though they have, without a logical doubt, more recently branched off from quadrupeds and lost the use of their legs? His logic and sarcasm are thus hopelessly shattered, while his theory is utterly dumb. He can give not a shadow of explanation for this ridiculously absurd performance of his god—Natural Selection, with the sobriquet "survival of the fittest"!

While I show scientifically why the whale —the largest of fish-mammals—has rudiments of legs, and by the same logic why not one of the smaller fish-mammals, such as the dugong, lamantin, porpoise, &c., could reasonably be expected to possess them, Mr. Darwin admits that the facts

correspond exactly with my hypothesis, and that not one of the smaller fish-mammals have a sign of a rudimentary leg in their bodies. While he does not question that these smaller fish-mammals were also reduced from quadrupeds the same as the whale, and in all reason were a more recent reduction, he is hopelessly dumb as to any reason why these smaller creatures do not show a vestige of rudimentary legs, when they should really possess them more distinctly marked than the whale, if there is the least truth in his hypothesis of their degeneracy from quadrupeds.

Suppose we had been completely ignorant of all these rudimentary facts of teeth and legs, and that my hypothesis had been sprung in scientific discussion. It would have been maintained naturally enough by opponents of the hypothesis, if it were possibly true, that the want or desire of the brute-mother could impress the desired object on the embryo, then, in that case, the cow so often standing in need of upper incisors would before this have produced them in the embryonic calf, and the same would also be true with the toothless whale! The opponents of my hypothesis would have even gone further, and assumed that although small snakes might not feel a necessity for legs sufficiently to impress their embryos, yet that a very large and unwieldy snake like the boa-constrictor would often need legs, and therefore it would be but reasonable to expect that such a constant necessity should finally have left their impression on the offspring, if my hypothesis had any foundation! So the whale, at least, for the same reason, they would urge, should have impressed its young with legs, though the absence of necessity and desire in the smaller fishes would necessarily prevent such a result, on the basis of my theory! Thus, the very phenomena which a shrewd opponent would have urged against my hypothesis as liable to occur if it was true, turn out to be scientific facts; and hence, the very predictions which a scientist would have made in view of the probable truth of such an hypothesis, after knowing the facts recorded by Alexander Walker, are fulfilled in advance, confirming my solution of the problem of rudimentary organs, while emphatically condemning that of Mr. Darwin.

I am thus through with the great argument of rudimentary organs, on which such stress has been laid by evolutionists. I do not pretend to go into the details of all the organs or parts of the various animals which have been supposed to be rudimentary, as time and space would forbid. Neither do I claim that the exact solution could in every case be distinctly made out. But, as the great representative facts bearing on this phase of evolution—those facts always referred to as the strongest—have been taken away from the theory by the very meaning of the terms evolution, development, and survival of the fittest, and shown to be fatally opposed to all such ideas of retrogression, I submit the question to the intelligence of the reader, whether my solution of the problem is not much more probably correct than the hypothesis which can only explain it by ignoring the true meaning of the principal words employed in the solution!

SUMMARY.

1.—I will now, as in the preceding chapter, briefly condense the arguments employed in this, in order to bring them in a mass before the reader. The very strongest argument, probably, known to evolutionists, is the one based on Rudimentary Organs; and the strongest facts ever employed to prove the existence of such organs are those cited from Darwin and Haeckel at the commencement of the

chapter, namely, the embryonic teeth in the calf and the whale, and the rudiments of legs in the whale and boa-constrictor.

2.—It has been shown clearly that these organs never could have come by descent from ancestors having such organs in a perfect state, as such a loss of useful structures would be a retrogression of the species to a lower plane, while such deterioration is exactly opposed to every true definition of evolution, development, or survival of the fittest.

3.—I quoted from Darwin, Huxley, and Spencer, direct evidence to prove that Evolution in all cases meant progress toward perfection, the survival of the fittest, a change from the simple to the complex, from the homogeneous to the heterogeneous, and from the few to the multiplicity of parts. Whereas, a creature like the cow losing its teeth, or a species of animals like that of the whale or boa-constrictor having completely developed legs and losing them by development, would be clearly a degradation and a deterioration of the species, or a survival of the weakest and most unfit in the struggle for existence. Such degeneracy would be a change directly from the complex to the simple, from the heterogeneous to the homogeneous, and from the multiplicity of parts to the few parts; and thus, in every sense of the word, such a transformation of a species would absolutely contradict the only true definition of evolution, development, or survival of the fittest, as accepted by the whole scientific world.

4.—It was shown, that, according to the rudimentary argument, Evolution wrought on the bovine genus a million generations to produce a perfect set of upper teeth, and then reversed its programme, working another million generations to take such teeth away, leaving the naked gums;—that it spent a million years, by saving up small variations, to construct the perfect legs of the boa-constrictor or its immediate ancestors, and then wrought another million years in taking such useful organs away, leaving only the "aborted little bones" beneath the skin, for no imaginable purpose under the heavens except to assist Darwin and Huxley in their theory of descent;—that natural selection gave the most "scrutinizing" care to a certain fish, working a million generations to raise it to a hoofed quadruped, through countless transmutations, and then turned round and worked an equal length of time to take away its legs and teeth and reduce it back to its primal form of fish! Thus, the necessities of this rudimentary argument, in order to make it of the least use to Darwinism, forces evolution and development to signify either backward or forward, up or down, improvement or retrogression; makes it mean either to go forward toward the complex or backward toward the simple,—either to become heterogeneous or homogeneous,—either to multiply parts and organs or take them away, and that, too, in utter defiance of etymology, philology, and the standard definitions of words! Can such a reckless, arbitrary, and contradictory system, by any possibility be the true scientific theory of man's origin? The common intelligence of every reader must compel him to answer, No!

5.—It was shown that a miracle would be as strictly a scientific fact as the growing of a tree from an acorn, according to the definition given of "science" by Huxley and Spencer, provided the weight of evidence sustained such miraculous event. It was further shown, that, according to Mr. Darwin's idea of the origin of the first forms by miraculous creation as a start and foundation for evolution, it unavoidably makes such primeval miraculous crea-

tion a scientific fact, otherwise there can be nothing scientific about his entire theory, based upon such fact. Hence, Darwin is obliged to admit that at least one miracle or supernatural event is scientific.

6.—It was also shown that if evolution can really develop a fish into a "hoofed animal," and can then go to work and reconvert the quadruped into a fish, it can, of course, continue on down and transform the fish into a crustacean, the crustacean into a mollusk, and the mollusk into a sponge; because the single instance of retrograde transformation proves it. Hence, it follows, according to these learned naturalists, that there may have been a downward or retrograde development from the highest mammal to the lowest polyp in the pre-Silurian ages, thus producing by natural means without miraculous interposition the first simple beings for Mr. Darwin's upward evolution to commence on! This being so, geologists are liable at any time to unearth from beneath the pre-Laurentian deposits the paleontologic remains of monkeys, quadrupeds, birds, and fishes, which have gradually developed downward from some ancient man! This shows how utterly unreliable is evolution as a scientific theory.

7.—As all evolution or development is necessarily upward toward the heterogeneous and complex, making it impossible for practical and useful organs, like teeth of mammals and legs of quadrupeds, to be lost by survival of the fittest, it follows that there is but one way in Nature for any useful organ ever to become atrophied or lost; and that is, for the animal and its descendants for many generations to be so situated as to be wholly deprived of its use. This I showed to be illustrated by the cave rats and fishes, which, being shut out from the light for many generations, had entirely lost the use of their eyes, till they had in consequence become overgrown with a membrane. Dervishes have been known to hold their hands and arms perpendicularly extended so long, from a superstitious or religious frenzy, that they would entirely lose their use and be unable to change their positions! So the wings of certain birds on isolated islands, where neither man nor wild beasts existed to cause alarm, have been for many generations so little used as to become finally incapable of flight. In the same way, were it possible to sever the olfactory nerve in a dog and then continue to do the same with all his lineal descendants as soon as born, the sense of smell would probably in time become entirely obliterated by disuse. But, as was shown, this is wholly inapplicable to any organ used even in the slightest degree, as with the tails of mammals, however unessential to their existence. Therefore, the utter impossibility of useful and essential organs, such as teeth and legs, which are necessarily always in use, becoming aborted, is at once manifest.

8.—The argument next showed that evolutionists, in seizing these rudiments of teeth and legs, and thus overthrowing evolution by reversing its signification in every sense of the word, had shown a lamentable want of ordinary business shrewdness in thus throwing away their strongest and most puzzling facts of science, and, in truth, the only real argument ever suggested by the theory which would seem to be difficult to answer. No one can deny the formidable nature of the argument, had Darwin originally claimed that the cow had descended from *toothless* ancestors, and that she had ever since been gradually developing teeth, and would, without a doubt, in time have upper incisors; and then, had he adduced as proof the undeniable fact that the calf already begins to show these incisors in

its embryonic condition, it is really difficult to imagine what could be said in reply! He could have also claimed with a flourish of logical trumpets that all quadrupeds had developed from legless reptiles; and, as conclusive confirmation, could have referred to the boa-constrictor, which was already gradually approaching the quadruped form under the "scrutinizing" care of natural selection, showing undeveloped but well defined leg-bones in the hinder portions of its body, which would no doubt in time be developed by survival of the fittest, and differentiated into perfect legs! The same position could have been taken in regard to the embryonic teeth and rudiments of legs in the whale tribe. But instead of this bold and triumphant position, the stupid inventor of "pangenesis" threw away the whole opportunity, just as he did in that hypothesis, called them "aborted organs," and thus reversed evolution, development, and survival of the fittest, breaking down his own theory of descent! A more witless escapade it is difficult to conceive of being perpetrated by a sane writer; while it is equally surprising that Huxley, Haeckel, and all other advocates of the theory, instead of discovering this fatal fiasco of their leader, have innocently followed in his footsteps, and still continue to stamp out evolution by claiming that the cow lost her teeth and the boa-constrictor its legs by "survival of the fittest"!

9.—This summary of the chapter brings us to the true explanation of these rudiments of organs. I assumed them to be the result of the mental impressions of the mothers in the lineal chain of the species inherited from generation to generation till the want or anxiety experienced by the succeeding mothers had impressed itself upon the offspring's organism. To sustain this view I referred to well known facts among breeders, in which the mare marked her future foals distinctly from her memory of a quagga by which she had formerly borne a colt, and also a cow which transferred to her calf both the white and black spots and the horns of an *ox* whose company she desired, though neither she nor any of her near relatives had horns or any black or white in their color. It was further shown that these modern facts corroborated scientifically the breeding exploit of Jacob in causing Laban's cattle to bear "ringstraked, speckled, and spotted" offspring, and that scientists were just beginning to find out what seemed to have been well known among the ancient patriarchs. In applying this solution to the whale it explained why it alone of all the fish-mammals showed any sign of leg-bones, while no kind of explanation can be given by the theory of descent. The same was shown to be the fact with the boa-constrictor. My solution clearly gives the reason why it alone of all the snake species should have rudiments of legs, while evolution can not even offer a guess. If the fact of descent by transmutation from quadrupeds is the true cause of whales and boa-constrictors having rudiments of legs, I showed clearly that the smaller fish-mammals and smaller snakes should by all odds have these rudiments more distinctly defined, as they are evidently a later degeneracy from the quadrupedal form. The very fact that no advocate of evolution can give even a surmise, according to the theory of descent, why whales among fish-mammals and boa-constrictors among serpents should alone have rudiments of legs, while my hypothesis gives a clear and distinct scientific reason for both, ought to be sufficient to show which is the more probable theory.

CHAPTER X.

EVOLUTION.—ITS STRONGEST ARGUMENTS EXAMINED.—(Continued.)

The Anatomical Resemblance of all Vertebrate Animals one of the Strong Supports of Evolution.—This Fact does not favor the Theory of Descent, but is shown to be directly opposed to it.—The very Assumption of a Graduated Scale of Structure the death-blow of Evolution.—Huxley's Book—"Man's Place in Nature"—a Complete Loss of Time and Labor.—He Wastes a Whole Volume on the Partial Resemblance of Men and Monkeys in their Osseous Structure, when there were dozens of Characters and Points of Resemblance exactly alike which he might have used.—Creation by a Graduated Scale of General Anatomy Consistent and Rational.—Illustrated by Man's Greatest Achievements.—If the Graduated Resemblance between Members of a Sub-Kingdom—as between the Vertebrates, for example—proves Evolution, then the breaks between Sub-Kingdoms prove Miraculous Creation.—The Logic of Evolution thus Breaks Down by its own Weight.—The Acknowledged Absence of all Transitional Forms a Clear Disproof of Evolution till they are Produced.—Darwin repeatedly declares that "Sudden Leaps" can not be taken by Natural Selection.—Transmutation thus rendered Impossible by Mr. Darwin himself, since the differences between the Nearest Related Species constitute such "Leaps."—The Great Fossil Lizards of Huxley, as connecting links, examined.—The Nearest Related Species shown still to be Great and Sudden Leaps.—The Archaeopteryx no sort of proof of Evolution.—Nature confirms this Distinction, proving Separate Creations by the Law of Sterility among different Species.—The Exploits of Breeders and Fanciers examined.—Man's Efforts the Exact Opposite of those of Nature.—They Overthrow the Claims of Evolution by producing Opposite Results.—Huxley Clearly Refutes Darwin's Theory.—His own Self-Destructive Logic turned against him.—Breeders acting on the Principles of Nature could never change a Feather of a Pigeon in a Million Years.—A Conclusive Proof given from Mr. Darwin himself.—The Great Argument based on Paleontology and the Geologic Record examined.—It is Shown to furnish no Proof in Favor of Evolution, but rather to Overthrow it.—All Fossil Species are found at their Greatest Perfection when they first appear in the Strata.—The Paleontologic Remains a Clear Proof of Miraculous Creation of the Succeeding Forms.—A Merciless Review of Professor Huxley's Lectures in New York.—He is Shown to have Abandoned all Proof of Evolution in the Fossil Remains of Animals prior to the Genesis of Mammals.—His Great Argument based on the "History of the Horse" a Total Failure.—It not only turns out to be no Evidence, but is the Exact Opposite of Evolution.—Professor Huxley's "Demonstrative Evidence of Evolution" demonstrates its Complete Want of Foundation.—His comparing the Basis of Evolution to that of the Copernican System of Astronomy rebuked as it deserves.—The Preposterous Character of the Comparison Exposed.

Next to the arguments based on Reversions, Embryology, and Rudimentary Organs, the anatomical resemblance and typical graduation of organic beings in connection with the geologic and paleontologic record constitute probably the strongest evidence in favor of the gradual transmutation of the higher from the lower forms of animal life. I may also add that intimately connected with such anatomical graduation and the evidence drawn from paleontology comes in the work of the breeder and the fancier, showing supposed corresponding changes in structure produced by methodical selection.

But having already shown, as I believe the attentive reader will admit, that the three first-named classes of phenomena and scientific facts not only fail to sustain evolution in the slightest degree, but are

directly opposed to the hypothesis, it must necessarily weaken in advance a class of facts and evidence secondary in importance, such as graduation in structure and the fossil deposits, even if there were no direct and cogent reasons by which to overthrow such evidence. For if the miraculous creation of a single species must be admitted as a *fact of science*, since it is unavoidably necessary as the foundation and start of evolution, so fully shown in the preceding chapter, and as Mr. Darwin is obliged to admit, then there necessarily can be no evidence, unless it consists of the most positive and direct kind, showing that the Creative Will changed this order of scientific facts, and adopted an entirely new and different plan for the origin of species after having created the first one.

We can not and have no logical right to shut our eyes on the first organic species, and say we don't know how that one came into existence but we do know how the others came! We can not be permitted to accept sullenly the first species at the hands of the Creator as a miraculous product out of inorganic matter, as does Mr. Darwin, and then forever after ignore the Creator, taking the work completely out of His hands, and running the machinery of Nature by the flimsy motive-power of a few weak and badly corroborated inferential proofs.

Mr. Darwin does not and can not believe that the first species sprang into existence by spontaneous generation or out of nothing, with no intelligence to conceive nor will to produce it. No reader can believe it after the conclusive evidence given to the contrary in the seventh chapter of this book. Hence, the first species, as the basis of evolution, must have come by miraculous creation: and, therefore, if evolution is a scientific hypothesis or theory, its foundation must be scientific. If its assumed stages of development and transmutations are facts of science, then the fundamental act or event on which all these other processes depend is equally a fact of science. This seems too self-evident and axiomatic a truism to require a moment's further argument.

I deny, then, that there is the least evidence in the gradation of animal forms or their anatomical resemblance in favor of evolution, or going to show in the remotest degree that one being was transmuted from another, but exactly the reverse. The general typal resemblance of all vertebrate animals, from the fish up to man, becomes on the contrary one of the most logical and necessary proofs that one and the same infinite Creator formed them all by the same miraculous power and under the same system of formative laws which produced the primordial species.

Every great worker—such as an artist, for example—is known and can be at once pointed out by a connoisseur from the general resemblance among themselves of his works of vertu. A critic can often at a single glance designate the author of a great painting by this simple law of general family resemblance which pervades and identifies every artist's productions, how different soever may be the subjects of the work. No artist thinks of changing this family resemblance in his successive achievements in art because he happens to change his subject from a group of portraits to a landscape, or from a cattle-scene to a sunset. He would rather, if he regards his works as meritorious, study to keep up and cultivate that peculiar and typical something which we may call artistic identity, with such *chiaro-oscuro*, which no other artist can exactly imitate, as would tend to advertise him, so to speak, whenever one of his works happened to be examined, whether it was labelled or not.

I have often been surprised at the stress which evolutionists lay on this resemblance of all vertebrate animals in their osseous structure as a proof of descent from a common prototype, which again shows their want of shrewdness and business tact, as so clearly illustrated in the preceding chapter. They thus select a character or peculiarity of structure which is only approximately alike in the different species, when they might have fixed upon a dozen different characters in which there is an absolute and unvarying resemblance even from the fish up to man! Professor Huxley wrote an entire book—*Man's Place in Nature*—to demonstrate this approximate resemblance in the skeletons and anatomies of man and the higher apes. Now, this was all useless and a waste of precious time, if we look at it correctly. It would not be Godlike or workmanlike or artistlike, if such an approximate resemblance did not exist. I can admit all Professor Huxley teaches about the peculiar and striking similarity existing between man and the orang-outang, both as to their cerebral resemblance and osseous conformation, and yet repudiate his absurd conclusion that man necessarily descended from the monkey by transmutation, and not only from the monkey but from the tortoise and crawfish.

Why, then, I repeat, waste all this valuable time in writing a book to demonstrate a partial resemblance of organic structure between all vertebrate animals when Professor Huxley could have triumphantly pointed to the fact *that all vertebrates have two eyes?* Even a *flounder* when young swims with its back upward, with one eye on each side of its head, but being so flat it soon forms the habit of swimming on one side. The lower eye then becomes useless in that position, but so determined is this asymmetric vertebrate to keep up this universal character of two eyes, that the lower one crawls around or goes directly through the skull, and deliberately takes its place by the side of the upper one!

