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The Royal College
of Physicians

from the Author

July 1862

ESSAYS

ON VARIOUS SUBJECTS.

BY

CUTHBERT COLLINGWOOD, M.A. & B.M.OXON., F.L.S.,

MEMBER OF THE ROYAL COLLEGE OF PHYSICIANS;

LECTURER ON BOTANY AT THE LIVERPOOL ROYAL INFIRMARY SCHOOL OF MEDICINE;

PROFESSOR OF PHYSIOLOGY, QUEEN'S COLLEGE;

PHYSICIAN TO THE LIVERPOOL NORTHERN HOSPITAL;

&c., &c.

LIVERPOOL.

1861.

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ON THE

SCOPE AND TENDENCY

OF

BOTANICAL STUDY;

AN INAUGURAL ADDRESS

DELIVERED BEFORE THE

Liverpool Royal Infirmary School of Medicine,

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CUTHBERT COLLINGWOOD, M.A. & B.M. OXON.
F.L.S., F.B.S.E.,

FELLOW OF THE MEDICAL SOCIETY OF LONDON,
OF THE ROYAL MEDICAL SOCIETY OF EDINBURGH,
OF THE ENGLISH MEDICAL SOCIETY AT PARIS,

LECTURER ON BOTANY AT THE ABOVE INSTITUTION;
ETC.

LONDON:
LONGMAN, BROWN, GREEN, LONGMANS, AND ROBERTS.
LIVERPOOL: E. HOWELL, 6, CHURCH STREET.

1858.

ON THE

SCOPE AND TENDENCY OF BOTANICAL STUDY.

An Inaugural Address delivered before the Liverpool Royal Infirmary School of Medicine, May 3rd, 1858.

GENTLEMEN,

THE Lecturer on Botany in our Schools of Medicine labours under a disadvantage which some may wish to ignore, but which I think should be fearlessly stated, as the best means to insure its removal, or at least its diminution. It is, that Botany, as a general rule, is *not* a popular study with medical students. The broad fact is one which no one will dispute, and for which, I am ready to admit, there exist some apparently reasonable grounds; but while I consider it right that these should be stated at the outset, I shall also adduce certain considerations which appeal to the good sense of the student, and will place the matter before him in such a light, that I trust he will see reason to suspend his judgment upon the utility of the study of Botany, and not follow in the train of the many, who, without giving the subject an independent thought, allow a prejudice to take possession of their minds, and to deprive them of the advantages derivable from the study in question.

The curriculum through which it is necessary that the student of medicine should pass before he can be considered as possessing a knowledge of disease and a due acquaintance with the art of healing, embraces numerous subjects which either directly or collaterally bear upon these two practical ends of his profession. Anatomy, Physiology, Pathology, Chemistry, and Botany are among those subjects, through an acquaintance with which he arrives at that facility in rapid and accurate diagnosis—that aptitude for duly balancing the importance of subtle influences and suggestive changes which assists the formation of a correct prognosis—that quick perception of the indications afforded for appropriate remedies—and that familiar acquaintance with the nature of those remedies, which are the essential elements of success in medical practice. But each of these subjects involves a certain amount of mental labour, and the whole, if properly attended to, presents no inconsiderable task. The student, therefore, not fully cognisant of the tendency and result of these studies, usually endeavours to relieve his mind as much as possible from either of the subjects which he conceives to have least practical bearing upon his profession —and he seldom fails to include *Botany* in that category.

Another reason of the disfavour with which this science is regarded is to be found in the complexity of its glossology. The cursory and unscientific mind is too ready to regard Botany as a mere useless enumeration of hard names; but nothing can be more unjust than this prejudice. It is true that Botany, like other natural sciences, is overlaid with a technology which has been increased to a somewhat cumbrous extent by the carelessness and vanity of authors. While, however, we must admit that a revisal of terms used in the science would be very acceptable, were it possible to be carried out, we must bear in mind that by far the greater number of these technical expressions are both necessary and useful. Organisms which are so various and so complex as plants necessitate a nomenclature which shall be sufficiently exact to discriminate safely and easily between not only generic and specific differences, but also between the more nice distinctions of cultivated and hybridal varieties to which they are so peculiarly susceptible. The value of a nomenclature which accomplishes this should be at once recognised, and although it may cost an effort at first to master the principal terms, the student may feel assured that his labour is well bestowed, and will bring him ample return in the facility which it affords for the comprehension of the science, as well as in the mental training which it involves.

The ingenuity and completeness of botanical terminology has been referred to as a pattern for imitation, and as illustrating the precision with which technical terms may be framed to suit the endless varieties of form and structure with which the botanist has to deal, and to picture to the mental eye a vivid and accurate image of an absent plant. By the commencing student, however, it is liable to be misunderstood, its value misinterpreted, and its difficulty over-rated; and although it is open to the objection just referred to, it would be folly to undervalue so useful and important an auxiliary.

It is too much the fashion to look upon Botany as an amusing, but barren accomplishment, to be pursued when nothing more serious claims the attention. But while on the one hand it must not be considered as a mere enumeration of hard names, so also it does not consist in a mere collection of dried plants. The day when the greatest collector was regarded as the greatest naturalist is happily past. True it is that collections have their use, and an important one it is when they are properly applied; but the *mere* collector cannot now pass muster as a botanist. The *real* botanist has a wider and more extended aim; for though it is possible that more serious subjects may in their proper season claim attention, it must nevertheless not be forgotten how comprehensive a science is his—how intimately it bears upon the phænomena of life—how universal are the objects whose study it embraces—how important a *rôle* they perform in the economy of nature—how vital a necessity they are to man, no less than to the lowest animal.