What a brilliant argument Professor Huxley could have made on such a persistent and invariable characteristic as two eyes, had he but thought of it! Had he applied to me before writing his book, I could have furnished him with a whole list of characters exactly alike in the thousands of vertebrate species, each one of which would have been so superior in proving that man descended from a fish to the half-rate resemblance in the backbone, phalanges, and cerebrum, and so much more convincing, that they should not be spoken of in the same day.

How striking the resemblance, for example, in the fact that all vertebrates *breathe*, and that, too, with their mouths and noses! They have all *five senses, and that, too, exactly of the same kind;*—all see with their eyes, hear with their ears, and smell with their noses! What better proof can be asked for in favor of a common origin by transmutation, or of the probable fact of a single primordial prototype? Not one vertebrate species, so far as natural history informs us, sees with its nose, smells with its eyes, or hears with its mouth, as some of them ought to do if separate miraculous creations! Why, such an idea as an infinite intelligent Creator making two separate species with the same number of senses, and that, too, of the same kind, is preposterous! Even the approximate resemblance in the backbone is a clear evidence, with these great scientists, that an intelligent God had nothing to do with them! Just look at the fact, Professor Huxley, that every one of these thousands of specific creatures live by eating, grow by food-assimilation, and then think of the

startling resemblance in the fact that they all have veins and circulation, all come into being by birth and cease to live by dying! This does not begin to fill out the list of absolute resemblances. Yet you overlook all these perfect characters, which would have been so demonstrably conclusive, and plod through *Man's Place in Nature*, all to prove what any man can admit without stirring a hair on his head, believing still with unshaken confidence that he is neither the son of an ape nor the great-grandson of a snapping-turtle!

Even if an infinite Creator did start each separate species by a miraculous creation, there was not the least necessity for or propriety in a separate general plan for each specific form. Evolutionists seem to look upon it as an absolute necessity, if a God originated the species, that there should be no two alike as to general type, —one, for example, should have three eyes instead of two,—one should have been made with two mouths instead of one,—some with one ear in the middle of the forehead,—others with one eye in front and another behind,—one having two pairs of arms, and another two spinal columns, one in front and the other back. I could easily go on with the list, if disposed, and suggest a separate typal plan for each specific form throughout the vertebrate sub-kingdom. The Creator could have done all this, had such variety been His object, just as easily as to follow the one vertebrate type. But it shows really greater artistic genius and more genuine wisdom in creating such almost infinite variety with such trifling variation to outward seeming. There would have been no more true genius or workmanship displayed, however, in such meaningless structural variations than if an artist in producing each separate painting should change pigments for the same color, use a different kind of canvas for each picture, or mix each separate color with a different kind of oil, and then apply them with brushes each made of a different kind of hair!

If an intelligent Creative Will really did design and then miraculously produce by fixed laws the various specific forms from the fish up to man, is it not every way reasonable to suppose that a part of such design and original purpose might have been to advertise Himself, by the monistic plan of His work, as the Author of all organic life, *and thus to impress upon the intelligence of His crowning work that the same God who finished with man began with the vertebrate fish as a model?* Would not man as a philosopher—as an intelligent and thoughtful student of Nature—do credit to his exalted intellectuality by recognizing and comprehending the Author of his own being even in the lowest forms of the vertebrata, rather than to make such identifying and necessary family resemblance a pretext for robbing Him of the glory by denying His existence, and then claiming such an orderly, artistic graduation, as the designless product of mindless, will-less, senseless laws of Nature? The very fact of such graduation and general typical resemblance in all vertebrate species thus seems to me to distinctly favor and point to the miraculous production of each original specific form by the one Creative Will, and to be, as I will now show, directly opposed to the transmutation of the various forms from a single prototype.

We see, for example, distinct and complete breaks in the typical form of anatomy between the mollusca and the articulata and between the articulata and all vertebrate animals. According to the hypothesis of miraculous creations the great Architect of Nature, working by law and under the direction of infinite intelligence, could, as a matter of course, either work on a single

typal plan and with a graduated scale of family resemblance, as in the vertebrata, from the dawn of life up; or He could, if according to infinite pleasure and from a love for variety and the beautiful, make each species from a separate typical model and on a distinctly unique plan, just as well as He could originate one plan at the start. But natural selection, beginning with the mollusk and working by the fixed law of development and transmutation, would naturally and necessarily be forced to keep within the typal limit. Consequently, it would have been impossible for transmutation to produce the abrupt typical break from the mollusk to the crustacean or from the crustacean to the vertebrate form.

Evolutionists thus completely overthrow their own principles of logic, and with them the whole argument based on structural resemblance. They assume that the typical similarity of all vertebrate animals—men, monkeys, dogs, marsupials, seals, reptiles, and fishes,—is a proof of transmutation under natural selection, thus absolutely assuming that such a process of development as evolution must *necessarily* keep within the type, or otherwise the whole argument of anatomical resemblance falls to the ground,—while at the same time claiming that the crab was transmuted from the oyster or its typal form, and that the fish was transmuted from some one of the invertebrata! Now, it comes right to this: either natural selection could not scale the barrier of subkingdoms or break over distant types, such as the leaping from the oyster to the lobster and from the crab to the ganoid, or else this boas'ed typical resemblance of vertebrate animals is not logically a necessary work of evolution; for if evolution can break through types, disregarding all family resemblance, as it must have done to transmute the articulata from the mollusca or the vertebrata from the articulata, then the necessity for the typal form of all vertebrate animals as the work of natural selection is wiped out at a single sweep, and the great evolution argument based on comparative anatomy is driven to the wall.

It thus clearly follows, by taking the anatomical argument just as evolutionists present it, that if the family resemblance of all vertebrate animals is a proof that they *could not have been formed by special creations, but must have been the work of evolution*, then the leaps or breaks from one type of structure to another, as just shown, *must have been the works of special creations, and could not have been the result of evolution!* If this logic, therefore, of Professor Huxley, based on a graduated anatomical type among vertebrate animals is worth anything at all, it completely shatters evolution by proving that the distinct anatomical breaks from one type to another must have been the work of miraculous creation, since the natural and logical tendency of evolution is to follow type! If the resemblance among vertebrates is *necessary evidence* in favor of evolution, then the leaps in defiance of such resemblance between the sub-kingdoms is *necessary evidence* of miraculous interventions! If, to avoid this pulverizing consequence of miraculous creations, Professor Huxley should assume that evolution can easily leap the chasms between those distinct types, transmuting a shad out of a scyllarian or a shrimp out of a strombus, in defiance of all typal graduation, then where is there any necessary evidence that the osseous resemblance between the man and monkey is the work of a principle or law which can just as well make leaps as not? Thus, the contradictory logic of evolution smothers in its own self-abnegation.

The resemblance, therefore, between species of the same genus and genera of the same family is thus shown to be no necessary evidence in favor of evolution, but rather a proof going to show a unity of design, and the consistent, harmonious plan of one creative mind, since all workers necessarily maintain a striking family resemblance between their different productions of merit and skill. Mr. Darwin can see nothing of this unity of plan and necessary creative graduation in the various animal species, the very thing he would be the first to point out in the different productions of any great artistic or architectural genius. Rather than to logically infer that the same Creative Will which designed and modeled the first few simple beings also organized other species, he prefers to suppose it the work of natural selection, which will soon be shown to be incapable of the first practical step toward transmutation. Read the following:—

"How *inexplicable* is the similar pattern of the *hand of a man*, the *foot of a dog*, the *wing of a bat*, the *flipper of a seal*, on the doctrine of the independent acts of creation! How *simply explained* on the principle of the natural selection of *successive slight variations* in the diverging descendants from a *single progenitor!*"

"The similar framework of bones in the hand of a man, wing of a bat, fin of a porpoise, and leg of a horse, . . . and innumerable other facts, *at once explain themselves* on the theory of descent with slow and slight successive modifications."

"We may further venture to believe that the several bones in the limbs of the monkey, horse, and bat, were originally developed on the principle of utility, probably through the *reduction of more numerous bones* [evolution backward, again, according to Herbert Spencer,] in the *fin of some ancient fish-like progenitor of the whole class.*"—*Origin of Species*, pp. 160, 420.—*Animals and Plants*, vol. i., p. 23.

But Mr. Darwin seems to be careful to go only half way back to the commencement of his supposed evolution. Why don't he tell us to look at the similarity between the hand of a man, wing of a bat, leg of a horse, and *body of an oyster*, or the jellatinous organism of the ascidia? Evolution can account for no such leaps of structure; whereas, if looked upon as the intelligent work of a Creative Will, this graduated scale of structure as well as these infinite leaps in typical form are at once solved and made to appear consistent.

As a clear proof that the most allied species ever found in a state of Nature are not transmutations the one from the other, we have only to note the fact that in not a single instance have there ever been found the transitional links which would have necessarily existed to lead to such specific difference in form, structure, and habits. It is distinctly taught by Mr. Darwin in many places that evolution or natural selection can make no *sudden leaps*, but must proceed in developing one species from another by short, sure, and slow steps:—

"Natural selection acts only by taking advantage of *slight successive variations*. *She can never take a great and sudden leap*, but must advance by *short* and sure though *slow steps*."—*Origin of Species*, p. 156.

Then, it follows, as there are no two species in the world, and never have been, as proved by the fossil record, so near together that they would not constitute "*a great and sudden leap*," it becomes the most complete refutation of this theory of transmutation by natural selection, unless evolutionists shall find two species somewhere on earth or embedded in the geologic strata with their transitional forms composed of such "*slight* successive modifications" and such "*short* and sure though slow steps" as would be possible to result as the work of natural selection. Such a thing has never been seen, nor anything bearing the least resemblance to such transitional graduations.

What clearer and more distinct over-

throw of the entire system of evolution can the world ask than this reiterated statement of Mr. Darwin that natural selection "can never take a great and sudden *leap*," but "acts *only* by taking advantage of *slight* successive variations"? No evolutionist thinks of doubting but that the hiatus between two sub-kingdoms, such as that between the articulata and vertebrata, even after the closest possible alliance is imagined, would constitute a "great and sudden leap," even greater than any monstrosity ever heard of has produced. Mr. Darwin thus gives up the whole theory of transmutation, by proclaiming to the world in numerous passages that the "great and sudden leap" unavoidably required between two distinct types of anatomy could never have been taken by natural selection! Until, therefore, he or Professor Huxley shall contrive some way of proving that the changes from a mollusk to a crustacean and from a crustacean to a fish would not constitute a "great and sudden leap," we shall be obliged to regard the citadel of evolution as voluntarily surrendered by the very engineer who built the works. Not only so, but in the next chapter I will give an unequivocal demonstration from Professor Haeckel, the great German apostle of evolution, that an articulate animal can not by any possible transmutation change to a vertebrate, but that each sub-kingdom is unavoidably and irrevocably confined to the "type of its tribe." If this is not done by unmistakable citations, then the reader has my full permission to believe nothing in this book.

Every now and then we hear through evolution sources of the discovery of some new animal which is an absolute connecting link between certain species, and which settles the question of transmutation! Now, I want to inform these evolution sensationalists once for all that these scientific surprises are all—well, I will be mild and call it self-deception, though it deserves a stronger epithet. I have carefully followed up these "conclusive proofs of evolution" for years, and, taking them in their most exaggerated representations, they invariably leave chasms on either side of such new forms, or between them and the species they are claimed to connect, so vast that it would take many monstrosities and even thousands of such "slight variations" and "short" steps as Mr. Darwin teaches to form the most rickety bridge from one to the other. One of the most astounding recent discoveries is the *archæopteryx*, claimed with a great flourish of evolution trumpets to be the true connecting link between birds and reptiles. Yet it is so different from a true bird and so far removed from a genuine reptile that it would require a number of well developed monstrosities to make the connection either way, to say nothing of the almost infinite number of Mr. Darwin's "slight successive modifications,"—the only way natural selection is supposed to work.

Now, if there never had been such a connecting link between the form of the reptile and the bird as the archæopteryx, or between the bird and the mammal as the cheiropter, I would say unhesitatingly there surely ought to have been, and that the work of the Creator was incomplete, and altogether unlike the conception we would naturally form of true artistic workmanship in the graduation of the vertebrate type. As weak an artificer and as poor an inventor as I am, I can conceive of scores of organic beings which might have naturally and consistently formed legitimate connecting links between many genera, orders, and classes, which at present exhibit "great and sudden leaps," having chasms out of due artistic proportion to the sliding scale of structure and family

resemblance at other points of the graduation. I can easily conceive, for example, of a compound species, with the head and forked tongue of the serpent, the scales and fins of the fish, the wings and quills of a bird, and the mammæ and tail of the wolf. The Creative Will may have formed many such connecting links and compound species, which have disappeared from the earth. Evolutionists, therefore, will not surprise as much as they will gratify me by increasing the number of these anatomical links, since in so doing they will but expand the evidence that the entire graduated scale of organic being was the monistic work of one great Creative Mind rather than the purposeless achievement of a mindless and will-less force of Nature.

The truth is, the *archæopteryx* is but another species of another distinct genus, ranking as a separate order if not a distinct class of animals, as much so as the bat. It is therefore nonsense for a naturalist to speak of some newly discovered animal, living or fossilized, sufficiently distinct from all known species to be ranked as a separate genus, order, or class, being a "*connecting link*" in any sense meant by evolution.

Professor Huxley thinks there once lived a being which may be called a man-ape or the speechless man, which connected the quadrumana with the human form, and evolutionists are just now extremely anxious to unearth this "connecting link" from some gravel-bank or cave-deposit, thinking thereby to settle the pedigree of man as a lineal descendant of the monkey. But I will here assure them, and save Professor Huxley and his coadjutors a good deal of doubtful digging, that when they have found this man-ape they will have only discovered an additional genus or family of animals which the Allwise Artist and Architect of Nature saw fit to construct as another—possibly the final—experimental model, before finishing His work in the creation of His own image and likeness. I therefore admit this man-ape in advance, and make this suggestion out of pure kindness, to save these naturalists the trouble of any further excavation.

As an unanswerable proof that species were separate creations and not the work of evolution, we have only to look at the well known fact that Nature has drawn an indelible line of demarkation between them. However nearly allied they may be in the scale of creative graduation, or however much they may resemble each other in the form and outline of their anatomy, they can not hybridize and thus produce between them a single new species,—notwithstanding, if Darwinism be true, there must have been a thousand different gradations called varieties in the course of Nature between two of the most intimately blended species!

By methodical selection and careful separation of peculiarly marked and diverging offspring a species may be greatly changed in form and appearance, as seen in the various breeds of pigeons, such as pouters, carriers, tumblers, fantails, &c., and in the beautiful forms of swine, sheep, and cattle. But it is a well known fact among breeders and fanciers that all such varieties are as fertile among each other or with the normal form of the species as the normal individuals are among themselves. In fact, it is often the case that such methodically selected breeds are actually improved in fertility.

How different it is in the coerced mingling of Nature's true species by man's intervention. A single cross may be effected, as in the case of the mule or hinny, but such hybrids are perfectly sterile, both among themselves and with the parent forms. Could a breed of mules be pro-

duced which would hybridize, as is the case with the numberless artificial breeds of cattle, pigeons, &c., then a true connecting link between two of Nature's species would for the first time be found.

In a state of Nature, or beyond man's control, no such attempt at hybridization ever occurs or would be made between the most nearly allied species, such as the wild ass and the zebra or the zebra and quagga, even were they to run in herds together; and thus Nature herself has erected a double wall of separation between all species, showing that there never could have existed numberless grades of connecting links between them, as must have been the case under the slight successive steps of natural selection spoken of by Mr. Darwin, or else such transitional links could be reproduced by hybridization.

Until, therefore, breeders shall produce such varieties by methodical selection as shall show some indications of sterility (the exact opposite of the result so far), or else produce a fertile species of hybrids, Mr. Darwin's theory of descent by adaptation is not only not aided in the least by the remarkable exploits of the breeder, but his assumption of the possible transmutation of species is absolutely disproved.

Professor Huxley himself declares that if it can be shown that such *sterility* can not be produced between breeds artificially selected, "I hold that *Mr. Darwin's hypothesis would be utterly shattered.*"—(*On the Origin of Species*, p. 141.) If, therefore, we may judge from the past, which shows no tendency to sterility among the most divergent artificial breeds, but, in many cases, right the opposite, or increased fertility, we may logically declare that Professor Huxley's condition is already fairly complied with, judging from the preponderance of evidence, and that "Mr. Darwin's hypothesis," therefore, is "utterly shattered." At all events, evolutionists have to assume that the future will produce results in artificial breeding the exact opposite of the last hundred years, in order to give the least basis to Mr. Darwin's theory.

I therefore declare, by the authority of Professor Huxley, that Mr. Darwin's hypothesis remains "utterly shattered" until such time as he or his coadjutors shall produce the result stipulated, namely, the sterility of artificially produced breeds among themselves and crossed with the normal form, thus making them to resemble natural species.

Professor Huxley ought to be, however, too good a logician to insist on our *proving a negative*, as he here does when he says: "if it could be proved, not only that this *has not been done* but that *it can not be done* . . . I hold that Mr. Darwin's hypothesis would be utterly shattered." This looks very much as if the Professor wanted to make it as unnecessarily difficult as possible for the opponents of evolution! Why does he stipulate so carefully about our proving "that this *has not been done*," when Mr. Darwin and all evolution authorities, including Professor Huxley himself, admit that such a thing as a sterile breed has never been artificially produced? He might, then, show himself a candid opponent, and oblige us by leaving out that part of the contract! It is childish to ask us to prove what he already admits as a fact! As to the other part of his stipulation, that is, for us to *prove* "that it *can not be done*," I must insist that it smacks a good deal of the absurd. I can not prove, and it is not supposed to be my place to prove, but that Mr. Darwin or his lineal descendants may some time or other succeed in turning a pigeon inside out, and still making it breed; and it is not my

business to undertake to establish this negative! Should he base a great revolutionary scientific theory upon such an absolutely preposterous assumption, Prof. Huxley ought to know, and I think does know, that it would be exclusively Mr. Darwin's business to prove it, or else his "hypothesis would be *utterly shattered*" till he did!

Evolutionists have somehow or other secured a reputation for candor, and square logical argument; but I deny that this reputation has been justly earned, judging from the above specimen. Professor Huxley would laugh at an opponent who professed to believe in miracles, but who, after admitting that no miracle had ever yet been performed, should then ask the Professor to prove "that it has not been done"! or who would gravely concede that his belief in the possibility of a miracle "would be utterly shattered" if Professor Huxley would only prove "that it can not be done"! I guarantee that this great anatomist would read his opponent a brief lecture on the elements of logic by informing him that since he had admitted that a miracle had never been performed, it was but a fair presumption that such a thing could not occur; and that instead of asking an unbeliever in supernatural intervention to prove miracles impossible, it was his business to assume the *onus probandi*, and prove that a result could occur in the future which he admitted had never taken place in the past,—ending with the emphatic suggestion that his hypothesis of miraculous intervention must necessarily remain "shattered" unconditionally, till such proof was produced! Are we not, then, fairly justified in proclaiming to the world, on the testimony and by the authority of Professor Huxley, since all evolutionists admit that a sterile species or variety has never been produced artificially, that "Mr. Darwin's hypothesis" is *now*, will be *to-morrow*, and must remain *forever* "utterly shattered," unless such proof of sterility is forthcoming?

I will not waste a long argument on the achievements of the breeder and the fancier, the importance of which has been so often and so much exaggerated in support of evolution. No man knows better than Mr. Darwin that the pigeon-fancier could not make the least improvement in the form or color of a dovecote pigeon except by first noticing some slight chance variation from the normal color or form, which might happen to occur, and then separating and breeding from that individual and its descendants having the same peculiarity, and thus exaggerating that peculiar character, whatever it might be, from generation to generation, by constantly separating and breeding from such individuals as possessed it in the most marked degree.

Should a fancier act on the principle and plan of Nature, according to Mr. Darwin's law of natural selection, and preserve only the hardiest, strongest, or ablest-bodied pigeons, paying no attention to any casual peculiar form of beak, head, crop, or tail, leaving all the species to cross and freely intermingle with the bare exception of following natural selection and weeding out the weak and puny individuals just as survival of the fittest is supposed to do, he would never succeed in producing the slightest difference in the present form and appearance of the pigeon, if he and his successors should follow this course for a million generations! Mr. Darwin and Professor Huxley both know this statement to be literally true. Can any one be so devoid of reason or so blinded by the theory of evolution as to suppose that a succession of even a million fanciers, working twenty-five years apiece, commencing with our common dovecote pigeons and treating

them exactly as Nature treats her species, in preserving only the fittest, the strongest, and the ablest-bodied, subjecting them at the same time to every conceivable variety of conditions, could produce a tumbler, carrier, pouter, or fantail, or the slightest change in form or color? If not, is it not the clearest demonstration that Nature, acting on the same plan precisely, could never have transmuted the wild-rock pigeon into our common dovecote? Yet evolution teaches that natural selection—with no intelligence, prevision, choice, or judgment, without the power of separation, and with no means of preventing free intercrossing, can not only do what a million intelligent men working in succession could not do, but is entirely competent to transmute a pigeon into a hawk, a robbin into a goose, or a sparrow into an eagle!

Mr. Darwin admits that under Nature the dovecote pigeon has not undergone the least change for thousands of years, existing as it has in all varieties of climate from the far north and south to the equator. He says:—

"Dovecote pigeons have remained unaltered *from time immemorial.*"—*Animals and Plants*, vol. i., p. 270.

Now, if dovecote pigeons, living under the greatest diversity of conditions and climate, feeding upon all varieties of food, possessing an organization more susceptible of variation or liable to undergo change than any known animal, shall still remain "unaltered from time immemorial," pray how long would it probably take to change a blue rock-pigeon into a dovecote, with no more diversified conditions or environments, to say nothing about the transmutation of the thousands of species, genera, families, and orders of birds, ranging from the smallest of the trochilidæ up to the ostrich, *from some kind of a reptile?* The mere propounding of such a question, in connection with the fact just quoted from Mr. Darwin, is sufficient to show the practical impossibility of transmutation under natural selection. If no change has been produced in the dovecote pigeon for five thousand years, under the most favorable situations and conditions for divergence, it is but fair to assert that under natural selection no change has ever been produced since this species was originally created. If Mr. Darwin admits, as he does, that a species with the most sensitively varying organism can thus have existed under the greatest variety of conditions and environments for five thousand years, or "from time immemorial," without the least change, it completely overthrows the hypothesis of specific transmutation, until such time as positive proof shall be adduced going to show beyond a peradventure where some one species has been transmuted into another.

Another fact, before leaving this point, must not be overlooked in this estimate of the dovecote pigeon. Tens of thousands of fancy and peculiar artificially bred pigeons have been constantly escaping, from time to time, from the aviaries of the rich and noble of all lands and throughout all historic ages, mingling with the normal dovecotes, as every man will admit who is conversant with the subject,—and thus adding the impetus of their already partially divergent structures to any tendency which might exist among dovecotes toward forming a new breed, thus proving that no such a tendency exists in Nature or ever has existed! It rather demonstrates that the tendency is exactly the opposite, since not the slightest remnant of such artificial forms can be traced among present pigeons.

There is not the least doubt, from the facts here hinted, if a thousand of the most perfectly bred carriers and a thou-

sand pure fantails were let loose in a village where there was an equal number of dovecotes, that not a vestige of the tail of the one or the beak of the other would be visible in their descendants even in ten years after they were free to intermingle. Thus, the direct tendency of every abnormal form in a species is to revert to the normal type, which is the exact opposite of evolution, and a flat contradiction of the possibility of transmutation.

If it be a law, as I have here stated, that an abnormal divergence in a species tends to revert to the normal form instead of tending to perpetuate itself, then Mr. Darwin's assumption of a tendency toward transmutation would be to suppose two laws of Nature acting in direct contradiction of each other, which is utterly impossible. Hence, the overthrow of the transmutation of species is clearly established by the natural tendency of all abnormities to subside into the normal type after a few generations. Evolution does not and can not exist as a law of Nature if this tendency to revert to the normal type be true, since the two tendencies are in absolute conflict.

I shall therefore leave the exploits of the fancier and breeder and the result of their efforts at methodical selection, with the simple remark that all such achievements are necessarily confined to specific limitations,—never have transcended and never can overstep the boundary of a species,—and can exist no longer than the careful efforts of the breeder and fancier continue; and that all argument based thereon supposed to favor evolution results from an erroneous conception of Nature and her laws.

I now invite the reader to the argument based on paleontology and the geologic record. I have no controversy with evolutionists in regard to the age of the earth, or the mode in which the superimposed strata of the geologic formations were produced. Neither shall I enter into the discussion of Genesis or the signification of the creative "days" of Moses. I am willing to take any view of the geologic order, gradation, and succession of species, which best suits evolutionists, and will undertake to show from the paleontologic argument, placed in its strongest light, that it positively and logically contradicts the fundamental principles of evolution, and absolutely overthrows the system.

It has just been shown that the graduation in the anatomy of the various vertebrate species, forming an inclined plane or sliding scale of structure, was directly in favor of the intelligent miraculous production of each specific form, while it was also shown to be entirely inconsistent with the idea of natural selection, since such a law can make no leaps such as those which would have necessarily occurred between typal forms. Hence, as the miraculous creation of the various species has been proved to have a scientific basis, in the necessary creation of one species, and since such miraculous intervention is clearly established as the only logical or rational process supposable in accounting for the alternate breaks and graduations from the moneron up to man, there is nothing at all, therefore, inconsistent with divine wisdom or infinite intelligence in the supposition that the creation of species should have taken place at different epochs of the earth's history, beginning with the lower forms of sponges, polyps, mollusks, and so on upward as the earth's crust became suited for more highly organized beings.

The enormous intervals of time supposed to have elapsed between the origin of one and another of those lower forms of life, or between the deposition of the strata

containing them, though they seem immense to us, are as but a watch of the night when it is past to the all-seeing eye of Him whose self-existent duration is from eternity to eternity.

At however remote a period those lower forms of life were originally produced, and in whatever geologic deposits their remains are now found, there is one great and central truth pervading the entire history of fossils which no evolutionist will dispute, and that is, that all such species at their genesis or first appearance in any geologic formation, are as perfectly developed and as highly organized as they are ever afterward found in subsequently deposited strata. For example, the earliest fish—the ganoid—found in the lowest geologic deposits of the Devonian age, was as perfectly formed and as highly organized as our present species of ganoids—the gars and sturgeons. At the earliest appearance of every species in the history of the earth's crust, the remains are found not only as highly organized and as perfectly differentiated as they ever afterward occur, but in most cases they are more completely developed and of larger and more powerful organization than they are ever found to be in subsequent geologic strata, so that degeneration is the rule rather than transmutation to higher organisms.

How clearly, then, does the fact that all species at their genesis on earth are at their best go to show their origin by direct creation! How demonstrably does it assert that species could not have come by gradual development from lower forms of being, since not a scintilla of such evidence can be found in the geologic record in the form of proper transitional developments! Is it at all likely that the thousands of fossil species which have been found in the rocks, and the same species which have been subsequently traced in hundreds of instances in succeeding orders of strata, should all, without exception, appear at their best at the start, if they came into being as evolution teaches? If evolutionists could name a single paleontologic fact as strong in favor of the transmutation of the higher specific forms from the lower as is this well authenticated fact which points so unmistakably to the miraculous creation of each species, they might well assert, as did Professor Huxley in his recent course of lectures in New York, that the fossil record furnishes "demonstrative evidence" of such transmutation of species.

The assumption of evolutionists that the graduated scale shown in the anatomical structures of organic beings is in favor of transmutation and opposed to miraculous creations has been fully refuted in the early part of this chapter, and such gradation of structure has been made clearly to point toward creative plan and intelligence. Hence, logically, the successive first appearance of different species following each other from the lower toward the higher in the geologic formations could have as easily resulted from creation by infinite intelligence, in six epochs or ages, as to have been formed in six literal days, or all at one fiat. These facts, taken in connection with the entire absence of any *transitional forms* between species which *would not each constitute a "great and sudden leap,"* surpassing any known monstrosity, with that other fact that all species are at their greatest perfection at their genesis, must show the wild and reckless character of Professor Huxley's assertion that any such graduation could constitute "demonstrative evidence of evolution," or even proof of the weakest circumstantial character.

To make it "demonstrative evidence of evolution," it should be shown that species could not possibly have come into exist-

ence in any other way, whereas everybody knows they could have come by miraculous creation, and most probably did so come, since Mr. Darwin admits the first species to have thus originated! Professor Huxley, even, admitted in his New York lectures that these species of the 'hippus might have been created by direct interposition of miraculous power, though he is careful to add that such an hypothesis would not be "scientific"! Who cares whether it is scientific or not? If there is another possible way for them to have originated, then evolution utterly falls short of a demonstration. Can not this great logical scientific lecturer see this?

While Professor Huxley admitted in the lectures just referred to that the earlier fossil remains of animals, such as those mammoth lizards, did not prove evolution, owing to the want of transitional forms connecting them, he consoled himself and his friends with the belief that they did not disprove it, since, if evolution were true, such gradation of forms should exist, and that owing to the "imperfection of the geologic record," the breaks between these species had to be filled by imaginary numberless transitional forms which have never been found. He even went so far as to admit that the fossil remains of the great flying lizards such as the pterodactyl, and other enormous creatures such as the ichthyosauria, plesiosauria, compsognathus, &c., were not direct proofs of evolution, since they do not occur in successive series of deposits corresponding with their gradation of specific structure. I will quote his language, so the reader need not take my paraphrase of it. He says:—

"If we take the particular case of reptiles and birds, upon which I dwelt at length, we find in the mesozoic rocks animals which, if ranged in series, would so completely bridge over the interval between the reptile and the bird that it would be hard to say where the reptile ends and where the bird begins. Evidence so distinctly favorable as this of evolution is far weightier than that upon which men undertake to say that they believe many important propositions; but it is not the highest kind of evidence attained, for this reason, that, as it happens the intermediate forms to which I have referred do not occur in the exact order in which they ought to occur if they really had formed steps in the progression from the reptile to the bird; that is to say, we find these forms in contemporaneous deposits, *whereas the requirements of the demonstrative evidence of evolution* demand that we should find the series of gradations between one group of animals and another in such order as they must have followed if they had constituted a succession of stages in time of the development of the form at which they ultimately arrive. That is to say, the complete evidence of the evolution of the bird from the reptile—what I call the demonstrative evidence, because it is the highest form of this class of evidence; that evidence should be of this character, that in some ancient formation reptiles alone should be found; in some later formations birds should first be met with, and in the intermediate forms we should discover in regular succession forms which I pointed out to you which are intermediate between the reptiles and the birds."

This seems to be a frank statement, and, at the same time, a very damaging one to the theory which the lecturer was laboring to support. He practically admits that all animals found fossilized prior to the genesis of mammals have occurred so irregularly and indiscriminately in the various strata that they fail to keep up the proper succession required by evolution or the demands of Mr. Darwin's law of transmutation. Hence, according to Professor Huxley's own admission, this part of the fossil record, or the formations prior to the appearance of mammals, amounts to absolutely nothing in favor of evolution so far as direct proof is concerned. In addition to this damaging state of the geologic record, the great fact to which I have before referred here stands out in bold relief—that every one of these separate petrefactions is so distinctly marked off and so radically different from the one on either side,

with which it is supposed to connect, as to form a "great and sudden leap," which Mr. Darwin says natural selection never can take.

Professor Haeckel agrees with Professor Huxley that the geologic record, so far as relates to the regular occurrence of fossil reptiles, is all confusion and utterly inexplicable, according to the demands of evolution:—

"The four extinct orders of reptiles *show among one another* and *with the four existing orders* just mentioned *such various and complicated relationships* that in the present state of our knowledge *we are obliged to give up the attempt at establishing their pedigree.*"—HAECKEL, *History of Creation*, vol. ii., p. 225.

In reading such confused attempts to solve the complex problems of the existence of animal species by means of the inconsistent principles and impossible demands of evolution, one sometimes feels disposed to sympathize with rather than to severely criticise these learned professors. It is really a pity to see them battling with such contradictions and irreconcilable problems, when the simple and beautifully consistent admission of a God as the intelligent Cause and Author of all things would at once dissipate their difficulties, no matter how confusedly "the four extinct orders of reptiles *show among one another* . . . such *various and complicated relationships.*"

I assert, as before intimated, that no two fossil species, how much soever they may be mixed up or in what manner they may be blended in the strata, have ever been found so near together in form but that it would require several well defined monstrosities to bridge the chasm between them, and that it would be so regarded by any naturalist should such a break happen to occur between the offspring of any of our present species. Mr. Darwin repeatedly says that it is impossible for natural selection to produce any such result. Besides this, each one of those fossil lizards referred to by Professor Huxley and Professor Haeckel are at their greatest perfection when found in the lowest strata containing their remains. Why should this always occur if transmutation be Nature's process for the origination of species?

It is therefore clear, by the testimony of Mr. Darwin, that natural selection could not have produced the most nearly related fossil species by transmutation, without numberless slight successive transitional forms which do not exist and have never been found in a single instance, while it is admitted by Professor Huxley that these supposed connecting links between classes which he describes do not occur in the proper succession, geologically speaking, to constitute direct proof.

Thus, after the lecturer had made sufficient concessions to practically surrender and absolutely wipe out the whole geologic record as direct proof of evolution up to the genesis of mammals, and in connection with Mr. Darwin's admissions to establish beyond all question the miraculous origin of all earlier species, he finally brings his audience to what he calls his "demonstrative evidence of evolution," and that class of evidence which he declares "rests upon exactly as *secure a foundation as the Copernican theory of the motions of the heavenly bodies*"!

I wish to say to the reader right here that in meeting the geologic argument based on the graduated succession of fossil remains, which many evolutionists consider the strongest class of facts in favor of the theory of descent, it becomes necessary that the very strongest and most demonstrative class of evidence should be examined. I have neither time nor space to take up all the cases of fossil graduation,

and such a systematized review is wholly unnecessary. If the strongest and most representative class of facts can be shown not only not to favor evolution but to be directly and absolutely opposed to it, then it is useless to waste the reader's time on the weaker or less important classes of facts.

Such an authoritative presentation, embodying the very strongest case of "demonstrative evidence of evolution," was naturally spread out before the great New York audience by Professor Huxley last September, in his first course of lectures in this country, when he knew that the eyes and ears of all America were concentrated upon him. It is wholly unsupposable, if there is such a thing as conclusive proof in favor of evolution, that Professor Huxley would not on such an important occasion have presented it; and the fact that he selected the paleontologic argument as the especial branch of evidence, and the "history of the horse" as the particular class of facts suited for that great event, proves that he regarded them as paramount in point of conclusiveness to all others at his command. Hence, if the "history of the horse" shall be clearly and conclusively wrenched from the Professor's hands, and turned with crushing effect against evolution, and thus made to favor the hypothesis of creation as the work of an infinite Intelligence, the reader will hardly care to go any further in search of evidence one way or the other.

Let us now examine this wonderful class of evidence, so "demonstrative" that it places evolution "upon exactly as secure a foundation as the Copernican theory" of astronomy rests on, and the only class of facts which Professor Huxley deemed it prudent to settle down on as "demonstrative evidence of evolution," in the presence of his great New York audience. It consists simply in the fossil remains of five different species of animals somewhat resembling our common horse, and which are assumed by evolutionists to have been successively transmuted, the later from the earlier forms, and all of which constituted the early progenitors of the present horse. Now, so far from this class of facts being "demonstrative evidence of evolution," I undertake to say that it is no evidence at all,—not even the weakest kind of circumstantial evidence,—and that, when carefully examined, this succession of animal forms will absolutely prove to be the very strongest evidence against evolution which any opponent of the theory can desire. I trust the reader will fully agree with this opinion before the argument is concluded.

The names given to these fossil animals in their order, as claimed, from the present horse downward, are the Pliohippus, Protohippus, Miohippus, Mesohippus, and Orohippus. The first in this list has a foot nearly like the hoof of our horse; the second has three fairly developed toes; the third has three toes more distinctly differentiated; and the fourth and fifth still more so,—the last having four toes in front and three behind to each foot. I will here let Professor Huxley, in his own words, draw his sweeping conclusion after reaching this earliest fossil animal called the Orohippus:—

"But this is probably the most important discovery of all—the *Orohippus*—which comes from the oldest part of the eocene formation, and is the oldest one known. Here we have the four toes on the front limb complete, three toes on the hind limb complete, a well developed ulna, a well developed fibula, and the teeth of simple pattern. So you are able, thanks to these great researches, to show that, so far as present knowledge extends, the history of the horse type is *exactly and precisely that which could have been predicted from a knowledge of the principles of evolution*. And the knowledge we now possess justifies us completely in the anticipation that when the still lower eocene de-

posits and those which belong to the cretaceous epoch have yielded up their remains of equine animals, we shall find first an equine creature with four toes in front and a rudiment of the thumb. Then, probably, a rudiment of the fifth toe will be gradually supplied, until we come to the five-toed animals, in which most assuredly the whole series took its origin. That is what I mean, ladies and gentlemen, by demonstrative evidence of evolution. An inductive hypothesis is said to be demonstrated when the facts are shown to be in entire accordance with it. If that is not scientific proof, there are no inductive conclusions which can be said to be scientific. And the doctrine of evolution at the present time rests upon exactly as secure a foundation as the Copernican theory of the motions of the heavenly bodies. Its basis is precisely of the same character—the coincidence of the observed facts with theoretical requirements."

Here, then, we have what may be justly styled the strongest and most demonstrative proof of transmutation of species which the believers in that hypothesis have to present; or, as Professor Huxley expresses it in the citation just made, "*exactly* and *precisely* that which could have been predicted from a *knowledge of the principles of evolution.*" Yet, as strange as it may seem to the reader, it flatly contradicts every known principle of evolution, as I now proceed to demonstrate.