But of those studies which I have alluded to as constituting medical education, none can be dispensed with without involving a defect in the groundwork, and a corresponding weakness in the superstructure. The very fact that a course of Botany is included in the requirements of the examining Boards should be sufficient to convince the thinking student that there may be a value discoverable in such a course and in the instruction which it either conveys or induces, which he, on the very threshold of his studies, is scarcely in a position to appreciate, and which he should be ready to accept on trust from those whom superior age and experience constitute the natural and proper, as well as official, guides of his course of study.

The advantages derived by the medical student from the study of Botany are of two kinds—*immediate* and *implied*. In order to set the former in their proper light, we will glance at the true scientific position occupied by Botany in the medical curriculum. Disease, and its relief or cure, are the two prominent points to which, through all his studies, the attention of the student is mainly directed. Before he can duly understand morbid action or pathological relations, he must have a clear perception of healthy action or physiological relations; and before he can comprehend the sufficient and normal performance of functions, he must possess a minute and accurate acquaintance with structure. Anatomy, therefore, is the groundwork of that first great practical part of medicine which consists in the perception of the nature of disturbed function, and the knowledge of the true cause and seat of diseased action. But he would be but a useless practitioner who, though ever so well skilled in diagnosis, should be unacquainted with the means of alleviating suffering by the application of remedies, or of curing disease by the administration of drugs. So that a knowledge of therapeutic agents is an essential qualification for the duly educated medical man. Now these therapeutic agents are, for the most part, of two distinct kinds, derived from two kingdoms of Nature—the inorganic, or mineral, and that subdivision of the organic kingdom which includes vegetables. A due acquaintance with mineral remedies involves the study of Chemistry—a study which is never afforded grudgingly, but, on the contrary, is always regarded as a necessary, useful, and practical branch of medical learning. Of therapeutic agents, however, while about one-fourth only are derived from the inorganic world, the remaining three-fourths are obtained from members of the vegetable kingdom; and no one will be so hardy as to affirm that they include the least important remedies. On this ground, therefore, it does not appear why the science which especially treats of this large and valuable class of materia medica should be regarded with contempt.

It is quite true that Chemistry has important physiological bearings which are more apparent or more practical than those of scientific Botany, as well as a general application to both classes of the materia medica, inasmuch as the organic branch of it, which has received such extensive additions of late years, gives us some information, and I trust will give yet more, relative as well to the *modus operandi* of medicines upon the system, as to the combination of mineral and vegetable substances for the formation of new and more subtle compounds. But the fact that Chemistry has a wider application does not appear to afford any reason why that science should be neglected by the student of medicine, which, in the words of Professor Lindley, "teaches the physician how to discover in every region the medicines that are best adapted for the maladies prevalent in it, and which furnishes him with a certain clue to the knowledge of the tribes in which particular properties are, or are not to be found."

It is only by means of a scientific acquaintance with Botany that our knowledge of medicinal plants can be increased and perfected. None but those whose intimate acquaintance with vegetable physiology enables them to trace out affinities and to understand the true position of newly discovered plants in the natural scale, can be expected to enlarge the usefulness of the vegetable world by bringing to light health-bearing treasures which have to this time escaped observation. It has been considered probable that the vast number of plants with which we are at present acquainted comprises little more than one-half of those which really exist, and we can scarcely imagine that this unknown moiety does not contain plants whose properties are little, if any, inferior to those with which we are already acquainted. It is possible that among them may be found remedies of which we at present little dream; and while such extended acquaintance with the members of the vegetable creation cannot fail, by bringing into prominence new affinities and analogies, gradually to perfect the natural system of classification, so, on the other hand, this very approximation to a philosophical scheme of Botany will tend to diminish the uncertainties of medical practice by enlarging our knowledge of specific remedies, and thus afford data which may assist in rendering medicine a more exact science. The sources of many valuable and well-known remedies which have long been used and appreciated, are still unknown to us, and their products reach us only in a commercial and crude state. It is the business of the scientific botanist to clear up these doubts, and thus assist in paving the way from empiricism to rational principles.

But besides these evident bearings of the science of Botany upon the pursuits of the medical practitioner, there are others which I have referred to under the term *implied* advantages, which, although they are less evident on a cursory inspection, exert no inconsiderable influence upon the professional character. It would indeed be difficult to define the exact amount of influence exercised by each one of the medical sciences upon the great practical ends in question—for each assists the other, and in the general and complete scheme the educational deficiencies of one are supplied by corresponding excellencies in another. One, specially descriptive, appeals to the memory, and is useful in exercising that important function; another, more particularly logical, addresses itself to the judgment; a third to some other faculty of the mind: so that all in turn are called into action, and none are permitted to lie dormant.