If the reader will turn back to page 445, he will see the true and universally accepted definition of "evolution" as given by Darwin, Huxley, and Spencer. The latter distinctly and repeatedly declares that all evolution or development signifies a change from the *homogeneous* to the *heterogeneous*, from the *simple* to the *complex*, from the *few parts* to the *multiplication of parts*. Instead of this "demonstrative evidence" furnished by Professor Huxley in the history of the horse genus corresponding with these "principles of evolution" as laid down by Herbert Spencer, the lecturer deliberately ignores both the intelligence of his auditors and the accepted definition of words, and assures his hearers that so far from evolution meaning a change from the homogeneous to the heterogeneous it consists in a change from the *four-toed* orohippus to the uni-ungulata, or to the homogeneous hoof of the horse. Instead of evolution being, as Spencer teaches, a change from the simple to the complex, Professor Huxley asserts it to be a change from the complex toes of the orohippus to the simple undifferentiated club-foot of the horse. Instead of evolution signifying a change from the few parts to the multiplication of parts, as this greatest authority on the principles of evolution asserts, Professor Huxley, in defiance of the received definitions of words, assures his audience that evolution is a change from the multiplication of parts to the single part!

Thus, the overwhelmingly "*demonstrative evidence of evolution*," which "rests upon *exactly as secure a foundation* as the Copernican theory of the movements of the heavenly bodies," turns out to be just no evidence at all,—while, at the same time, it flatly contradicts all the ideas and "principles of evolution," and ignores its true definition as acknowledged by the whole world! Was there ever a more signal and pitiable collapse of an argument before an intelligent audience?

Look at the facts, as Professor Huxley and Mr. Darwin both teach, in regard to the theory of descent by transmutation. All mammals, including the horse and the monkey, developed from the marsupial, the earliest mammiferous form, by *evolution*. Some ancient opossum or kangaroo must have divaricated into two lineal branches —one *evolving*, according to Mr. Darwin, toward the monkey; and the other, according to Professor Huxley, toward the horse. The branch leading toward the monkey *evolved* by having its fingers and toes still more and more differentiated, till they were brought by evolution to perfection in the

quadrumana, or till they were gradually developed from the simple to the complex and from the homogeneous to the heterogeneous,—while the branch leading toward the horse had its fingers and toes gradually taken away by evolution, or changed from the complex to the simple and from the heterogeneous to the homogeneous! Which, now, Professor Huxley, must we understand to be the *evolution* and the *development*,—the process leading toward the monkey, which cultivated the fingers and toes of the marsupial and improved upon their differentiation, or the process leading toward the horse, which reduced them more and more, and finally took them entirely away? Both surely can not be evolution, and it requires very little intelligence to answer the question and to determine on which side this startling "demonstrative evidence of evolution" is forced to take its stand. Professor Huxley's lectures are thus utterly broken down by a simple comprehension of the meaning of the words he employs.

His "demonstrative evidence of evolution" turns out to be about as serious a joke as was the sermon of the illiterate minister who took for his text the words—"I knew thou art an *austere* man." He mistook the word "austere" and read the passage—"I knew thou art an *oyster*-man." The upshot was, his congregation was treated to a dissertation on the manner of laying out and planting oyster-beds, the various means employed for designating their localities, and the danger of an incompetent harvester raking in the wrong beds, and thus reaping where he had not sown and gathering where he had not strewn!

Professor Huxley gave his New York audience almost a perfect duplicate of this sermon. He took for his text the "history of the horse," and fastened upon the word "evolution," applying it to the supposed transformation of the orohippus, with four perfect toes, into a horse, with no toes at all,—and thus, to the amusement of the reflecting portion of his congregation, he showed a complete misunderstanding of the leading word in his text, making it teach the exact opposite of its true signification all the way through! Instead of selecting "evolution," he should have chosen the word "deterioration" or "retrogression," since those words convey the exact idea he was trying to develop. While aiming to prove that the orohippus, with four distinctly developed and highly differentiated toes, had gradually degenerated into the horse, with a single, homogeneous, undifferentiated, clumsy hoof, he innocently supposed, and so did some of his congregation who happened to be no better posted than the Professor, that this going backward was development,—this retrogression was survival of the fittest,—and this degeneracy was evolution! He then wound up, as I have quoted: "That is what I mean, ladies and gentlemen, by *demonstrative evidence of evolution*"! In precisely the same manner the minister closed his sermon: "That is what is meant in the text, brethren and sisters, by an *oyster-man*"!

It will not do to assume, in order to escape this difficulty, that the horse's feet were degenerated toward homogeneity from the four-toed orohippus, to improve the speed or endurance of the animal, since the leopard or the antelope is swifter than the horse, while a team of Esquimau dogs will do more work and travel farther on a less quantity of food in proportion to their size than any horse-team in the world. Besides, how are evolutionists able to know but that the orohippus was far swifter and of greater endurance than the present horse? There is nothing in a clumsy hoof

which necessarily adds either to speed or endurance.

Professor Huxley will hardly assume that the foot of the horse was gradually changed from the complex toes of the orohippus into its present form of a hoof, to subserve a useful purpose and add to the happiness of man. A believer in God's providence and in an intelligent Creative Will can easily admit that the horse, hoofs and all, was a special creation, intended principally for man's good. But a believer in a primordial atom of protoplasm as all the God there was in the universe to originate not only the horse but all other organisms, including man, and who denies the existence of any primeval intelligence, plan, or purpose, in the infinite diversity of design, use, and ingenious adaptation, seen everywhere in Nature, will hardly step beyond the blind, mindless, and senseless purview of evolution,—which, had it worked at all on the orohippus, must have taken its already differentiated toes forward toward the feet of the monkey instead of backward toward the hoofs of the horse. Whenever Professor Huxley shall give a particle of proof that an orohippus or any other toed animal can by any possibility or any imaginable consistency have its toes aborted while constantly using them, he may then, and not till then, employ the word "evolution" as synonymous with degeneracy or retrogression.

By thus summarily wrenching the "history of the horse" from the possession of Professor Huxley, we are again squarely brought face to face with the important and irresistible fact, as taught so many times and so distinctly by Mr. Darwin in defining the office of natural selection, that it can not work by taking sudden leaps or by preserving monstrosities at all,—which, should they occur, would be lost and obliterated by intercrossing (see pp. 394, 395); but that it must proceed by "*short* and sure though slow steps," and by "slight successive variations"!

Now, who does not know that the change, for example, from the four-toed orohippus to the three-toed mesohippus would necessarily have constituted a monstrosity or a "great and sudden leap," had it occurred in any species at the present time, to say nothing of the other marked differences between these two forms of 'hippus? Who can not see that the change from the three distinct toes of the pliohippus to the homogeneous hoof of our horse would have constituted a "great and sudden leap" never heard of in a monstrosity which could be perpetuated?

The assumption of both Darwin and Huxley that there were numerous transitional forms dividing up this "great and sudden leap" from one of these species to another amounts to nothing. It is a mere hypothetic guess to obviate a difficulty. Such transitional forms have never been found, and until they are found it is a mere imaginary assumption, no better than any other guess, as will in a moment be conclusively proved by Mr. Darwin. We have only to deal with the facts as they are discovered, and every such fact so far brought to light constitutes but another "great and sudden leap" like the archæopteryx, which Mr. Darwin says could not have been produced by natural selection without the hundreds of slight transitional steps leading from one to the other, which have never in a single instance been brought to the surface.

Hence, as the interval between any two species yet discovered, either fossil or living, constitutes a "great and sudden leap," which natural selection could not have taken without many transitional intervening forms which have never been found, it conclusively follows that the entire

theory of evolution rests upon something which does not now exist in Nature; and which, judging from the geologic and paleontologic records, never has existed, and, as seen by the efforts of breeders and fanciers, never can be made to exist. What a baseless, foundationless thing, then, is the theory of modern evolution! What a shallow scientific hypothesis on which to build a great revolutionary doctrine, to assume that because species have a general anatomical resemblance they must have come by transmutation the one from the other, while admitting that natural selection could not possibly have taken the "leaps" necessary to form them! And, finally, how absurd to deny their creation by infinite power and wisdom, because they have just such a family resemblance as would constitute one of the strongest arguments in favor of such monistic origin!

But Mr. Darwin is himself the strongest witness against Professor Huxley's "demonstrative evidence of evolution" drawn from this so-called "history of he horse." I assert, on the authority of the founder of modern evolution, that Professor Huxley has not one particle of evidence or reason for believing that one of these 'hippus species was derived from another, and that no such evidence can exist *without the "intermediate links" connecting them.* I will now demonstrate the truth of this startling assertion by Mr. Darwin's own words. If I do so, without the least perversion of his language, then away goes Professor Huxley's demonstration! Here is the fatal passage:—

"*We should not be able to recognize a species* [such as the *orohippus*] as the parent of another and modified species [the *mesohippus*] *if we were to examine the two ever so closely, unless we possessed most of the intermediate links;* and owing to the imperfection of the geological record we have no just right to expect to find so many links."—"Although geological research has undoubtedly revealed the former existence of many links, bringing numerous forms of life much closer together, *it does not yield the infinitely many fine gradations between past and present species required on the theory;* and this is the most obvious of the many objections which may be urged against it."—DARWIN, *Origin of Species*, p. 408.

Here the whole bottom falls out of Professor Huxley's "demonstrative evidence of evolution," drawn from these five graduated species resembling the horse. No paraphrase of mine can possibly render the words of Mr. Darwin more directly applicable to the case in hand, or more crushingly conclusive against Professor Huxley's "demonstrative" failure.

Had Mr. Darwin been an opponent of evolution, and had he been making a direct reply to Professor Huxley's position, that the five species of 'hippus "demonstrably" proved that the later were developed from the earlier forms, he could not have used language more to the point or which would have more flatly contradicted the Professor's assumption. Or had some one risen in the audience at the close of his great New York lecture and read this single passage from Mr. Darwin's book, it would have effectually and beautifully pricked the enormous bubble which had been so arrogantly inflated and pronounced equal in point of conclusiveness to the "Copernican theory of the motions of the heavenly bodies"! Neither Professor Huxley nor any one else could have made the least reply to these words: "*We should not be able to recognize a species* [orohippus] *as the parent of another and modified species* [mesohippus] *if we were to examine the two ever so closely, unless we possessed most of the intermediate links*"! Yet Professor Huxley, in the presence of his New York audience, after a mere cursory examination of these two forms, without the presence of one of the transitional links

which Mr. Darwin designates as "the *infinitely many fine* gradations" connecting them, declares the one to be the progenitor of the other, and that the fact is thereby so "demonstrably" established as to be equal in certainty to the Copernican system of astronomy! If there had been a schoolboy in that audience ten years old who could not have overthrown this whole "demonstrative evidence of evolution" with this single quotation from Mr. Darwin, he ought, as a just punishment for his stupidity, to be compelled to attend a lecture of Professor Huxley once a year during his natural lifetime!

Notwithstanding all this, these distinct species, which Mr. Darwin so emphatically declares can not constitute the least proof that one was the progenitor of another "*if we were to examine the two ever so closely, unless we possessed most of the intermediate links*," which everybody knows have never been found, are spread out by Professor Huxley before his New York audience, without even claiming that such "infinitely many fine gradations" ever existed, and then are proclaimed in a triumphant and eloquently worded peroration to be "demonstrative evidence of evolution" *resting upon "exactly as secure a foundation as the Copernican theory of the motions of the heavenly bodies"!* Yet Professor Huxley knows, and so does every tyro in science, that the Copernican system of astronomy is so certainly established *that hundreds of ascertained and universally admitted facts could not exist at all if that system were not mathematically true!* Where is there one single known fact which depends for its existence on the truth of evolution? We have only to look at this startling and unpardonable assertion to be able to properly estimate all the other statements made during these remarkable lectures.

If Professor Huxley does not know, he surely ought to, that no proposition was ever *demonstrably* proved which admitted of another and exactly opposite interpretation, much less is a proposition demonstrated when the only evidence in support of it is based on a mere inference, which is compelled absolutely and flatly to contradict the meaning of the words employed in the solution to afford such proposition any kind of support, as is the case with Professor Huxley's great demonstration! Whereas, the Copernican system of astronomy admits of no other conceivable explanation since the solar system has been surveyed by means of the telescope, while hundreds of astronomical and mathematically demonstrated facts, as just remarked, prohibit any other imaginable interpretation. A more absurdly perverse and reckless statement than this of Professor Huxley, in comparing the scientific basis of evolution, as shown by the "history of the horse," to that of the Copernican system of astronomy, was never made by a scientist having the least reputation for accuracy of judgment. How an intelligent audience, composed of scientific and learned men, could sit by quietly and hear such a monstrous and transparent fallacy proclaimed to the world without rebuking it on the spot is more than I can see. Had I been present I feel convinced that I could not have restrained myself from publicly denouncing such a statement as scientific blasphemy! As I was not present, I take the liberty of doing so on this page, here and now; and with it, of expressing the deliberate opinion that a scientist as well informed as Professor Huxley must be, who can write out and then read to a great audience such a statement, in defiance of the laws of logic and the facts of science, justly forfeits the confidence of the world till such time as he shall publicly renounce it. For it has been shown by the highest au-

thority that if the horse came from the orohippus at all, it must have come by some principle or process *the exact opposite of evolution!* Hence, the reader can appreciate "the marvelous flexibility of language" which admits of such an interpretation, as well as the marvelous audacity and reckless disregard of the received meaning of words in a great lecturer who would thus assert publicly and premeditatedly that *evolution*, resting upon facts, which, if they exist at all, prove exactly the opposite, is thus based on as sure a foundation as the present mathematical system of astronomy! Such a case of either scientific effrontery or ignorance, or both combined, has never before been witnessed in this city. It would almost seem that Professor Tyndall had Professor Huxley in his eye when he said:—

"The desire to establish or avoid a certain result *can so warp the mind as to destroy its power of estimating facts.*"—*Fragments of Science*, p. 47.

Unless Professor Huxley's intellect was absolutely *warped* to mental blindness by his anxiety to sustain evolution, he must have known better than to assert that there existed the slightest comparison between the character of evolution as a demonstrated theory and that of our present system of astronomy. Whenever the Professor can take up the principles of his evolution hypothesis and figure back thousands upon thousands of generations, and point out the exact time when and process by which, in all its details, the orohippus lost its fourth toe and commenced to change into the mesohippus with but three toes, and tell exactly how long the change was in being effected, then, and not till then, can he dare to assert that evolution "rests upon exactly as secure a foundation as the Copernican theory of the motions of the heavenly bodies." The advocate of the Copernican theory can go back tens of thousands of years, or even to the time of the orohippus, and tell to a single minute when an eclipse of the sun or moon commenced or ended; and he can then figure forward, under the rules and principles laid down by Copernicus, Kepler, and Newton, to the far-distant future, and record with mathematical certainty the precise minute when Venus shall begin its ten-thousandth transit from the one recently witnessed!

What inscrutable assurance, then, in a scientist asserting in the face of such mathematical facts as these that the evolution of the horse, by its degeneracy from a more highly organized and differentiated animal, is as *demonstrably established* as the Copernican system of astronomy! Yet these are the teachers who sneeringly allude to the marvelous flexibility of Scripture language, which may possibly have a double signification,—who vauntingly bid us accept such science (!) as *evolution*, based on the "history of the horse," in place of the religion of the New Testament,—who learnedly ignore Intelligent Causation,—who laugh at the superstitious idea of the immortality of the soul,—and offer as a substitute for all these this "demonstrative evidence" that we are lineal descendants of pollywogs and lizards!

I shall here, in parting from Professor Huxley, take the liberty of turning him directly against himself. He asserts in these lectures that *evolution* is a *true physical cause* for the orohippus with four toes changing into the mesohippus with three toes, and then into the horse with no toes, while "evolution" means exactly the opposite, and while such a difference necessarily constitutes a "leap," which Mr. Darwin says natural selection can not take. The Professor remarks:—

"A *true physical cause* is, however, admitted to be such *only on one condition—that it shall account*

for all the phenomena which come within the range of its operation. If it is inconsistent with any one phenomenon it must be rejected."—HUXLEY, *Man's Place in Nature*, p. 126.

Now, this completely overthrows the theory of descent, for here is "one phenomenon" with which evolution is diametrically "inconsistent," since it means the opposite in every sense of the word, and therefore, by the authority of Professor Huxley himself, "*it must be rejected*" as "a true physical cause"! Does not evolution, therefore, "fall to the ground" at the hands of one of its ablest exponents? (See another quotation from Professor Huxley, equally fatal, on page 325.) For surely, as the difference between any one of these species of 'hippus and the one nearest to it constitutes necessarily "a great and sudden leap," which natural selection could not take, if Mr. Darwin is admitted as authority, unless connected by numerous "slight successive variations," it follows that so long as such slight transitional forms are not produced and can not be produced as evidence, so long does evolution fail to constitute "a true physical cause," and therefore "must be rejected." If Professor Huxley shall say that such transitional forms in the shape of "slight successive variations" will yet be found some time in the future, then, I answer, wait for your "true physical cause" till they are found and produced as evidence; for, until such time, evolution "must be rejected," by your own consistent law of logic, as here laid down!

I have thus considered all the main arguments heretofore advanced by evolutionists in support of Mr. Darwin's theory of descent. I began with *reversions* and the great class of arguments based on *embryology*, leading on to *rudimentary organs*, *anatomical resemblance*, the achievements of the *breeder* and the *fancier*, ending with the *geologic record* and the graduated succession of *paleontologic remains*.

By the simplest and most casual analysis, and even from a superficial examination of these various classes of facts, it has been seen that every argument relied upon in support of evolution not only fails to aid it in the slightest degree but has been shown to be directly and absolutely opposed to the system, by fair rules of logic and universally accepted definitions of words. It must therefore strike the reader —since not a single argument heretofore considered unanswerable is found to favor the theory, but that all classes of physiological and biological facts are opposed to it—that a weaker and more fallacious scientific hypothesis has not been seriously proposed from the days of Aristotle to the present time. It is simply a matter of astonishment that every argument adduced by these authors, on being brought to the test of even a casual examination, should not only have turned out hopelessly weak but utterly self-stultifying. That a number of the greatest naturalists and most learned scientists, such as Darwin, Huxley, Wallace, Tyndall, Haeckel, Spencer, &c., should not have been able to see the utter inefficiency and defectiveness, to say nothing of the self-contradiction of the main arguments they have been employing for so many years, is enough to weaken one's faith in the value of intellectual culture or the benefits resulting from a scientific education. At all events, it goes to show that the time has come for people, even of the most ordinary education, to think for themselves rather than subscribe unreservedly to the opinion of any scientist, however learned, —believing, as they may safely do, from this on, that the greatest minds oftentimes fall into the greatest errors.

CHAPTER XI.

DIFFICULTIES AND INCONSISTENCIES OF EVOLUTION.

The Origin of Wings in Birds, Bats, and Insects, Wholly Inexplicable on the Principles of Natural Selection.—A Difficulty which Evolutionists never Attempt to Meet.—Natural Selection can Only Work on Useful Organs and Variations.—Incipient Wings shown to be not only Useless but Injurious, if they ever Existed.—As Natural Selection can make no "Leaps," Wings must have been Miraculously Created.—Reasons for this Conclusion.—The First Wings demonstrated to have been Miraculously Formed.—All Mechanical Operations which Overcome Laws of Nature, Supernatural.—No Device, such as a Wing, where Multiplied Parts show Design for One End, can Result Without Primordial Intellect.—The Flying of Human Beings, by Mechanical Wings Alone, not only Possible but Probable in the Near Future.—Mr. Darwin's Theory Again Breaks Down by his own Express Stipulation.—The Rattlesnake's Musical Appendage could not have been Started by Evolution, even if it could Afterward be Improved by it.—The Venom of Serpents Conclusive Proof Against the Theory, being a Wonderful Chemical Combination Relating Solely to Other Organisms.—It could only have Originated by Prior Intelligence.—The Vegetable Kingdom has Many Examples of Design, and a Clearly Intelligent and Preconceived Intention.—The Pappus of the Thistle and Dandelion, for Carrying Seeds through the Air, could not have Originated by Natural Selection, as their Incipiency would have been Wholly Useless.—Mr. Darwin Admits that on Certain Conditions his Theory would be Annihilated.—The Conditions Distinctly Complied With, to the Letter.—Peculiar Odor and Flavor of Ants and Bees made for the Special Benefit of Other Species.—The Odor of the Fox's Feet not for its own Good (since it leads to its Destruction), but for the Advantage of the Dog and Wolf.—Inconsistencies of Evolution Pointed Out.—The Mane of the Lion claimed by Mr. Darwin to have been Developed as a Protection.—The Question of the Neck of the Giraffe having been Elongated to Reach the Branches of Trees Examined.—The Whole Supposition Shown to be Clearly Absurd.—The Trunks of Elephants Considered.—The Hive-Bee's Sting Developed to Cause Suicide if Used.—Natural Selection could not have Produced it.—Useless Bees, such as Hornets, Wasps, and Bumble-Bees, can Sting Without Danger to Themselves.—The Reason Why, and a Design in this Difference.—The Mimicry of Insects, Worms, &c., for Protection from Birds, Examined.—Mr. Darwin Congratulates Himself that he has Aided in Overthrowing Creation.—A Former Pledge Redeemed.—Professor Haeckel Proved to have Unwittingly Yielded the Whole Question of Evolution.—He is Indorsed by Mr. Darwin.—The Proof Conclusive.—Mr. Darwin again Admits his Theory will "Break Down" on Certain Conditions.—These Conditions Pointed Out in Hundreds of Instances.—He Furnishes Himself the Direct Proof which Breaks Down his Theory.—He Virtually but Unwittingly Admits that Wings must have been Created.—Self-Contradictions and Inconsistencies Multiply.—The Theory of Descent Hopelessly Breaks Down.

The object in this closing chapter will be to point out some of the more prominent and manifest difficulties in the way of evolution as a reasonable or scientific hypothesis, and to indicate such contradictions and inconsistencies as can not possibly be found in a theory based on truth, whether claiming to be scientific or not.

The evident impossibility of the origin of *wings*, for example, in flying animals, such as birds, bats, insects, and some reptiles and fishes, by natural selection, is alone sufficient to overthrow evolution if there was not another objection to the hypothesis. It is a difficulty which has not only never been answered, but has remained a distinct rebuttal of the evolution hypothesis ever since the first publication of Mr. Darwin's *Origin of Species*. In his later editions of that work, he has had the

candor to refer to this objection and state it, but has lacked the candor to admit its unanswerable character,—while, at the same time, he does not even make an attempt to meet it. No better proof need be asked to show that the origin of wings must have been the result of special miraculous creation than this failure on the part of all evolutionists, from Mr. Darwin down, to point out even a supposable solution on the basis of natural selection. If any imaginable explanation had been possible it would surely some time or other have been attempted. How such great naturalists as Darwin, Huxley, and Haeckel, can feel satisfied to still believe in evolution while quietly ignoring this crushing difficulty, seen in its millions of forms all around them,—while each bird, bat, or insect, constitutes a perpetual refutation of their theory of natural selection,—is more than I can comprehend. The reason why they can not even attempt an explanation of this problem will now be clearly shown.

Natural selection, Mr. Darwin repeatedly and particularly reminds his readers, can not, in the first place, produce an organ of any kind, since it can not even cause the smallest *variation*, thousands of which it takes to constitute an organ, if carefully preserved. It can only cultivate organs *after they exist and are useful*, by saving in one direction such variations as "arise" by unknown laws, and tend to add to their usefulness:—

"Several writers have misapprehended or objected to the term *natural selection*. Some have even imagined that natural selection induces variability, whereas it implies only the preservation of *such variations as arise* and are *beneficial* to the being under its conditions of life."—"Unless *favorable variations* be inherited by some at least of the offspring, *nothing can be effected by natural selection*."—DARWIN, *Origin of Species*, pp. 63, 80.

Mr. Darwin and other evolutionists can easily tell how natural selection might cultivate a bird's wings by making them more and more effective after such wings exist, and are so far useful as to answer the functional purpose of *flying*. But until the wings of birds are so far developed as to actually serve the purpose of flight they are utterly useless (with a very few exceptions, as in the case of the ostrich,) and Mr. Darwin is well aware of it. Hence, natural selection could not have touched the first bird's wings during all their incipient stages of development, since such stumps or rudiments of wings could have been of no service to the bird. The common intelligence of every reader must assure him that a stump of a wing in any animal would not only be useless but would be a clumsy and awkward appendage, burthensome for transportation and requiring extra nutrition for its growth and waste of substance. Hence, during all the incipiency of the wing-bones in starting the organ, or until the wings became at least of sufficient size to aid in running, as with the wings of the ostrich referred to, they would be not only useless but harmful, for the reasons given. No answer can possibly be made to this state of facts; and therefore no answer has ever been attempted.

There is a distinct intelligent design in the wing of a bird, bat, or insect, and it defies the ingenuity and reason of any man to conceive of such adaptation of the most wonderful mechanical principles and parts to uses and results, without admitting an intelligent purpose in the very incipiency of the mechanism. Atheism, materialism, pantheism, evolution, and every other theory or philosophical hypothesis which denies the absolute and intelligent existence and intervention of a personal Creator must forever stand dumb and confounded in the presence of a humming-bird. The whole question of evolution, with its truth or falsity, is thus narrowed right down to

this one class of facts—the wings of birds. If they could not, by any possibility, have been originally produced by natural selection, as I will now demonstrate, then the intervention of an intelligent Creative Will is an unavoidable necessity. No candid evolutionist can or will dispute this.

The idea of the possible development of a wing by natural selection saving up slight favorable variations is a very different thing from the development of a leg in a snake, for instance, or any animal which is legless, and which moves on the ground. Evolutionists might, with some show of plausibility, claim that the nascent leg of a reptile, even in its most incipient rudiment or before it showed through the skin, might be of some use in causing a sensible protuberance of the surface at that portion of the body which might act upon the ground in helping to move the body of the snake. But not so with the wing of a bird. All its earlier stages of development would not only have been useless but actually harmful, as shown, consuming nutrition and strength for transportation; and therefore natural selection, so far from assisting its development, would, aided by the economy of growth, have suppressed it, since Mr. Darwin in a score of places reiterates the law that natural selection "acts only," "acts exclusively," "acts solely," in saving variations which are "beneficial," while he repeatedly tells us that "This preservation of *favorable* individual differences and variations, and the *destruction of those which are injurious* [such as partly developed wings, which could be of no service,] I have called natural selection or survival of the fittest."—(*Origin of Species*, p. 63.)

The movement of any body through the air which is many times its specific gravity is utterly *unnatural*, and opposed to every law or principle of evolution as expounded by Mr. Darwin above. Such a mode of locomotion as the movement of a body through the atmosphere having a thousand times its weight *being absolutely opposed to Nature, is, therefore, in its original design and construction, supernatural!* Being supernatural, and depending for its accomplishment on the combination of numerous mechanical devices and principles, in opposition to the laws of Nature, and embracing the highest elements and faculties of reason, it amounts to an absolute demonstration that the first wings were constructed and adapted to their use by an intelligent Creative Will!

Evolutionists often ask their opponents to produce a miracle. I assert that birds, bats, and insects, are perpetual and unmistakable miracles, at least in their primal origin, according to the intrinsic definition of the word. Our dictionaries define a miracle to be *a supernatural event—an occurrence contrary to the established laws of Nature.* The flying of a bird, a thousand times heavier than the air, is a purely mechanical process,—an operation of the very highest order of intelligent skill,—and is accomplished in violation of the central law of Nature—*gravitation.* There is no part of the process of flying but what is or must have been in its primordial commencement a miraculous operation, since all mechanical results come from the intelligent use of one law of Nature by which to overcome another, and are therefore supernatural events.

Thus, evolutionists have the indisputable proof of *bona fide* miracles all around them all the time; while the inventor who shall in the future construct an apparatus by which a man may fly through the air by the mechanical aid of wings alone, operated by his own individual strength, will have wrought a new miracle in mechanics, and one of the greatest since the world began. Such a supernatural event I believe not

only possible but probable, and in strict accord with the rapidly advancing triumphs of human skill in employing one set of Nature's laws to overcome and render subservient another set.

While the assumption here maintained (that the incipient structure or unuseful stage of a bird's wing, if developed at all, could not have been produced by natural selection,) would seem an almost self-evident proposition, I will add a few remarks and quotations which will prevent the most casual reader from losing the annihilating force of this single argument.

I have already shown from Mr. Darwin, as just quoted, that natural selection can not *induce* a single variation, much less a whole organ,—that it can "*only*" save by survival of the fittest those slight variations which happen to "*arise*" and are "*beneficial*" to the creature. As shown in the preceding chapter, Mr. Darwin lays it down as a law of evolution, that natural selection can not advance by *sudden leaps*, but must proceed by means of *short and slow steps*. I will add here a citation or two:—

"Natural selection *acts only* by taking advantage of *slight successive variations;* she can never take a *great and sudden leap* [such as producing an efficient *wing*], but must advance by *short and sure though slow steps*."

"Natural selection is a *slow process*, and the same favorable conditions must long endure in order that any marked effect should thus be produced."

"As natural selection *acts solely* by accumulating *slight successive favorable variations*, it can produce no *great sudden modifications* [such as a useful wing]; it can *act only by short and slow steps*."

"Natural selection *acts exclusively* by the preservation and accumulation of variations which are *beneficial*."—DARWIN, *Origin of Species*, pp. 97, 156, 180, 413.

The reader can not misunderstand this language. A wing of a bird has a score or more of distinct, ingenious, but co-ordinated parts and devices, each of which is essential to make it useful, the whole showing unmistakably the work of the highest order of intellectual skill and designing capability. Such a complex and perfect organ could not have come by chance as a monstrosity or a single spontaneous variation. It could not have been produced by evolution, for natural selection makes no "sudden leaps" nor saves any such monstrosities should they occur, since it "acts solely by accumulating *slight* successive favorable variations," and "can act *only* by *short* and *slow steps*." As if to impress it on the reader's mind, Mr. Darwin takes pains to show that monstrosities, should they occur in a species, can not be saved by natural selection, but will be soon lost and obliterated by intercrossing with the normal individuals. (See pages 394, 395, of this book.) He also adds:—

"We have abundant evidence of the constant occurrence under Nature of *slight individual differences* of the most diversified kinds; and thus we are led to conclude that species have generally originated by the natural selection, *not of abrupt modifications*, but of *extremely slight differences*."—*Animals and Plants*, vol. ii., p. 495.

Here, then, we have the demonstration, so completely established by Mr. Darwin himself that there is no evading or misunderstanding it, as follows: The wing of the first bird in its incipient stages, if it came by "short and slow steps" at all, would have been wholly useless, and not only useless but absolutely injurious during numberless generations of incipiency, for reasons given. As "natural selection acts *exclusively* by the preservation and accumulation of variations which are *beneficial*" and "the *destruction* of those which are injurious," it could have done nothing toward developing the first pair of perfect wings, since it could not *touch* them till they were already sufficiently developed to be *useful*, except to destroy them as "injurious" appendages! Hence, here is one complex

organ, in tens of thousands of forms, which is outside of the operations of evolution, and must therefore be inevitably relegated to the intelligent workings of the Creative Will. Can anything be more clearly demonstrated?

How completely, then, does Mr. Darwin's theory again "break down" by his own definite stipulation, already quoted. Here it is reproduced, that the reader may not lose the benefit of the edifying lesson which it inculcates:—

"If it could be demonstrated that any *complex organ* [such as the wing of a bird] existed, which could not possibly have been formed by numerous successive slight modifications, *my theory would absolutely break down.*"—DARWIN, *Origin of Species*, p. 146.

The *demonstration* is "absolutely" complete, since it is in Mr. Darwin's own very concise and unmistakable language. Not only have we "demonstrated" a single "complex organ"—all he stipulates—which could not "possibly" have been produced by "numerous successive slight modifications," but we have pointed out countless millions of them all around us in the wings of the myriad birds, bats, and insects, not one of which could have been so produced, since they would have been utterly useless during all their "numerous successive slight modifications," or until they had attained functional capacity! I ask the reader, therefore, does not his theory "absolutely break down"?

The wings of flying creatures are not the only organs, however, which necessarily "break down" Mr. Darwin's theory. He alludes to the musical appendage of the rattlesnake as intended to frighten away its enemies. Now, we can safely admit that natural selection might cultivate this rattling apparatus, making it more and more useful after it had been so far developed as to produce an alarming sound, by continually preserving those reptiles which had the best developed rattles. But what produced this rattle in its incipiency up to the point of utility? What caused the *first joint* of this rattle, which will make no sound and would be of no possible use in alarming enemies? Then, what prepared the end of the tail especially for the growth of such an organ? Natural selection did not do it, as it can *act only* on useful or beneficial organs! Hence, the rattle of this snake was originally designed by an intelligent Creative Will, and thus "absolutely" breaks down the theory of descent, according to Mr. Darwin's definite agreement.

Not only the rattle but the encysted poison beneath the serpent's fangs is clearly beyond the power of natural selection. This venom has exclusive reference to the organisms of other animals, and involves the nicest and most profound knowledge of chemical principles. It is not of the least direct use to these reptiles, as they are proved to live just as long after the vesicle is removed. As serpents are among the earliest land animals, they were produced with this most complex chemical adaptation to other animals long before their natural enemies were in existence! Hence, even if the gradual development of this poison in the snake were possible by natural selection, as a weapon of offence and defence, through its relationship and combats with other animals, it is utterly barred, since its natural enemies had yet to be created.

But if even they had existed, the incipient correlation and co-ordination of ingenious parts necessary to make this poison beneficial as a weapon is entirely beyond the power of natural selection. Without the tubular fang the poison could not be conducted into the wound, to be made effectual; and without the vesicular cyst secured to the base of the fang and open-

ing into its conduit, the poisonous secretion would be of no use. Which was developed first—the hollow tooth or the vesicle to contain the poison? Either of them developed before the other would have been *useless*, and hence could not have been produced by natural selection, as Mr. Darwin tells us in twenty places. If they were both gradually developed together, what good would a partly developed sac have done, or while in its incipiency, before it would hold the poison? —and of what use would a fang have been with its conduit but partly perfected?—and of what benefit would both have been if the complex secretive vessels conveying the fluid to the sac had been absent?—and then how could the poison have been injected into the wound after the cyst, the secretive vessels, and the hollow tooth, were perfect, but for that most wonderful system of muscles by which the contraction of the cyst is effected? Yet all these complicated parts, if developed at all, were, during their incipiency, absolutely worthless so far as their ultimate end or use was concerned,—since, being of no use to the serpent itself, they were only serviceable as a weapon when perfected and all combined so as to act in co-operation and correlation.

It conclusively follows, therefore, as natural selection can "act only" in cultivating useful organs, that the cyst, the contracting muscles, the secretive ducts, and the tubular fang, in all their incipient stages of development (if developed at all) were completely beyond the reach of evolution, and hence must have been the result of a designing and intelligent Creative Will. These are only bare specimens of the tens of thousands of insuperable difficulties in the way of Mr. Darwin's theory of development throughout every department of Nature's polity.

Even in the vegetable kingdom the same law prevails. There are many organs in flowers and plants, such as numerous species of. orchids, which could only have been formed and adjusted to their uses by the designing capacity of an intelligent Creative Will,—organs which would have been wholly *useless* in their incipient stages of development if gradually produced by evolution. They must therefore have been created complete, or at one "sudden leap." I will give but a single illustration of this law in the pappus of the thistle or dandelion, which I have never seen noticed. Mr. Darwin urges, and correctly I have no doubt, that the real design or object of the thistle-down is to carry and distribute the seeds of the plant by floating them through the air. Yet he is so short-sighted as to suppose that natural selection could build up this pappus to its floating capacity by "short and slow steps," while such down in its incipiency would have been absolutely useless, and therefore beyond the reach of natural selection! I will quote his words:—

> "If it profit a *plant* to have its seeds more and more widely disseminated by the wind, I can see *no greater difficulty in this being effected by natural selection* than in the *cotton-planter* increasing and improving by *selecting the down in the pods on his cotton-trees*."—*Origin of Species*, p. 67.

Really, if Mr. Darwin is so blinded by evolution that he "can see no greater difficulty" in the operations of a thistle under so-called natural selection than in the intelligent selection practiced by the cotton-planter, he ought to see no manner of "difficulty" in the miraculous creation of each separate species. The truth is, no man can candidly say what Mr. Darwin so deliberately says above and be in a state of mind to reason logically on any subject. Besides, the cotton-planter would not think of improving the down of his

cotton-pods till the down existed. Here, then, by this single illustration, evolution completely breaks down; for, as natural selection can only act on the thistle-pappus after the down has attained a useful size, or is sufficiently developed to admit of its being carried by the wind, will Mr. Darwin tell us what started this incipient down and developed the beautifully complex organ out of which these myriad hairs shoot? This *focal organ* is specially adapted to the outgrowth of these down-hairs, and is of marvelously complex structure under microscopic power, containing hundreds of separate and correlated parts, and hence must have been specially prepared for the development of that mass of down! It follows, therefore, that natural selection is utterly overthrown, since this focal organ, with its countless incipient hairs of down were absolutely useless till the down was sufficiently developed to be drifted by the wind. Hence, natural selection could have had nothing to do with it in its original and complicated structure, and therefore Mr. Darwin's theory must "absolutely break down," by his own express stipulation.

I am compelled to admire the extravagantly liberal propositions of Mr. Darwin, if I am obliged to disagree with his logic. He not only stipulates that his "theory would absolutely *break down*" if a single organ could be found which natural selection could not have developed, but he frankly declares:—

> "If it could be proved that *any part* of the structure of *any species* had been formed for the exclusive good of another species *it would annihilate my theory*, for such could not have been produced by natural selection."—*Origin of Species*, p. 162.

Why did Mr. Darwin carefully use the word "species" in the above stipulation instead of the word *being?* Evidently it was a matter of shrewd precaution; for, had he stipulated "any part of the structure of any *being*" "for the exclusive good of another *being*" he would have just annihilated his own theory by proving, as he did, that the *mammary glands* of every mother throughout the class of mammals are developed "exclusively," not for her own good but for the good of other beings! But as carefully as this precaution aims to guard the difficulty, it falls fatally short, for the mammary glands of the *first mammal mother* were developed (if developed at all) for the benefit of all the mammal "species" on earth, *since they all came from her by transmutation!* How much does Mr. Darwin's theory lack of being *annihilated*, then, according to his own agreement?