It cannot be doubted that the study of Nature has considerable effect in expanding the mind and sharpening the intellectual powers. The infinite variety of organs and of forms—the wonderful and beautiful adaptations which everywhere arrest the attention in the study of living organisms—the extraordinary exhibitions of contrivance and design which without fail unfold themselves before the careful and candid inquirer, tend materially to strengthen the mental tone and to elevate the general character; and for this reason it is well calculated to be made a branch of general liberal education. The minute attention and the accurate examination and discrimination which plants demand is an excellent training for the mind, and singularly favourable to habits of observation. Such habits of observation are peculiarly useful and valuable to the medical practitioner, and assist him greatly in the formation of a correct diagnosis. For as the botanist omits no organ, however inconspicuous, no mark, however slight, in his examination of a plant, with a view to trace its affinities, so the physician at the bedside passes by no symptom, however obscure, no hint, however vague, well knowing that a just opinion may result from a combination of circumstances minute and unimportant in themselves, or even from one little fact, for the elucidation of which a keen and subtle search is necessary. Thus the training which the botanist gives himself is not without its direct bearing upon his professional capacity, as well as on his perception of obscured truth in any other inquiry to which he may direct the powers of his mind.

Again, the varied studies which medical men require, in order to fit them for the practice of their profession, tend to render them, as a class, the best-informed men in society—and it is right that it should be so; and while asserting this proud position, it would be pity indeed if they should be found deficient in a branch of scientific inquiry bearing so directly upon their profession. The class of medical practitioners is that class to whom, *ex officio* as it were, we are indebted for our knowledge of anatomy and physiology, and of biological science —they are the chief depositaries of the arcana of natural science in general, and of the phenomena of life in the vegetable, no less than in the animal kingdom. A few narrow-minded individuals may grudge them this wide range of knowledge, and may wish to limit them to the strict and exclusive study of professional subjects; but such illiberal and short-sighted views are, I trust, at the present time fast dying out. I may perhaps be pardoned if, by way of carrying authoritative weight upon this subject, I here use the words of the late eminent and lamented Professor Edward Forbes, who, fifteen years ago, on an occasion similar to the present, observed, "A time was, when an acquaintance with the purely practical parts of the profession was all too many practitioners thought it necessary to acquire. This degrading idea was favoured by the non-professional public, and to gain a prominent position in literature or science was too often to close the gates of professional success. But that time is either gone by, or is fast waning away. That profession, the investigation of which involves some of tne deepest problems in human philosophy, must become more and more philosophical every day. Sound education in literature and scientific instruction in his profession are fast elevating the character of the medical student; and in the end, an unscientific practitioner will become as rare as a medical sceptic."*

But before quitting this part of my subject, which relates to the inducements which this science holds out to the student of medicine, I will allude to one which is too generally overlooked. In every active profession it is advisable to have some pursuit which shall act as a relief, or safety valve, if I may so term it, to the pressure of every-day business. A mind which has been harassed by professional routine reverts gladly, in its moments of leisure, however scanty, to something which is at once congenial and interesting—something which may be pursued for its own sake—some recreation which, although itself requiring thought and attention, is yet a change, and turns the mental activity into another channel. The truly philosophic mind is never idle, and although immediately professional calls do not challenge him, he is not content to pass these intervals in sloth and inactivity, but will find it agreeable—nay, *necessary*—to have something to which to turn in these leisure moments. And let no one imagine that such leisure moments have no existence—only he who has endeavoured to reckon them, and to turn them to account, is able to judge how numerous and how valuable they are. Minutes make hours, and hours days, and days months; and if the first are neglected, the last are lost; and the student who conscientiously garners his spare moments, and exchanges them for scientific information, will find himself possessed of a rich harvest of knowledge, which will be a never-failing source of enjoyment in the pursuit, as well as a treasure accumulating for the future. Many have lived a second life by the discriminating use of intervals of leisure, and have surprised the world by their acquaintance with subjects for the attainment of which their active business life has appeared to leave no space; but it is by a jealous and methodical employment of such intervals that

* Prof. E. Forbes' Inaugural Lecture at King's College, May, 1843.

the wonder has been effected. Scientific eminence is NOT incompatible with the pursuit of an active profession: this axiom is proved by the numerous examples around us in our own day, of men who have reached the highest pinnacle of professional eminence, and at the same time have acquired a scientific reputation second to none. Such examples must occur to every one, drawn from all professions, and embracing every department of literature and science.

Again, there is a contingency to which medical men are liable, and which should be early provided against. A time may come—it may be soon, it may be late—when circumstances may render it necessary to abandon the practice of their profession. Fortune may smile, or may frown, illness may incapacitate, or other circumstances may combine to prevent a further pursuit of its active duties. The incapacitated by sickness or accident are thrown back upon their own internal resources—the retired practitioner seeks rest from his labours, and promises himself ease and enjoyment—how vainly! if nothing but strictly professional duties have occupied his life. He is restless, unhappy, disappointed, soured by ennui, and instances will not be wanting to the minds of all, in which he has rushed back into the tide of an active professional career, as the only means of escape from the burden of *himself*.