But there are numerous species which have parts (or *qualities*, which are the same thing,) exclusively for the benefit of other species. The flavor and odor of the *ants*, which adapt them to the taste and smell of the ant-bear, can be of no service to these insects. For countless generations natural selection has kept right on cultivating the emmet, keeping up its peculiar flavor which adapted it to the peculiar appetite of the ant-eater, when, by survival of the fittest, it might have completely changed both its flavor and odor to a quality which would have disgusted its devourer.

The same is true of the peculiar flavor of the hive-bee, which adapts it to the special benefit of the *midwald*, a bird which feeds on nothing else. Mr. Darwin urges with all his ingenuity that the marvelous instinct of the hive-bee, as well as its remarkable structure, is the result of "numerous successive slight variations" saved up from age to age "by natural selection" for the good of this insect. Yet this "scrutinizing" law keeps right on cultivating the flavor of this insect, which it has otherwise

so vastly improved, and which fits it so exactly and "exclusively" for the appetite of the midwald, since it is fair to infer, as the bees do not eat one another, their peculiar flavor must be for the special benefit of this other species, and therefore must inevitably "annihilate" his theory!

The odor of the fox's feet "is for the exclusive good of another species," the wolf or the dog, since by it the latter is enabled to run down and destroy the former on account of greater endurance. The odor of the fox is clearly, then, of no good to it, since it is the most efficient means of its destruction. That this proverbially cunning animal knows instinctively that its odor is its deadly enemy, and would, no doubt, be glad to have it abolished, if possible, is proved by its habit of "doubling" on its own track to misdirect the hounds. Yet Mr. Darwin's "scrutinizing" law of natural selection, after weeding out the foxes for ages which gave forth the strongest odor, on the principle of *survival of the fittest* or the less odorous, still continues right on cultivating this destructive quality, which can only be for the "exclusive good" of renard's enemies! Hence, by the unanimous judgment of all the foxes in Christendom and heathendom, Mr. Darwin's theory is hopelessly annihilated, according to his own stipulation!

But, then, Mr. Darwin would say, while natural selection was substituting a new *flavor* for the ant it would also have been at work on the ant-bear, changing its taste, so that in the end the ant would not have gained anything by the modification! This, however, does not quite correspond with the work of natural selection, which Mr. Darwin and Mr. Wallace so elaborately discuss, where worms and insects of various kinds are made to imitate the bark of trees, dead and green leaves, &c., all to protect them from the devouring insectiverous birds. It is remarkably strange that natural selection should have thus devoted all its attention to the form and color of worms, while neglecting the *eyes* of the birds! Had the birds' eyes been as assiduously cultivated as the color and form of these insects, their imitation of the leaves and bark of trees would have done them no manner of good, and the mimicry would have consequently been abandoned in its incipiency.

This stupid performance of Nature is also illustrated by the *mane of the lion*, which, Mr. Darwin gives it as his learned opinion, was developed by selection to protect his neck from the teeth of other lions and the teeth and claws of tigers! But it seems singular that the teeth of the tiger were completely neglected by natural selection, while taking the particular pains to produce such an enormous growth of hair as a protection for the lion! If natural selection devotes such careful attention to worms and insects, it might show a little regard for the tiger's teeth, and at least cause them to keep pace with the hair on a lion's neck!

But is not Mr. Darwin slightly mistaken? The tiger finds the lion's matted mane an excellent foundation into which it fastens its teeth and fore-claws while using its hind-claws in fearful lancination upon the loins and hips of the lion, where natural selection has wholly neglected to provide a suitable protection! I think the lion can justly enter his stentorian protest against Mr. Darwin's "scrutinizing" law, as a great scientific humbug in furnishing him with a matted mane for the particular advantage of the tiger to cling to while unmercifully raking his hinder parts, where there is no protecting hair! And while protesting, he should petition natural selection to show a little discrimination and remove the useless bunch of hair from the

end of his *tail* (the same as that of his *mane*, precisely,) and distribute it over his hips!

Elephants in some parts of India, Mr. Darwin says, were gradually destroyed by insects which bored into their backs. Now this is attributable wholly to the inexcusable neglect of natural selection in not covering the backs of those princely beasts with a protection like the lion's mane! That Mr. Darwin's great and "scrutinizing" law could have done this, and thus have saved these pachydermatous proboscidians of the jungle from such contemptible enemies as gadflies is clearly evident, after having stretched the same animal's nose five feet long for the primitive purpose, as supposed, of smelling at a distance!

If there is the least truth in natural selection having elongated the neck of the giraffe just to enable it to browse off the limbs of the acacia, as Mr. Darwin insists, rather than to change its mode of living, and cultivate in it a taste and habit like those of its sensible neighbor the eland, there would have been surely no trouble in evolving a carapace for the back of the elephant as impenetrable as that of the tortoise, or else in extending its trunk till it would reach clear around it! Pshaw! This whole business of natural selection, judging it by its bungling operations, is an unmitigated fraud on the brute creation. While it can industriously build up a mane on the lion's neck, it leaves its loins at the mercy of the tiger and protects the end of its tail! While it allows certain insects to bore into the elephant's back for the want of a coat of hair half as dense as that of the lion's mane, it changes other insects into forms and colors to protect them from the hungry birds, at the same time totally neglecting the birds' eyesight. It stretches the complicated neck of the giraffe, with all its important vital organs, such as vertebra, thyroid cartilage, larynx, trachea, tongue, æsophagus, with the numerous arteries, ligaments, and muscles involved, to enable it to reach the branches of trees, when by simply stretching its nose as it did in the case of the elephant, it could have reached much higher branches and stood square on its feet! Inconsistency, thy name is evolution!

The hive-bee is another example of the infamous unfairness of natural selection. While this most valuable and intelligent of all insects has its defensive weapon so awkwardly constructed by Darwin's "scrutinizing" law that it is compelled to commit suicide by pulling out its barbed sting whenever it defends itself from an enemy, all other bees, such as wasps, hornets, bumble-bees, &c., worthless and uncivilized in habit, can sting *ad libitum* without doing the least damage to their own mechanically constructed weapon. And, further, while the bumble-bee has a proboscis sufficiently long to suck red clover and extract its precious stores of delicious nectar which hive-bees so dearly love (as proved by their sucking at broken corollas), the proboscides of the latter have been neglected for ages by natural selection, when the sixteenth of an inch added would have opened up to these deserving little geometricians untold wealth of honey. Yet a worthless moth, Mr. Darwin assures us, has had its proboscis extended by natural selection *four inches in length*, simply to adapt it to sucking the nectar from a single bell-shaped flower! Just a hundredth part of this development added to the hive-bee's proboscis would have enabled it to suck the red clover, and thus compete with its big, awkward cousin.

Now, is it at all reasonable or probable that the same "scrutinizing" universal law, natural selection, should have developed

so enormously the proboscis of a moth while utterly neglecting the most persistently industrious insect in the world? Is it not rather probable and reasonable that both species are exactly as they were created primordially by the intelligent cause of all animal forms? Is it not altogether and rationally more probable, even if natural selection is all Mr. Darwin claims it to be, that it should have acted on this moth in such a manner as to change its habits and mode of living to that of ordinary millers and butterflies rather than to have kept on in one direction till such a prodigious and monstrous proboscis had been formed?

This latter question is equally applicable to numerous other species. Take the salamander, for example, with its extensile tongue so enormously developed that it can thrust it out seven or eight inches, like an arrow, and seize an insect! Even conceding such a law as natural selection and such a process as specific development, is it not vastly more probable that this little reptile would have been adapted by evolution to a mode of life and a means of securing food analogous to that of the newt or the frog rather than to have undergone such an almost miraculous transformation in its tongue? It would seem infinitely more sensible and consistent that it should have evolved by an increasing strength in its legs, and thus have attained an agility enabling it to leap upon its prey with the requisite precision and velocity. The extensile elongation of one of its fingers would have seemed far more probable and consistent. This enormous extension of the tongue is absolutely the last thing any one but a perfect inventor could have thought of. I should have undertaken to make it feed on grass or dig for worms twenty times over, had I been natural selection, before thinking of such an ingenious and apparently impossible contrivance. Yet the same "scrutinizing" principle, according to Mr. Darwin, did this which leaves barbs on the sting of the hive-bee, by which it kills itself whenever it undertakes to defend itself!

Of course, it would not suit Mr. Darwin's designless and purposeless ideas of the universe to suppose that the hive-bee was originally intended as man's servant, and that its self-destructive barbed sting was a wise provision by which to gradually weed out, by a kind of natural selection, the more vicious and belligerent individuals, and thus adapt the community more and more to the wants of man, by making it more and more domestic and less and less dangerous; while, at the same time, such bees as can never be of service to man—the hornet and wasp—are left with weapons, however harmful to their enemies, perfectly harmless to themselves! Such a conception of the hive-bee and its self-destructive sting would not have answered Mr. Darwin's purpose at all, as it would at once have involved the necessity of an intelligent Creative Will for the origin of each species, and rather than to admit such a fatal blow to evolution as the hand of God in Nature would necessarily be he would rather see natural selection proved guilty of a thousand just such inexplicable inconsistencies as I have been pointing out.

His chief congratulation of himself, as he takes a retrospect of his work in a late publication, is that he has at least done something to cripple the idea of an intelligent Creative Power in the origination of the various specific forms:—

"I may be permitted to say, as some excuse [for errors in a former work] that I had *two distinct objects in view:* firstly, to show that species had not been separately created; and secondly, that natural selection had been the chief agent of change. . . . I was not, however, able to annul the influence of

my former belief, then almost universal, that each species had been purposely created. . . . *I have at least, as I hope, done good service in aiding to overthrow the dogma of separate creations.*"—DARWIN, *Descent of Man*, p. 61.

If the reader will pardon the egotism, I will add, as modestly as possible, the belief that "I have at least, as I hope, done good service in aiding to overthrow the" almost infinitely absurd theory of natural selection!

My limit forbids me touching upon more than a fraction of the inconsistencies which crowd upon and overwhelm Mr. Darwin's theory of natural selection; yet I must name one which is so self-evidently suicidal that it is a profound puzzle how this shrewd naturalist could ever have been led to iterate and reiterate a principle so fatal to evolution. I refer to the law, emphasized in more than twenty places in his various publications, that, as soon as a species becomes changed in structure by natural selection the improved descendants must inevitably exterminate the parent form and take its place. To show that I do not misconceive Mr. Darwin's real meaning I will quote a few specimen passages:—

"*In all cases the new and improved forms of life tend to supplant the old and unimproved forms.*"

"New varieties continually take the place of and *supplant the parent form.*"

"New and improved varieties will *inevitably supplant and exterminate the older.*"—*Origin of Species*, pp. 264, 266, 413.

A mere child is capable of seeing that the principle here laid down must necessarily and inevitably overthrow the whole system of evolution, since it involves the existence of but one single species now on earth, and that the last one developed by transmutation! If the fox came from the marsupial as a modified descendant, the marsupial, as the "parent form," would have been "inevitably" extinguished. If the wolf came from the fox by specific transformation through Mr. Darwin's law of development, then the fox would have shared the same fate as the parent marsupial, and in turn would have been "inevitably" exterminated. If the dog developed from the wolf, then no wolf could now exist, if there is the least truth in Mr. Darwin's law. Neither could the dog exist after the transmutation to the lemur had taken place. And so on through all the various species of the monkey, from the lemur up to the gorilla; as soon as one had given rise to a more perfectly developed form, the unimproved parent form must "inevitably" have suffered extirpation, leaving, as a matter of course, but one permanent breed of monkeys in existence all the time, and that the highest or last developed! And, finally, when some orang-outang gave the initial divergence which inaugurated the human race, the last species of the monkey would have perished, since the law is *inevitable*, as laid down by Mr. Darwin, that the "New and improved varieties will *inevitably supplant and exterminate the older.*"

Thus, the self-stultifying principle of evolution under natural selection, as expounded by the founder of the system, involves the necessary and unavoidable fact that man should now be the only living species on this earth, since every form below him through which his line of descent has progressed would have successively and "inevitably" succumbed and been exterminated as soon as each improved form had made its appearance! The fact, therefore, that we now have a hundred thousand species of living animals known to zoology, all of which have survived that *inevitable extermination* which is and must be the necessary result of evolution, if it be a true theory, shows conclusively that we have one hundred thousand living witnesses now on earth demonstrating the utter fallacy of Mr. Darwin's hypothesis!

But, even worse than this: I will now prove, from Mr. Darwin's own express admissions, that the start of evolution by natural selection from his supposed primeval form of life was a practical impossibility. It will be remembered that all evolutionists assume the first animal form of life—whether created by miraculous power, as Mr. Darwin concedes, or formed by spontaneous generation, as Prof. Haeckel assumes,—was the *simplest being imaginable*, and that from such a homogeneous organism higher organic forms were gradually and successively differentiated. Now, it is easy to prove by Mr. Darwin's own statements, repeatedly made throughout his works, that no such differentiation or development from a low to a high organism would occur in Nature, *since there is no advantage to a simple being in having a higher organism!* Look at a few passages:—

"A *very simple form* fitted for *very simple conditions of life* [such as his own first forms and those of Professor Haeckel] might remain for *indefinite ages unaltered or unimproved;* for what would it *profit* an infusorial animalcule, for instance, or an intestinal worm *to become highly organized?*"—*Animals and Plants*, vol. i., p. 19.

This very manner of putting the question —"for what would it *profit*," &c., shows that this author means to convey the idea that it would *profit them nothing*. Then, as natural selection only acts on profitable variations, it follows that such simple beings as the monera or primordial mollusks would not have changed their structures to become more highly organized. Mr. Darwin says:—

"Natural selection acts through one form having *some advantage* over other forms in the struggle for existence."

"Natural selection *acts only* by the preservation and accumulation of small inherited modifications, *each profitable to the preserved being.*"—*Origin of Species*, pp. 75, 96.

Then, it is clear, since it would not profit a very simple being to change and assume a high organism, natural selection could do nothing with those first forms, consequently transmutation receives its quietus at the start. This Mr. Darwin absolutely confirms, as follows:—

"*Under very simple conditions of life a high organism would be of no service.*"—*Origin of Species*, p. 100.

How, then, in the name of science and common reason did natural selection go to work to transmute a moneron or a simple mollusk into a higher organism, since a high organism would be of *no profit* to such simple creatures, and since natural selection, as he tells us in numerous places, can only work for the *profit* of a being? Thus, his entire theory of natural selection is broken down at the very point where he supposes it to have started, and by the inevitable working of the very laws he has established to control its action; for, if a "high organism would be of *no service*" to simple beings "under very simple conditions of life" (the very *conditions* and the very *beings* his transmutation starts with), then it utterly prohibits the initial steps of evolution, and consequently overthrows the whole system!

This sweeping and annihilating conclusion harmonizes with the innumerable beauties and wonders witnessed in examining the shells of ocean, with their marvelous symmetry, elegant forms, and exquisite shades of color. In particular, the forms of the shells of many mollusks, such as the wonderful janthina, the beautiful triton, and the marvelously balanced scalaria, never could have been produced by natural selection, since it works only for the good of beings, and the shells here indicated are immeasurably more difficult for the beings to manage either in the breakers or in the deep sea than would have been the simple shell of the oyster or clam.

The beautiful variegation and harmonious design in form and color in these thousands of shells, which no art can ever imitate or even approach, have but one solution. They are the product of an intelligent Creative Will acting with the same love for the beautiful and varied in form and hue which He has instilled into the higher and nobler faculties of man. Such wonderful designs and patterns, which become more and more elaborate and exquisite as the microscope unfolds their indescribable beauties, can only be contemplated by a well balanced and logical mind as the workmanship of an intelligence like our own but infinite in ideal, and an executive capability immeasurably above human powers of conception.

I will now redeem my pledge, made in the preceding chapter, and show that Professor Haeckel distinctly teaches (to the utter contradiction and refutation of his whole theory) that natural selection is limited in its operations to the *type* or *tribe* of creatures which it is improving,—that is to say, the members of one type or phylum, such as articulata, can not be changed into some form of the vetebrata, nor *vice versa!* I am sure this would hardly be believed, unless I quote his language, for it absolutely destroys the foundation of evolution, making special creations necessary to bridge over the chasms between all the different types. These are his words:—

"There appears, indeed, to be a *limit given* to the *adaptability* of *every organism*, by the *type of its tribe or phylum*. . . . Thus, for example, *no vertebrate animal can acquire the ventral nerve-chord of articulate animals*, instead of the characteristic *spinal marrow of the vertebrate animals*. However, *within this hereditary primary form, within this inalienable type*, the *degree of adaptability is unlimited*." [By "adaptability" he means the same as "transmutability."]—HAECKEL, *History of Creation*, vol. i., p. 250.

This is a most astounding admission to be made by the greatest apostle of Darwinism in Germany; and, in order to show how he is recognized by Mr. Darwin himself, I quote the following:—

"Professor Haeckel, in his *General Morphology* and other works, has brought his *great knowledge and abilities* to bear on what he calls phylogeny or the lines of descent of all organic beings."—DARWIN.—*Origin of Species*, p. 381.

The statement I have just quoted from Professor Haeckel is a part of the "*great knowledge and abilities*" to which Mr. Darwin refers, and is thus endorsed by him,—which is also a clear admission that Mr. Darwin himself believes with Professor Haeckel that every organism is limited to "the type of its tribe," and can not by natural selection, transmutation, or "adaptability," go beyond it! What clearer proof do we need than this concise statement that there must have necessarily been a special miracle required at the beginning of each new tribe or type of organism, since the "adaptability" of a being is rigidly confined to the "type of its tribe"? It may develop or be transmuted in every direction, he says, within the "tribe or phylum," and to this extent the Professor insists that "the degree of adaptability is *unlimited*," but it can not be transmuted *beyond such type or tribe*. He does not leave us in the slightest doubt as to what he means by "type," "tribe," or "phylum," but distinctly illustrates his meaning by saying that it signifies the same as *sub-kingdom*, since "no vertebrate animal *can acquire the ventral nerve-chord of articulate animals*, instead of the characteristic spinal marrow of the vertebrate animals"; and, of course, as the "articulate animal" is also confined to the "type of its tribe," since "every organism" is thus limited, no "articulate animal" could overstep the boundaries of the "tribe" or "phylum" to which it belonged.

Here, then, I assert that Prof. Haeckel,

with Mr. Darwin's endorsement, surrenders the whole citadel of evolution, showing in the plainest and most unequivocal language that the first animal with a "spinal marrow" and a backbone, or the first fish, was the work of miraculous creation, since no articulate animal, or those in the sub-kingdoms below it being limited to their type or tribe, *could have been transmuted into vertebrate animals!* There is no evading the force of this annihilating admission; and it therefore follows, that, as the first vertebrate animal could not have been produced by natural selection through slight successive modifications, Mr. Darwin's theory has, for the fourth time, "absolutely" *broken down.* The reader must not forget his language:—

"If it could be *demonstrated* that any *complex organ* [such as the *backbone* and *spinal marrow* of the first vertebrate animal] existed, which could not possibly have been formed by numerous successive slight modifications, *my theory would absolutely break down.*"—DARWIN, *Origin of Species*, p. 146.