But there is an internal source of gratification and pleasure arising from the study of Botany in common with the other departments of Natural History—an intellectual enjoyment which springs from a perception of beauties which unfold themselves at every step to the diligent inquirer in the field of Nature, which especially adapts itself to all these cases, and renders it peculiarly fitted to be followed out as an extra-professional pursuit. No one can arrive at a well-grounded knowledge of those wonderful modifications of organs to meet an infinite variety of conditions—at the exquisite balance which is maintained either in the vegetable world itself, or in its relations to the inorganic world on the one hand, and to the animal creation on the other,—no one can contemplate their vital actions, their physiological conditions, without feeling a deep sentiment of wonder, and a degree of fascination in the study of them. Even a cursory view is provocative of admiration, as their beautiful flowers appeal to our senses of sight and smell, and tall and stately trees afford us an umbrageous shelter, making us long to know more concerning the members of that middle kingdom of Nature, of what elements they are composed, in what manner they are combined or aggregated, what are the conditions of their well-being, and what is the nature of the forces which set the dormant seed in action to become the living plant, and which give the decaying plant the power of reproducing its like, before it finally returns to the inorganic elements from which it built itself up. The very fact of having stepped within the threshold of Nature's temple gives a man self-respect and a just feeling of superiority which elevates him above his fellows.

There are advantages, too, of a physical nature, which, as they illustrate the adaptability of this study to the cases in question should not be altogether passed over in silence. The pursuit of the science, while it affords a pleasing recreation from the stern duties of actual life, at the same time offers an inducement to a healthful out-door occupation, so conducive to the *mens sana in corpore sano*. The objects which it embraces are to be found everywhere under the canopy of the sky, unless they have been thrust aside or trampled under foot by the self-imposed necessities of men; and thus while they attract the inquirer to the woods and fields, their native haunts, for purposes of observation, they at the same time afford constant and unfailing food for contemplation; and while, on the one hand, they prevent the mind from falling into vacant inactivity, and thus assist in keeping up a healthy tone, on the other hand, they distract the attention from pressing cares, which otherwise sometimes unnecessarily intrude themselves, even in what should be moments of relaxation; so that in either case physical and mental health mutually react and fortify one another.

Thus far I have confined myself to the strictly medical aspects of Botany, and endeavoured to show that these alone are sufficiently extended and important to render the science well worthy the attentive consideration of the medical student.

I shall now turn from that part of my subject, not, however, because those aspects have been by any means exhausted, or because I have said all that *could* be said in favour of Botany when regarded from that point of view, but because I should ill befit my office if I did not call your attention to other considerations. The science of Botany has bearings far more extensive and far more important than the merely medical, whether we regard the vegetable kingdom as a whole, in its vital relations to the entire animal creation, and to Man in particular, or whether we view the simple cell which is at the foundation of every organised body, and by its aid as a stepping stone arrive inductively at broad views of vegetable, animal, and human physiology. The great domain of Nature may be conveniently divided into three kingdoms—the animal, the vegetable, and the mineral; and Botany in its widest and most comprehensive sense may be considered as embracing every kind of inquiry which can be made into all the varied phenomena of that kingdom which occupies the important and interesting intermediate position between the other two. Not only does it busy itself with the description of the infinite variety in the forms of vegetable organs, modified as they are by every condition of soil and climate, but the relative importance of each organ, its functions, and its uses to the well-being of the entire organism must be considered. These lead to that appreciation of natural affinities which is essential to the formation of a philosophical arrangement of the individuals composing the whole kingdom, both for purposes of reference and for the elucidation of botanical principles; while the study of the distribution of plants over the surface of the globe throws light upon the mutual relations existing between climate and vegetation; and the restoration of the plants of past and distant epochs assists in the comprehension of the affinities between those existing in our own day. I shall therefore touch upon each of these branches of Botanical Science—viz., Organography, Physiology, Taxonomy, Geography, and Palæontology, and endeavour to point out the scope and relations of each.

The great uses of a study which is in itself an accumulation of isolated facts, do not consist merely in such accumulation, but that is, in fact, *the means* to the attainment of some higher and more important *end*, which can only be arrived at by some such tedious and laborious process. This end is Generalisation, or the deduction of broad principles from a comparison of results —a natural synthesis, by which Laws, as we call them, are discovered—which are, in fact, general expressions of the limits within which Creative Power thought fit to act. For the discovery of such general principles a high order of genius is necessary, in addition to an extensive and accurate acquaintance with facts, so that usually the observations of thousands furnish material for the generalisation of one. Vegetable Organography may be therefore regarded as the alphabet of the science, which it is necessary to master before broad principles can be even understood and appreciated, much less discovered. It is to Botany what Anatomy is to medicine—the groundwork upon which all safe inquiry is to be conducted. The vast accumulation of facts in Vegetable Organography has resulted in the discovery of that important generalisation which is usually designated as the Law of Morphology—a law which, although it leads to views which on a superficial inspection appear strained and unphilosophical, is nevertheless a truth whose fundamental simplicity and harmonious expression render it well worthy of attentive study and dispassionate examination—a law which reduces variety to unity, and expands uniformity into infinite complexity—the key, by means of which every variation of form, however remarkable—every deviation from type, however wide—every abnormality, however apparently capricious, may be referred to a common and well known elementary standard, by contrast with which its deviation may be measured and its abnormality explained. This great fact, the simplicity of which is proportionate to its importance, did not escape the discernment of the great Swedish Botanist, and Linnæus first gave, in his Prolepsis Plantarum,* indications that he regarded the leaf as the type of all the other parts. But he had obtained but glimpses of this great generalisation, and it remained for a poet to foster it, and for one of the greatest of modern botanists to adopt it,