Here, then, again Mr. Darwin surrenders his whole theory as having "absolutely" broken down, since I have *demonstrated* by Professor Haeckel, with his own endorsement, that the first organic individual of every "tribe," "phylum," or "type," could not possibly have come from the preceding tribe or type by transmutation or through natural selection, and must of necessity therefore have been miraculously created!

A man who will carefully follow these great scientists and critically scan their writings needs but very little argumentative ability to overthrow the theory at every crook and turn of its anfractuous meanderings, for they will invariably furnish him with such an abundance of materials in the shape of self-contradictory reasoning and absurd logic that he only needs the classificatory talent of a druggist's clerk to sort them out, label them, and place them conspicuously upon the shelf.

A single illustration right here, in passing, will confirm this representation. In the last quotation Mr. Darwin says his "theory would absolutely break down" if a single "complex organ" could be shown which could not have been produced by natural selection, or slight successive modifications. Yet he himself points out a "complex organ" which he distinctly declares *could not have been produced by "variation and natural selection"!* Reader, be astonished as you may, this is the exact and literal truth. Speaking of the *wings* of the *ostrich*, only partly developed as they are now found, he remarks:—

"As *organs* in this condition would formerly, when still less developed, have been of even less use than at present, *they can not formerly have been produced through variation and natural selection*, which acts solely for the preservation of *useful modifications.*"—DARWIN, *Origin of Species*, p. 398.

I have thus only to place his two statements in juxtaposition, and his hypothesis breaks down! And here, surprising as it may seem, I have accidentally and unexpectedly run across a complete confirmation of the argument made use of at the beginning of this chapter, namely, that the wings of all birds in their incipiency or when just beginning to develop (if developed at all) could not have been produced by natural selection, since such rudimental wings would have been wholly *useless!* Is it not astonishing how a false theory, however ably managed, is necessarily compelled to destroy itself by its own inconsistencies and self-contradictions? Mr. Darwin, if he were an out-and-out opponent of evolution, and if he had been using this incipient-wing argument directly against the theory of natural selection, could not have employed stronger or more direct and explicit language; for, "As organs in this condition [wings not sufficiently developed for

flight, as those of the ostrich,] *would formerly when still less developed have been of even less use than at present, they can not formerly have been produced through variation and natural selection, which acts solely by the preservation of useful modifications"!*

Then wings must "formerly have been produced" by miraculous creation! Really Messrs. Darwin, Huxley, and Haeckel, when properly understood and brought out, form a trio of the ablest opponents of evolution who have ever written on the subject. This was clearly seen while following Professor Huxley through his "history of the horse." The world of science will ever stand indebted to these great naturalists for the efficient service they have rendered the cause of progressive truth in so thoroughly annihilating such a hideous scientific excrescence as modern evolution.

Mr. Darwin, as the founder of this system, can not be quietly permitted to teach, as he does here, that wings partly developed would be useless, and therefore "*can not formerly have been produced through variation and natural selection,*" and then escape scot-free, and be allowed to go on tinkering away at his broken-down theory the same as if it still existed unimpaired. He, as well as his followers, will be and must be held literally and rigidly bound to all the consequences of such a truthful and necessary admission. Among these consequences are, firstly, his theory "absolutely breaks down" by his own voluntary stipulation, since he himself points out an organ which he declares could not have been produced by "variation and natural selection"; and secondly, as the wings of all flying animals—birds, bats, and insects,—in their incipient stages of development were likewise necessarily useless, they were also beyond the power of natural selection, *and hence were the product of miraculous creation!* Thus, by the fairest logical inductive reasoning and from irresistible conclusions drawn from premises laid down by Mr. Darwin himself, I have demonstrated the miraculous creation of the different classes of flying animals, since they are wholly beyond the reach of natural selection.

In fact, by noticing the last quotation, it will be seen that Mr. Darwin distinctly teaches that any *useless organ*, no matter what it may be, would equally break down his theory if pointed out, since he lays it down as a principle that such organs "can not formerly have been produced through variation and natural selection, *which acts solely by the preservation of useful modifications"!* I can within ten minutes count off on my fingers a hundred complex organs which are now and must have always been wholly useless to their owners, such as the tails of dogs, wolves, foxes, panthers, tigers, lions, &c. These organs have clearly never been of any service to these animals, not even as rudders to aid in turning when pursuing prey, as some have supposed, since the rabbit can make quicker turns than any dog or wolf! Others have supposed that they may have been of use as balances in leaping from branch to branch. This is exploded by the fact that no animal can balance so well or leap so accurately as the tailless gibbon. The truth is, such organs are not only useless but injurious, being burthensome to carry, while they consume nutrition, and hence must necessarily break down Mr. Darwin's theory.

No one will dispute that the humps of a camel are now useless to their owner, and necessarily have always been. How, then, have these humps been gradually developed? Mr. Darwin distinctly says "they can not formerly have been produced through variation and natural selection, which acts solely by the preservation of

useful modifications." The camel's humps, therefore, as Mr. Darwin must necessarily believe, could only have come in the first place by miraculous creation; and thus, like all other useless organs, "absolutely break down" his theory! Yet this contradictory and self-stultifying hypothesis is the kind of science (!) we are called upon to accept, and these are the great scientific investigators held up for the guidance and admiration of the world,—who would, with such logic as we have just been examining, overthrow religion, annihilate creation, and dethrone the God of Nature, by demonstrating their own lineal descent from the monkey if not from the ass.

But I do not propose to let Professor Haeckel off quite so easily with his fatal concession that no creature can be differentiated or transmuted beyond its "phylum" or the "type of its tribe." If these great naturalists, as just remarked, who are pointed to as infallible guides in scientific matters, will persist in striking fatal blows unwittingly at their own favorite theory of evolution, I propose to do them the justice, if not the favor, of holding them rigidly to their own annihilating admissions.

In one part of his book Prof. Haeckel asserts, without proviso or qualification, that there is "no limit" to the transmutation or "adaptation" of a species, but that such adaptivity is not only "unlimited" but "infinite":—

"An eighth and last *law of adaptation* we may call the law of *unlimited* or *infinite adaptation*. By it we simply mean to express that we know of *no limit to the variation of organic forms occasioned by the external conditions of existence*."—HAECKEL, *History of Creation*, vol. i., p. 249.

As I have always thought, it is here finally proved that evolutionists have no real occasion for denying man's immortal being in a future life, or even of doubting the existence of a personal God; for Professor Haeckel believes, as he here says, in "infinite adaptation" "occasioned by the external conditions of existence"! Why, then, in the name of natural selection and common reason, should not a man develop into a God, after first evolving into an angel, just as consistently as that a *mollusk* has already developed into a *man* after having evolved into a *kangaroo*? There surely can be but little more difference between a God and an intellectual man than between man and the almost lifeless polyp! At all events, I would be willing to pay adoration to such a God as sufficiently exalted above myself to be regarded as an infinite Creator!

Professor Haeckel, however, is not so much to blame in speaking thus of the "*unlimited* or *infinite adaptation*" of animals to other forms by natural selection, and of thus making it possible for an infinite God to evolve out of a man, since his great leader and master in evolution has set the example:—

"I can see *no limit* to *this power* [natural selection] in slowly and beautifully *adapting each form to the most complex relations of life*."—DARWIN, *Origin of Species*, p. 412.

The reader would be astonished if he could really see in a classified list the number of instances in which Mr. Darwin (as well as Professor Haeckel) contradicts himself in his incongruous reasoning about natural selection, and what it must accomplish if evolution be true. I will just here digress sufficiently to instance a few examples.

As just quoted, he sees "no limit" to this power; and yet, as quoted a page or two back, he does see a distinct "limit," since natural selection can not touch a partly developed wing nor any other organ unless it is useful!

He teaches in numerous places in his various works, as already quoted, that no

matter how numerous the normal individuals of a species or the parent form may be, the diverging offspring, which are necessarily few in number, will inevitably exterminate their parents. A single example:—

"New and improved varieties will inevitably supplant and exterminate the older."—*Origin of Species*, p. 413.

Yet, in another place he tells us that—

"Any form existing in *lesser numbers* [such as modified offspring] would, as already remarked, *run a greater chance of being exterminated than one existing in large numbers.*"

"The more common forms in the race for life [such as the unimproved parent forms] *will tend to beat and supplant the less common forms.*"—*Origin of Species*, p. 136.

Thus, as the *modified offspring* are always at the start "the less common forms" they would be beaten by "the more common forms" or those "existing in large numbers," and consequently no transmutation could ever take place!

Take the following two passages, side by side:—

"We have every reason to believe from the study of the tertiary formations, that species and groups of species *gradually disappear one after another, first from one spot then from another, and finally from the world.*"

"Scarcely any paleontological discovery is more striking than the fact, *that the forms of life change almost simultaneously throughout the world.*"—*Origin of Species*, pp. 293, 297.

The above passages need no comment. Finally, read the following lucid contradiction:—

"Judging from the *past* we may safely infer *that not one living species* will transmit its unaltered likeness *to a distant futurity.*" ["Judging from the past" read the following:—]

"Some groups, as we have seen, have endured *from the earliest known dawn of life to the present day.*"—"The genus lingula, for instance, the species which have successively appeared at all ages, *must have been connected by an unbroken series of generations from the lowest Silurian stratum to the present day.*"—*Origin of Species*, pp. 293, 294, 428.

Out of compassion for the inventor of "pangenesis" and the discoverer of "gemmules," I will discontinue this list and return to Professor Haeckel, who made the not less important discovery of his "eighth and last law of adaptation," which he says "we may call the law of *unlimited* or *infinite adaptation.*"

After maintaining his hold on this "law" for a while, the Professor probably saw that he and Mr. Darwin were both running the transmutation business headlong into the development of angels and Gods out of monkeys and men, with such a tremendous principle in Nature as this "eighth and last law" called "the law of *unlimited* or *infinite adaptation*"; so he was shrewd enough to contradict himself, and thus avoid the catastrophe of even the possible evolution of a God! He saw there was no conceivable way of doing it gracefully, so he resolutely took the evolution bull by the horns and announced, as formerly quoted, that there is unavoidably a limit to the variation of organic forms which absolutely confines the adaptability of every creature to the "*type of its tribe*"; and, although he annihilates Mr. Darwin's theory of descent by so doing, and demonstrates the necessity of a miraculous creation at the start of each sub-kingdom, he thought it safest, all things considered, to confine the transmutation of each species to its tribe by this consoling remark: "However, within this hereditary primary form, within this inalienable *type*, the *degree of adaptability is unlimited.*" (See the whole quotation, page 516.)

Thus, we have at last arrived at a clear insight as to the meaning of evolution, as taught by Professor Haeckel. A member of a vertebrate species, for example, can not step over the bounds of its "phylum" or "tribe" and become a lobster, an oyster, or a star-fish, but it can do anything else!

Inside of the "type of its tribe" its "adaptability is unlimited," and therefore a *mouse* is not only capable of becoming an *elephant* by "adaptation" under natural selection, but it is equally possible for an *elephant to become a mouse*, as Professor Haeckel absolutely believes, if he has any confidence in his own statement! A *tortoise* is not only capable of being transmuted into a *monkey*, since its "adaptability is unlimited" within its "type," but it is equally possible for a monkey to evolve into a tortoise, notwithstanding "evolution," as already shown, means exactly the opposite! It is not only possible for a *fish* to develop into a *man*, but, according to this great authority on evolution, it is equally feasible for a man to be transmuted into a fish, since within the "type of his tribe" his adaptability is unlimited!

Thus, again, unexpectedly we are brought to another distinct example of the monstrous absurdity exposed in the last chapter, while reviewing Professor Huxley's "history of the horse," that evolution signifies, when necessary with these naturalists, either forward or backward, improvement or retrogression, progress toward perfection or degradation toward imperfection! It means, with them, when pressed for explanation, either a development toward the heterogeneous or a transformation toward the homogeneous,—involves either the addition of parts and organs to a being or their elimination,—signifying anything or nothing, whichever best suits the temporary convenience of these great scientists! What better proof can a superficial mind require than this indefinite misapplication of definite words that the whole system of evolution is a bungling fraud!

If such false employment of words and such apparently reckless and visionary statements were not of such common occurrence throughout these writings we might attribute them to slips of the pen or an unguarded use of language. But they are almost as numerous as the pages of the books. Take this fact as an illustration: Mr. Darwin distinctly teaches, as quoted in the conclusion of the seventh chapter, that a prominent, abrupt, or monstrous variation, accidentally occurring in a species, would be lost in a state of Nature by the promiscuous intercrossing of such abnormal individual with the ordinary creatures, just because Nature lacks the power of forcible separation; while the breeder or fancier begins his selection on some half-monstrous deviation, and succeeds in time, by methodical separation and selection, in producing a distinct breed. Mr. Darwin does not hesitate to admit that no kind of improvement in fancy pigeons, sheep, cattle, or swine, could be made by the breeder except by forcible separation and intelligent selection, both of which is entirely out of the question in a state of Nature. Yet both Professors Haeckel and Huxley distinctly ignore this essential and fundamental difference:—

"The nature of the transformation and the *means by which it is produced are precisely the same in both artificial and natural selection.*"—HAECKEL, *History of Creation*, vol. i., p. 168.—Also, his *General Morphology*, vol. ii., p. 248.

"As I have already said, the operation of Nature [in transforming a species] is *exactly the same as the artificial operation of man.*" . . . "The conditions of existence may play *exactly the same part for natural varieties* as man does for domestic varieties."—HUXLEY, *On the Origin of Species*, p. 122.

Now, such false and purely reckless statements as these should be frowned down by all scientific investigators as degrading to the cause of science and true knowledge. Yet, to favor the theory of natural selection and show its power to change one specific form into another of the most diverse structure, these writers both publish to the world what they must

have known to be pure fiction, by a fair construction of their language.

Almost entire chapters in Mr. Darwin's works are devoted to showing the difference between the breeder's operation (where intelligent and methodical selection culls out a peculiar form or color, and then forcibly separates and breeds from those alone which have the same peculiarity) and Nature's efforts, where no forcible separation or prevention of promiscuous intercrossing can take place, except so far as the stronger prevail over the weaker. Yet these authors both tell us that the efforts and the process of selection under Nature are "exactly" and "precisely" like those of the fancier and the breeder!

This is quite an unusual thing for Professor Huxley, but is an every-chapter occurrence with Professor Haeckel. Take the following, where he is so anxious to make the reader believe that, owing to the universal "struggle for existence" so eulogized by Mr. Darwin, there would be no trouble in natural selection soon improving a species and transmuting it into another form:—

"*Every individual* of *every animal* and vegetable species is engaged in the *fiercest competition* with *every other individual of the same species which lives in the same place with it.*"—HAECKEL, *History of Creation*, vol. i., p. 163.

Really, to suppose that this author did not know when he wrote it that this whole statement was pure fiction from beginning to end, would be to write him down a scientific idiot. But, as Mr. Darwin insists that Professor Haeckel has brought his "great knowledge and abilities to bear" on this subject, we can not even throw the mantle of charity over it as the result of any want of information. Does this great naturalist pretend candidly to teach us that "every individual" of a swarm of bees "is engaged in the *fiercest competition* with *every other individual* of the same species"? He knows, if he knows anything at all about natural history or entomology, that there is not the slightest competition among these unselfish and harmonious workers, but that all unite by a division of labor to the accomplishment of the same end. This is true, also, of the various species of ants, which work in the most perfect order and harmony at whatever is for the general good, assisting each other in their battles and some of them in taking care of their wounded, while never fighting or quarreling among themselves. Yet this learned scientist assures us, after bringing "his great knowledge and abilities to bear," that "every individual" ant is "*engaged in the fiercest competition with every other individual of the same species*"!

He would teach us that the millions of mammal mothers, which furnish their own substance in the form of pabulum to nourish and sustain their young ones, and would, in many instances, sacrifice their own lives to defend them from danger, are struggling with those same young ones for the mastery and "engaged in the *fiercest competition*" with them, if there is any meaning in his language! But why waste time with such a reckless scientific latitudinarian?

I might thus go on and fill out a whole chapter with just such examples from Professor Haeckel, and could then add another chapter with similar self-annihilating passages from Mr. Darwin, but the size allotted to the book forbids. I therefore leave the question, with my best wishes and a kind adieu to the reader.

SCIENTISTS AND THE IMMORTALITY OF THE SOUL.

The true scientist—the ideal investigator of Nature—cannot be indifferent to the question of a future state of existence, nor treat the subject as one suited only to the contemplation of the weak-minded. It is an utter impossibility for the real seeker after scientific knowledge willingly to oppose the hypothesis of the immortality of the soul, or look upon its possible fallacy with anything but sadness of heart, for the reason that true science leads all her votaries to desire a knowledge of that which lies beyond the reach of our present earthly facilities; and the more real is the scientific aspiration, and the more refined and devoted is the investigator, the more keenly must he desire to know the secrets of the intangible universe from which he is forever debarred with his present circumscribed means of attaining knowledge.

We see distinctly vast storehouses of knowledge all around us in Nature, with the stores locked and the keys almost within our grasp, but so far out of reach that we can never hope to possess them in the present life. We behold ten thousand suns and planets with their unlimited treasures of scientific information, though by aid of our best earthly facilities we are enabled barely to view their shining surfaces; and as we peer intently through our glasses to learn, if possible, more of their hidden mysteries, they twinkle provokingly at our puny efforts, and mock derisively the abrupt limits of our circumscribed powers. It is, therefore, self-evidently false and absurd to say that the real student of science would not wish to know as much, at least, about the glorious Pleiades, the burning Aldebaran, the cold Boötes, or the dazzling Sirius as he knows about his own earthly planet, could such knowledge, by any possibility, be attained; while the true scientist would welcome with joy even the faintest hope, the dimmest prospect, of an achievement so transcendent as some means by which a mere fraction of such knowledge could be gained. Yet, all this immeasurable knowledge and inconceivably more, is held out to the scientific investigator in the single conception of the immortality of the soul and what it implies.

As a proof that a knowledge of these secrets of the distant worlds suspended in space, now so completely beyond our grasp, is intensely desirable, we have only to observe with what eager and almost sleepless vigils the astronomer watches through his telescope the indistinct surface of our poor frozen moon, trying to catch a glimpse of some yet undiscovered crater or mountain peak, and thus to unravel a trifle more of her available but almost useless secrets, and which at best leave the mind in the wretchedness of confused uncertainty! Look how he scans the rings of Saturn, or puzzles over the problems involved in the moons of Mars! And witness with what cheerfulness he spends his thousands of dollars and months of precious time in trying to solve the comparatively trifling problem of the existence of an inter-Mercurial planet! And even then, what a contemptible supply of knowledge does he acquire with all this wear of nerve and strain of intellect! A single glance of the soul's immortal telescope, if there be any truth in the hypothesis of a future life, would unfold ten

thousand such problems, which must remain hidden from man throughout the endless cycles of earthly generations, if death is to end all. Yet, astonishing to contemplate, our greatest investigators of Nature and most industriously interested seekers after her hidden treasures of knowledge, while realizing their own puny efforts, seem to take not the slightest interest in, or to have the least desire for, the rational proof of the possibility of a state of being which will so absolutely open to the mind all these now unsearchable mysteries! On the contrary, they even earnestly and almost bitterly oppose every argument which tends to demonstrate the probability of such a glorious consummation.