* Amœnitates Academicæ. Vol. VI., p. 324.

before it was generally recognised. Goethe's† doctrine was tinged with the transcendentalism of his nation, and was, in fact, the *poem* of Morphology; De Candolle‡ dressed it in sober prose, divested it of its fantastic garb, and exhibited it in its simple grandeur, and it was forthwith accepted. Not, however, without opposition, as everything great is opposed; but *magna est veritas*, and no truth in Botany is now more firmly established than the doctrine of Morphology. Indeed so evident is its application that it is probable that only a misconception, arising from an unhappy choice of the term *metamorphosis*, stood in the way of its being at once embraced. The floral whorls are *not* metamorphosed leaves—they are physiologically totally different from leaves—they never were, at any period, leaves—and they cannot, therefore, be said to be metamorphosed leaves; but they are all formed upon the pattern and type of the leaf—they are, in other words, homologous with leaves; and if their special function be lost, they tend to a closer resemblance to their original type. Another term, no less unfortunate, is *Abortion*. There is no such thing as abortion in Nature, and what is thoughtlessly so designated is in reality the very opposite. *Modification* or *adaptation* is the proper term, for while abortion consists in a failure to arrive at the degree of perfection aimed at, Modification, which is what we everywhere meet with, is a special Adaptation, made by express design, to meet particular cases.

When this great principle of Homology is once accepted, what a view does it afford us of the Unity of the vegetable kingdom, since all the diverse and fantastic forms which give a feature to the vegetation of the globe are referable to one common standard. The complex ovaries, the delicate stamens, the gorgeous blossoms of the Magnolia and of the Rose, the insectiform flowers of the Orchideæ, the papilionaceous Leguminosæ, the feathery pappus of the Compositæ, and the helmet-like sepals of the Aconite—all these, no less than the capacious pitchers of Nepenthes and Sarracenia, the spreading fans of the Talipot and the Sabal, the phyllodia of the Acacias, and

† Versuch die Metamorphose der Pflanzen zu Erklären. Gotha, 1790.
‡ Organographie Vegetale. Paris, 1827.

the twining tendril of the pea-like plants, are all modifications of a definite organ, consisting of a vascular petiole and a cellular lamina. On the other hand, what an impression does it give us of the illimitable fertility of design, and the supreme wisdom of the Divine Artificer who has so varied the pattern of the simple leaf, that not only an endless series of forms has resulted in the organs of plants, which at the same time delight the sense by the charms of variety, and employ the intellect in the search for uniformity, but has so adapted each modification to the purpose it has to fulfil, and to the peculiar conditions under which it exists, that the study of these mutual relations becomes an intellectual banquet, constantly renewed, and never surfeiting.

But it is probable that this law of Morphology may be safely carried yet further, and the investigations of Dr. M'Cosh seem to indicate that not only are the appendages of the plant modifications of the primary type, but that the whole plant is, in fact, built up upon a plan which may be examined in miniature in an individual leaf of it.* The correspondences which he has illustrated between the tree and the leaf relate to the presence or absence of the petiole, implying a corresponding developement of the stem—the disposition of branches of the tree, and the analogous distribution of veins of the leaf—the agreement of their angles of divergence, as well as their curves of arrangement; so that the varied physiognomy of the whole tree in a normal condition of growth is distinctly figured by each of the leaves, thus tending to prove that the leaf is the archetype of the entire plant, no less than of its individual organs. Should further investigations confirm the hypothesis of Professor M'Cosh, it will establish a principle of unity throughout the whole vegetable kingdom which analogy would lead us to believe as very probably existing, and which should not be confined to the vegetable world, inasmuch as the homologies already known to exist in the animal kingdom give promise of a similar generalisation in that department of Nature.

In studying the organs of plants one can hardly fail to be

* Proceedings of Edin. Bot. Soc. July, 1851. Reports of the British Association, 1854, p. 100.

struck by certain constant qualities which they exhibit, and which place their harmonious relations in a clearer light. The qualities to which I particularly refer are those of numerical relation, spiral form, and harmonious colouring. The constancy of particular numbers in particular classes of plants—the arrangement of fives in Dicotyledons, of threes in Monocotyledons, and of fours in Acotyledonous plants—is a circumstance which cannot be regarded as accidental. But numerical agreements are best illustrated in connection with spiral form, inasmuch as it has been shown that the fractions which represent the divergence of nodes in the ordinary forms of spiral development have a mutual relation, not single only, but threefold. These considerations are worthy of profound attention, and the universality of these numerical relations in the appendages of the plant, taken in connection with what has just been said concerning the unity of plan in the whole tree, renders it probable that some such numerical harmonies are at the foundation of those beauties of form which plants universally exhibit, and which are universally appreciated, and that a certain mathematical relation, in fact, exists throughout the whole vegetable kingdom, which, although its laws cannot be immediately studied, yet unerringly influences our sentiments of admiration, in the same manner that Mr. Hay has demonstrated the application of mathematical principles to be the basis of the ideal beauty in the human figure.