That a future life, involving all the intellectual advantages here contemplated, is *possible*, no intelligent or candid scientist will question. That it is *probable*, thousands of the best and wisest even among scientific investigators have fully agreed. That it is a *certainty*, millions of the noblest of earth have maintained even with their dying breath. Under such circumstances it would naturally be presumed that the true scientist, from his paramount desire to acquire information alone, would be the first to lend a helping hand to those investigators whose lives are devoted to the cause of demonstrating the soul's immortality, rather than almost virulently throwing obstacles in their way by belligerently belittling every consideration advanced in its support. This willing opposition to an assurance of grander scientific resources, and of a higher plane of intellectuality than earth affords, as the only conceivable means by which this knowledge of the mysteries of Nature can ever be attained by man, proclaims in more than words, that such votaries at the altar of science are mere pretenders in their great profession and unworthy of the name of true philosophers. They are priests who hold the temple by force, but their worship is the sham of hypocrisy.

Should even a single Edison declare his belief that an improvement was reasonably possible in the telescope by which Venus might be brought as near to us as the moon is now by means of our best instruments, would true astronomers, I ask, discourage his efforts by ridicule and virulent opposition? Would they seize upon every opportunity to throw obstacles in his way by discouraging his friends from even lending him the aid of their sympathy, and thus prevent the necessary demonstrations by which to show the possibility of such a marvelous achievement? No. Even with the testimony of one such witness, and the small assurance it would give, every true scientist in the land would come to his aid, at least in sympathy, and thus help him to achieve a consummation so grand and glorious, or at least to prove its possibility even should the time required for its accomplishment permit no man now living to enjoy the sight. But when thousands of the best educated scientists of the world declare their unshaken faith that it is possible for an immortal telescope to be placed in the hands of every man at death by which Venus, and Mars, and Jupiter, and Sirius, and the Pleiades can be examined more minutely and satisfactorily than we can now scrutinize this earth, the Haeckels and Ingersolls of modern science—these pretenders to true philosophical research—are up in arms against it, contesting every inch of ground in its favor with an earnestness and even bitterness indicative that their own personal interest would be jeopardized should a future life and its grand scientific results be proved true! They thus plainly proclaim to the world their intuitive love of ignorance, rather than an inherent desire for knowledge, by discarding with contempt the only possible hope of knowing more of the mysteries of the universe than is afforded by our present brief and circumscribed life. Let the truth, then, stand recorded,—let it be written in letters of electric light never to be effaced,—that the real scientist and ideal investigator of Nature's problems can not oppose the Christian philosopher in his efforts to establish the truth of the proposition that death does not end all, and consequently that the present life, intellectually, socially, and spiritually, cannot be all there is of us or for us.

THE PROBLEM OF HUMAN LIFE.

[*REVISED EDITION.*]

The following indorsements of this book are a sample of the notices we are receiving, the like of which have never before been read in favor of any other book.

[*From the Illustrated Christian Weekly, N. Y.*]

"A very remarkable book has come under our notice, *The Problem of Human Life*, which we have examined with some care, in which the author reviews most successfully the works of Darwin, Huxley, Tyndall, Haeckel, Helmholtz, and Mayer, demonstrating, as we think, the utter fallacy of scientific materialism. The book challenges the fullest examination; and without undertaking to indorse all its positions (though we know of none which we would combat), it clearly annihilates the last standing-ground of Darwinism as a scientific theory."

[*From the Methodist Protestant, Baltimore, Md.*]

"This is the book of the age; and its unknown author need aspire to no greater literary immortality than the production of this work will give him; and thousands of the best-educated minds, that have been appalled by the philosophical teachings of modern scientists, will 'rise up and call him blessed.' Hitherto it has been the boast of atheistic scientists that the opponents of their doctrines have never ventured to deny or to solve the scientific facts upon which their theories are based. But our author, accepting these very facts, unfolds another gospel; and Tyndall, Darwin, Haeckel, *et al*, are mere pigmies in his giant grasp. His logic is not only resistless but overwhelming, exciting alternately our pity and contempt for the helpless victims. 'A Daniel has come to judgment,' and the work will inevitably stir the scientific world and the theological world from center to circumference, and revolutionize much of the teachings of modern scientists. . . . We do not think it possible to discount the force and conclusiveness of Wilford's arguments. In our judgment it is the ablest and most timely production since the appearance of Bishop Butler's '*Analogy*,' in 1796."

[*From the Kansas City Daily Journal.*]

"When the reader lays down this book, after having gone through with it, he will admit one thing—that no part of the theory, or any of its collateral questions, has been omitted. The argument is thorough, compact, strong, nervous, and clear. In fact, as a simple mental achievement, it is one of the most remarkable that has fallen under our observation for a long time. There can be no doubt of the ability and originality with which the subjects treated of are handled. The casual thinker will wonder at the fact that in support of such a theory the author should select *sound* as the leading subject with which to overthrow evolution. But when the manner in which it is treated is understood, and the theory of the writer is comprehended, it will be found to be almost the very citadel that has been attacked and captured. . . . We believe when the candid reader lays down the book he will concede that the wave-theory, at least, has little besides the names of these great men [Tyndall, Helmholtz, and Mayer] to support it. . . . He don't dogmatize or theorize, but he marshals an array of facts that seems simply conclusive. . . . It is by such demonstrative illustrations as these [the performance of the locust] that the author sustains his argument against the accepted theory of sound. . . . But it is impossible to follow the multitude of illustrations in which the book abounds. No man who wishes to explore the whole field can afford to ignore this work, because it furnishes a magazine of facts and arguments which must be answered. Authorities can not be quoted against it, because it assails all these authorities. To quote them is simply to assume that their positions have not been assailed. . . . Get the book and read—yes, study it."

[*From the Brethren at Work, Lanark, Ill.*]

"It is unquestionably the most startling and revolutionary book published in a century. In its overwhelming power of analytical reasoning there is nothing extant to compare with it, save, perhaps, Butler's '*Analogy*.' He takes a flower or a bit of musk, and evolves therefrom a cogent argument for the immortality of the soul. From a sunbeam or the sonorous emissions of the tuning-fork he elaborates principles which are the corner-stones of the universe. He catches the chirp of a cricket or the stridulation of a locust, and draws from it a demonstration that hopelessly shatters the very foundations of materialism. There is no escape from the massive accumulation of facts, and the overpowering application of principles, in which the work abounds from lid to lid. The glory of the book is, that it is not only scientific, but eminently Christian. It marks an epoch in the centuries. It is the work of Providence, and will not accomplish its mission in a generation. It unfolds truths that will stay as long as Christ is preached. Although strictly scientific, its one aim is the demonstration of a personal God, and a hereafter for humanity. We never tire reading it. It is an exhaustless mine of Christian truth. It is the literary *chef d'œuvre* of the age. Those who appreciate scientific truth, lucidly stated, will revel in its pages. All ministers and intelligent lay members should read it. It is worth its weight in diamonds. It is an armory full of the weapons of the Almighty, for the pulling down of strongholds."

[*Prof. Chas. Dion's Letter in the New York Sun.*]

"These positions and arguments [against the wave-theory of sound] can not be ignored as unworthy of notice by the eminent scientific men assailed, since quite a number of professors of the physical sciences, whose names are appended at the close of the work, have unconditionally indorsed the author's views. Among these are Prof. Kephart, A. M., of Western College, Iowa, and Prof. Osborn, LL.D., of Madison University, both professors of physics in the institutions named. Such men can hardly be supposed capable of surrendering unreservedly to a new theory in science wholly unworthy of the notice of writers on sound. It is for the distinguished authorities assailed to come to the rescue of their favorite theory; and thus, if they can, aid their fellow professors, who freely confess their inability to defend the received theory against Wilford's attacks. If he is right, there should be an immediate reconstruction of the sound-theory, so that our schools and colleges may teach truth instead of error upon that subject. These great authorities must not mistake the public. Scientific

students look to them for some explanation of these very damaging criticisms, and they will not be content till it is forthcoming. I write as an investigator of sonorous phenomena, and wholly in the interests of science."

[*From The Watchtower, Newberne, N. C.*]

"The problem of human life is at last solved, the Bible is saved, and the Christian faith is redeemed; and the broad space of eternity is too short for evolutionists to think of recovering from the death-blow of *The Problem of Human Life*. . . Without doubt it is the most startling book of the century. We would rather have the honor of writing such a book than to be president of the United States."

[*From the Methodist Christian Advocate, St. Louis.*]

"Some months ago we received, through the kindness of Messrs. Hall & Co., *The Problem of Human Life*. We have examined the work, and pronounce it one of the most, if not *the* most remarkable books of the age, demonstrating as it does some of the fundamental truths of our holy religion on purely scientific grounds, and from purely a scientific standpoint. Among these truths particularly are the existence of God, and the substantial and conscious nature of the human soul. . . . Taken all in all, it is the most remarkable book we have read in many a day. . . . As a religionist we enjoy these discussions hugely. Those whose friends claim for them the power to overthrow our Bible, and who, it may be, regard themselves as competent to the task, are met on their own ground, fought with their own weapons, and are hewn to pieces as completely as was Agag by the sword of Samuel."

[*From the Dexter (Iowa) Herald.*]

(Edited by Prof. Henry C. Cox, A.M., for 15 years Professor of Physical Science.)

"About two months since we procured a copy of Wilford Hall's *Problem of Human Life*, and as time has been given us we have been busy in its study. It is a great book. We believe it to be the ablest scientific work written in a hundred years. It is strong enough to refute, utterly, the specious pleadings of Darwin and Haeckel for evolution and spontaneous generation, and the sophistry of Professor Tyndall on Heat as a mode of Motion. The first division of the book is given to a discussion of the wave-theory of sound; and so completely does he show the absurdity of that hypothesis, that we feel mortified to reflect that for fifteen years we taught it for science."

[*From the Gospel Preacher, Ashland, Ohio.*]

"The angelic jubilate that undulated over the plains of Bethlehem is not yet spent. It still quivers in the air. God has sent a new messenger in the latter half of the nineteenth century to pronounce with fresh and glorious emphasis the Deuteronomy of the Gospel. Wilford Hall of New York is the Cyrus elect of the Most High to liberate Israel from the Babylonian yoke of scientific bondage. A divinely-panoplied and invincible champion of the truth has been providentially placed in the van of the host battling for God and the authenticity of His revelation. The gospel of the masses among the intelligent to-day, throughout the civilized world, is Evolution,—no God, no Emmanuel, no Heaven, no future,—conscience an educated lie, responsibility a delusion, and the Bible a stupendous fraud. But God Almighty has come down once more upon Sinai in fire and terror,—in scathing lightning, and in stunning, world-shaking thunder, in that wonderful, church-gladdening and hell-confounding book entitled *The Problem of Human Life, Here and Hereafter*. Nothing like it has ever come from the pen of man, save from prophet or apostle. God passes by and proclaims his awful name anew, as the old white-bearded Christian Philosopher lies in the cleft of the Rock under the hand of the partly disclosed I AM. Next to the Bible, it is the book for the redemption of the world. *The Problem of Human Life* is written wholly in the interests of the Bible. It throws the light of Heaven over Nature. It evokes the sweet, solemn, inspiring Amen of Jehovah, out of the commonest objects and occurrences. A "new heaven and a new earth" spring to view in the rapt, luminous pages of Wilford Hall. It is a God-indited book, spelled out of the slow-evolving data of the centuries and eternities, and the great truths it brings will last forever. The gates of hell can not prevail against it. The sword of the Almighty gleams on every page; and no atheistic weapon forged in Germany, France, England, America, or Pandemonium, can turn or blunt its edge. It is a heaven-burnished mirror that opens the mind to a thousand wonders never thought of before."

[*From The Christian, St. Louis, Mo.*]

"The author now comes forward with what may well be styled *Darwinism Against Itself;* for if ever a system of doctrine was beaten over the head with its own clubs, even unto death, Darwinism has been in this book. . . . The very least that can be said about the work is, that it is one of the most remarkable products of this fertile age."

[*From the Christian Preacher, Dallas, Texas.*]

"For years the author has been lost to his former friends; and now comes as one from the grave to overthrow the enemies of Christ and the Bible. He has dealt infidelity a deadly blow. The perusal of the work will amply repay any one for the money and time spent, in the way of vigorous exercise to the reasoning powers. It is the production of one of the most gigantic intellects of the age, and will produce a sensation in the scientific world."

[*From the Medical Brief, St. Louis, Mo.*]

"The book discusses the Problem of Human Life from a scientific standpoint, and is the greatest and grandest book of the century. Physicians who believe in the theories of Darwin, Tyndall, Haeckel, &c., should by all means procure this book and read it. It knocks the evolution doctrine of the so-called scientists into *smithereens*."

[*From the Presbyterian Weekly, Baltimore, Md.*]

"The trenchant criticism, logical force, scientific attainments, and the clear popular style of the author, have combined in producing in *The Problem of Human Life* a volume that meets a pressing want, and one that will be warmly welcomed."

[*From the Primitive Christian, Huntingdon, Pa.*]

"When such Goliaths of theology as Dr. McCosh, of Princeton, and Joseph Cook, of Boston, had surrendered their last inch of standing-ground to the evolutionists, it verily looked as if the 'Ark of the Testimony' was fairly in the hands of the Philistines. But God was educating a Daniel upon better mental fare than the King's meat; and has now given to the world through Wilford Hall, of New York, the grandest, the most triumphant, the most complete reclamation of all the facts and principles of science the world has ever seen. In that wonderful, unapproachable book—*The Problem of Human Life*—this man of "seven locks" and Divine ordination has taken the distinguished infidels of

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the present day by their throats, and shaken them in the eternal grip of truth till not a joint hangs together. From lid to lid the book peals with the seven thunders of everlasting truth. It is God's fresh seal to His Word and Works,—the like of which has never before been given to mankind."

[*From the Apostolic Church, Mayfield, Ky.*]

"This is in many respects the most remarkable book produced within the last quarter of a century,—a period remarkable in itself for the great advancement made in all departments of religious and scientific investigation. . . . Wilford Hall has well repaid the world, both in a religious and scientific point of view, for his thirty years of seclusion. May he yet live many years to unmask error and set forth truth; and that he may enjoy some of the fruits of his unparalleled labors, before he goes hence, is the fervent prayer of the writer."

[*From the Episcopal Recorder, Philadelphia.*]

"We have not seen any discussion which takes hold of scientific difficulties and suggested doubts with so great confidence. It is like grasping a nettle, the vigorous squeezing of which reduces it to a harmless mass. We rejoice to see this thorough and conclusive work; and think it well adapted to confirm the believer in revelation, and to encourage the timid. The work is in the interest of revealed truth, and is a zealous champion."

[*From the Texas Baptist.*]

"It is a real pleasure to read the book, and mark the lines of thought at every step of development, away from the ordinary channels of reasoning, concerning the things of which he writes. If the positions are true, Wilford is master of the situation; and if, upon the increased circulation of his interesting book, its readers are persuaded that his arguments are well grounded, he will be considered greater by far than any other man of the age in which he lives; and not less great than Sir Isaac Newton himself."

[*From the Journal and Messenger, Cincinnati.*]

"*The Problem of Human Life* is a very unexpected contribution to scientific polemics, which, if its reasonings shall be justified, on thorough investigation, will prove to be one of the loftiest achievements of this age, and effect one of the mightiest scientific revolutions ever seen."

[*From the Christian Standard, Cincinnati, O.*]

"The scientists who have dealt so flippantly with the solemn questions of spiritual and divine existence, and talked so vauntingly of their scientific demonstrations, will find that they have caught a Tartar. We cordially commend this work to our readers for earnest study."

[*From the Dominion Churchman, Toronto.*]

"We most cordially concede to *The Problem of Human Life* the well-earned title—*the book of the age.* Doubtless the God of Providence has raised up the author to meet the wants of the church in this time of need."

[*From the Western Christian Advocate, Cincinnati.*]

"It is a contribution upon the great questions involved of masterly ability. . . . It is indeed a surprise to find a writer of such evident ability concealing his name from the public."

[*From the Buffalo Christian Advocate.*]

"The logic of the author is very convincing, and leaves very little of Darwinism. We think the book is destined to wield a great influence against the materialistic notions of the day."

[Rev. Dr. Boyle's letter,—a specimen of hundreds we are receiving from Ministers of all denominations.]

"ALEXANDRIA, Va., Jan 14, 1881.

"A. WILFORD HALL, Esq.

"*My dear Sir:* I finished reading your book last night, and write to thank you heartily for the pleasure it has given me, and for its crushing arguments against the scientists. I read it too rapidly to digest it well, and must therefore carefully review it. It had to me all the fascination of a romance, and I was as eager to bolt it down as a novel-reader is to reach the denouement. Should you write again, please send me notice of publication that I may promptly avail myself of your thoughts.

I hope some time to make your personal acquaintance. I am, with esteem, yours very gratefully,

W. K. BOYLE,

Pastor of M. E. Church, South."

[*From Dr. Adams, President Wesleyan University.*]

"BLOOMINGTON, Ill., Feb. 6.

"HALL & Co.— *Gentlemen:* I have examined the new theory of sound, or, rather, as it seems to me, *the complete overthrow of the undulatory theory.* Other members of the Faculty have come to the same conclusion with myself. We are all very anxious to read Wilford's entire work. Please send me *The Problem of Human Life,* complete, with bill, and oblige yours truly,

W. H. H. ADAMS."

[From Prof. Kephart, A.M., Professor of Physics in Western College, at Western, Iowa, in a letter to the author.]

"I have no hesitation in admitting that in my opinion the undulatory theory of sound is hopelessly shattered. . . . I am therefore fully satisfied that your reasoning is sound, and that the works on physical science which teach the contrary are wrong. I am consequently now prepared to drop the undulatory theory of sound as a monstrous absurdity. . . . I am glad to learn that there are a few investigators of physical science who can lay aside their prejudices and give your arguments a candid reading. All such must be convinced that the undulatory theory of sound is a scientific delusion, and wholly without foundation in fact. I am still reading *Evolution of Sound,* and the more I examine it the greater is my astonishment that the wave-theory should ever have been accepted as correct, much less that it should have been believed in, for centuries, by so many eminent men.

"Sincerely yours, I. L. KEPHART."

[From Prof. L. M. Osborne, LL.D., Professor of Physical Science in Madison University, at Hamilton, N. Y., in a letter to the publishers.]

"The part on Sound I prize very highly,—a new departure that must be *permanent,* and lead to many modifications of old notions.

"L. M. OSBORNE."

[*From the Amer. Christian Review, Cin., O.*]

"The author (a man of acknowledged genius, and confessedly the brightest scientific star of modern times) has startled the religious world into transports of joy and praise. No religio-scientific work has received both from the secular and religious press such willing and unqualified praise as the *Problem of Human Life.* It is the death-blow of atheistic science."

"We can truly say that we are amazed at the originality, thoroughness, and marvelous ability of the author of this work."—*New Covenant, Chicago.*