The law of spiral development is itself sufficiently remarkable to make such a generalisation probable. Its universality does not appear to me to be dwelt upon as its importance deserves.* The existence of a spiral impulse, if I may so designate it, is visible in the monarch of the forest, no less than in the simple cell. Aged trunks exhibit a spiral twist in their gnarled bark, and the same may be observed in old branches; scandent plants twine spirally round their supports; the law of alternation, (which is the expression of the spiral impulse,)

* I am aware that a considerable authority, Dr. J. M. Schleiden, is disposed to attach very little weight either to the spiral development or the numerical relations of parts in a plant. Such circumstances, which cannot be reduced to rigid scientific rules, are apt to strike differently constituted minds in a very different manner. The Jena Professor, however, it will be remembered, is sufficiently tenacious of a theory which he has once adopted, although it may want the support of analogy.

obtains almost universally in the growth of axial appendages; spires regulate the position of the floral whorls, no less than that of the true leaves, reaching a typical perfection in the scales of coniferous trees; the fundamental distinction between monocotyledons and dicotyledons consists but in a modification of the spiral in germinating seeds;* spiral embryos distinguish a division of Crucifers; spiral or phytozoary filaments play an important part in most, if not all, of the Cryptogamic divisions of plants; a spiral fibre keeps open the vessels of the medullary sheath; a similar spiral fibre is coiled within certain cells; spiral movements are visible throughout entire plants, constituting what is termed Gyration in Charads; and lastly, similar spiral movements take place within the limits of a simple membranous cell in many of the higher Phanerogams.

This universality of the spiral would seem to indicate forces acting in the vegetable kingdom with which, or with the modes of action of which, we are yet unacquainted, but which are well deserving of attention and research. Whatever they are, it may with probability be supposed that the same influence which acts upon the contents of the simple cell induces also the spiral arrangements of the more complex organs, as well as of the entire organism.

It may be remarked that analogous forces are not wanting in animal structures. The shells of Mollusca, whe thertur-binate or discoidal, all exhibit evidence of a spiral formation, more or less distinct, of the kind called Logarithmic, and which has been examined with great acumen by Professors Moseley and Goodsir.

It is in the highest degree dangerous to call in question any apparent defect of adjustment in the works of Nature. So often have such assumed imperfections been proved to be nothing more than the fruit of deficient observation and hasty judgment, that one would suppose that philosophers would by this time have learnt the untenable ground which they occupied when urging such objections. But scarce any one, however eminent, has been free from this fault in some degree; and although the anatomist and physiologist can hardly be

* Cf. Lindley's Introduction to Botany, Vol. II., p. 67. London, 1848.

conceived to be in danger of falling into it to any great extent as heretofore, still there are aspects of Nature which engage attention, and whose relations are not apparent without special study. A rising doubt concerning any special adjustment not at once obvious should be sufficient to set the philosophical mind musing, with the persuasion that patient investigation will unfold relations and harmonies whose effects are visible to all, while their *rationale* is only disclosed to the candid inquirer. Thus it is with regard to the colours of flowers. The general aspect of the vegetable creation is proverbially pleasing, but still persons of high taste and conversant with the principles of æsthetics, have thrown out doubts whether there be in them any relation between form and colour. Dr. Dickie, of Belfast, has, however, lately pointed out as the result of widely extended observations, that such a relation *does* exist, both as regards the uniform colouring of regular flowers and the special distribution of colour in irregular corollas; and further, that a distinct and easily recognisable complementary harmony characterises the tints of flowers in general. The general conclusion which he derives from his observations is expressed as follows:—"That simplicity of figure corresponds with simpler contrast of colour in the monocotyledons, while greater complexity of colour and greater complexity of structure are in direct relation in dicotyledons."* But it is in fact this very perfection and balance of adjustment which renders us blind to it. Had the laws of harmony been violated in the colouring of flowers, the intuitive taste would have been offended, and the discord at once detected; but but where no discord exists, no jarring is perceived. The laws of the Beautiful are not agreed upon, but the educated eye, no less than the educated ear, assents to harmony however produced; and since it can be shown that the colours not only of the flower, strictly so called, but of the other chromatic parts of the plant, are complementary, so also they cannot be otherwise than harmonious.

* Typical Forms and Special Ends in Creation, by Profs. McCosh and Dickie, p. 153. Edin., 1857. In order to arrive at these results of Dr. Dickie's observations, I was led to procure this excellent work, and was gratified to remark how I had unknowingly regarded some of the subjects referred to in the present lecture from the same point of view as the learned authors.

If the study of the structure of vegetable organs be of so interesting a nature, from its unfoldng relations the most unlooked for, and adaptations the most exquisite, a consideration of the plant in action and in full performance of its physiological functions is no less important, as illustrating the remarkable position occupied by vegetables in the organic scale, and the entire dependence upon them of animals, not only for subsistence, but also for the very air they breathe. The plant stands between the herbivorous animal and the inorganic elements which compose the crust of the earth, and by a vital or chemico-vital power entirely peculiar to itself, converts the latter into a pabulum adapted to the former. No animal can exist unless it receives as food matter in a certain state of combination, which we designate *organised;* and the plant, with which such a necessity does not exist, is constantly preparing for the animal vast stores of nutriment by taking up the simple elements of which the earth's crust is composed, and combining them into ternary and quarternary compounds of the most complex description. The vegetable world is a vast laboratory, in which inorganic matter is taken up, elaborated, and fixed, no longer dead, mineral, and innutritious, but part of a living tissue, performing vital actions so long as the organism exists, and affording a pabulum fitted for animals, by means of which the highest functions of the perceptive creature may be adequately performed. Viewed in this aspect, the vegetable creation receives an importance inferior to no department of Nature. A plant may be regarded on the one hand as a living organism whose whole existence is one round of antagonism to animal life: whatever is essential to the well-being and functions of an animal, we may be almost certain to be opposed to the requirements of a plant—those elements which are fatal to the one, are the very essence of existence to the other. But, on the other hand, this very antagonism is made to subserve to the most perfectly balanced harmony between the two, and to result in their mutual and inseparable advantage. They are therefore rather to be regarded as dual powers, mutually assisting one another, than as antagonistic; the one totally and entirely dependent upon the other—a disturbance in the balance of the functions of the one inevitably reacting, and causing a failure in the powers of the other. But while their mutual dependence is thus illustrated, the subserviency of plants to the higher functions of animal life becomes apparent, since it is they who originate organic matter, and who reorganise the elements loosened from their combination by the decay of animal bodies. A careful study of Vegetable Physiology, especially when added to the examination of the lower forms of Animal life, is therefore the best school in which to learn the true relations of living organisms, and the means by which we may hope to attain a deeper insight into the nature of vital force. It is in vegetables that this vital power first makes its appearance, and it is through them that it is communicated to earthy materials. A consideration of the textures of plants, taken in this relation, cannot fail to surprise the inquirer from the apparent simplicity of the organisation which performs these important changes—changes which the chemist in his laboratory, aided by all the appliances of art, and the accumulated knowledge and experience of the thousands of years which have elapsed since the birth of that ancient science, with few exceptions, vainly attempts to imitate. The nature of this simplicity cannot be better expressed than it is in the opening passage of Lindley's "Vegetable Kingdom:" — "Organic vesicles usually extending into tubes of various kinds exclusively constitute vegetation, but the simplicity of nature is attended by very complex details of arrangement, as is shown in trees, whose framework is knit together by countless myriads of such vesicles and tubes, entangled with *an astonishing intricacy of simple arrangement*" Vesicles and tubes are indeed the apparatus by which the organic alchemy is effected, but the essential organ which performs the wonder may be regarded as the simple cell, consisting of a membrane inclosing a minute quantity of a certain plastic substance. To this protoplasm the membrane probably plays only a subordinate part, its chief importance being, according to Mr. Thwaites, "to locate, protect, or isolate the matter it contains," Here, then, we have arrived at the simplest expression of organising power which our senses have yet sufficed to reach; and it is by a careful study of the contents of the vegetable cell that any advance is to be made in the comprehension of the phenomena of life.

Much has been learnt from such an attentive examination, and much light has been thrown upon the physiology of the more complex organs of the higher animals by a consideration of vital phenomena as exhibited by the most remote divisions of the animal and vegetable kingdoms. The more we can simplify these phenomena, the more we can reduce the complexity of the organs exhibiting them, the more probability is there of our arriving at the laws which govern them and the modes in which they act. The earliest possible life, then—that exhibited by the lowest dawning forms, becomes the most valuable to this end, and we find in the independent cells of Protococcus and Torula, organs in which the utmost degree of simplicity is attained compatible with the performance of vital functions. Still the complex operations of these functions baffles us; nutrition is carried on, the cell as an individual lives and dies, but not before it has provided for a successor; and reproduction is no less perfect after its kind in the simple cell than in the more complex organs of higher organisms. Two cells may be undistinguishable from one another by the highest powers of the microscope, or by the nicest chemical tests, and yet possess functions essentially distinct; which distinction could not, in the nature of things, exist without a difference of constitution. There *are*, therefore, existing differences in apparently similar cells, which imply forces whose nature or whose minuteness we cannot appreciate; but this does not necessitate the existence of forces altogether unknown to us. The effects of light, heat, electricity, and chemical combination are to a certain extent known, but is their nature appreciated, and are their mutual relations fully understood? Light and heat we know to have most important influences upon vegetation, but we cannot yet measure their value and extent; chemical differences are obvious in the mass, may they not exert important influence upon the component parts? while electrical currents can only be inferred or conjectured from the presence of regular crystals in the cell;

but where there is chemical combination, must there not also be electrical action? and the regular movements so frequently observed within cells would seem to point to this as their determining cause. Such papers as that of Mr. Thwaites on Cell Formation,* and the speculations of Dr. Carpenter on the mutual relations of vital and physical forces† awaken deep reflections, and almost inspire a hope that glimpses at least towards the comprehension of vital phenomena are not so far beyond the reach of human analysis as might at first sight be supposed.

The application of Vegetable Anatomy and Physiology to the Classification of plants is a subject of high interest and importance. The necessity of some such classification is apparent when the vast mass of materials is considered, both for the purpose of rendering available the discoveries already made, and also for the comprehension of the relations of constantly increasing novelties. A careful study of natural affinities is necessary to this end, undoubtedly useful as it is, and which, in a restricted sense, may be considered one of the chief aims of botanical investigation. Although, however, it should not be regarded as the grand and ultimate aim, the labours of systematic botanists are not to be despised. They to whom we are most indebted for a successful generalisation in this department, and who have been most happy in the arrangement of the vegetable kingdom in a natural and truthful manner, have been Botanists who possessed the widest acquaintance with the descriptive and physiological parts of the science; for without these, approximations cannot be arrived at, and nothing but fallacious and perishable results can be obtained. The steps by which botanists have attained the present degree of perfection are interesting and instructive, and while they show that the path is open before us to a correct system, they also indicate that perfection in this department cannot be arrived at, until we can take cognizance of a vast number of plants which, "born to blush unseen," have hitherto eluded the energetic researches of the exploring traveller.

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* Ann. Nat. Hist., Vol. XVIII.
† Phil. Trans., 1850.

To the ancients little arrangement was known beyond the simple one into trees, shrubs, and herbs, and this probably amply sufficed for the requirements of their limited knowledge of vegetables, which does not appear to have embraced more than five or six hundred plants. But in modern times the rapid increase of our acquaintance with newly discovered materials has given rise to systems ever changing, though not always new. The old herbalists of the sixteenth century, who studied plants solely as the depositaries of elixirs, decoctions, and electuaries, which were supposed to soothe all mental as well as bodily ailments, adopted divisions no less artificial, and their botanical descriptions, which contained as much of fable as of truth, referred to plants as esculent or medicinal, bulbous or grassy. It was Conrad Gesner, and soon after him Andreas Cæsalpinus, who first conceived the idea of taking some important organ as a basis for classification; and they selected the fructification. The work of the latter, published in 1583, describes 1,520 plants, which were all that were then known. A century later, Rivinus and Tournefort classified nearly 8,000 species of plants, founding their classes upon the corolla, and their orders upon the fruit. To this there was the manifest objection, that inasmuch as flower and fruit are seldom seen together, it was necessary to wait a month after discovering the class before the order could be ascertained. In the History of Classification, our illustrious countryman, John Ray, holds an honourable position; about the close of the seventeenth century, and simultaneously with the system of Tournefort, appeared his Historia Plantarum—a work still in use as a book of reference, wherein are described on principles which near a century later formed the foundation of the system of Jussieu, 8,625 plants, the limits of botanical knowledge in that day. Thirty years later, about 10,000 plants being known, the great Linnæus promulgated his admirable artificial method, which, with all its defects, (and well its author knew them,) has done vast service to botanical science, and remains a monument of his acumen and originality. The Linnæan system has been ungenerously decried by many who have failed to perceive its influence on the more natural and perfect methods of Jussieu and De Candolle; but it should never be forgotten, in the first place, that the re-modeller of Natural History was well aware of the true principles upon which a natural classification would ultimately be founded, and in the second place, that the artificial system has materially assisted the introduction of the method of Jussieu, by its value as an index, by means of which temporary order and arrangement became a matter of the most perfect and complete facility, and thus accomplished the first great and difficult stride to higher things.

Simply, therefore, as a system for reference, the Linnæan method admirably answers the conditions proposed; but for a comprehensive and philosophical view of the vegetable kingdom, natural affinities must be elucidated, and the principle of unity discovered and illustrated. In order to place the difficulties of a natural classification in their proper light, let us suppose that 200,000 cards are each marked with a secret but complex sign in such a way that the whole number forms a series. Let us next imagine that the whole series be shaken into a vast heap, and mingled together in wild confusion; and further, that 192,000 of them be then abstracted at random, and concealed from view. If a person were now requested to examine the remaining 8,000 for the purpose of discovering the clue to that secret series with which the whole are marked, what difficulty would he find in the attempt; he would indeed scarcely be in a position to make an approximation to the truth, and unless possessed of extraordinary sagacity, would give up the attempt in despair. Such was the position of Botanical Science in Ray's time, when our excellent and pious countryman succeeded, in spite of these drawbacks, in reaching such an approximation. Let us now suppose that two or three more thousands of the concealed series are brought to light, thus increasing the number at command. The facilities for arriving at correct ideas of the whole are proportionately increased, but other difficulties at the same time arise. The number under examination is so considerable, that although it bears but a small proportion to the whole, yet, in the absence of the proper clue, it becomes unwieldy, and without some artificial and temporary method of arrangement the inquirer would be lost in the very complexity and abundance of his materials. Linnæus met that difficulty, which would have increased every day but for his simple and admirable artificial system, which, if it were useful then, became yet doubly so before the clue was recognised. Regarded in this light, the services of Linnæus exhibit a value unmatched by those of any other naturalist; and even apart from the vast benefits to science from his dual system of nomenclature, his botanical terminology, and his revision of species both of plants and animals, his artificial system has paved the way for, and considerably hastened the introduction of, a natural system, while at the same time it has tended to advance the science by popularising it. And be it remembered that Linnæaus justly estimated the relation it bore to the natural system, the "primum et ultimum desideratum," as he termed it; while no one knew better than he that "the formation of a natural system must result from a close attention, not to one or two, but to *all* the parts of plants." These are his own words. But the illustrious Swede was a man of a thousand—one of that handful of men whose appearance in all ages of the world has marked an era in philosophy—one of those human landmarks whose personal history is the History of Science. It was no fault of his, if his successors, from a blind adherence to their master, mistook the shadow for the substance, and in their anxiety for his honour resisted the improvements to whieh he had hopefully looked forward.

It was Jussieu who, in 1774, still having less than 20,000 numbers of the series at his disposal, by deep study and patient research, aided by profound sagacity, indicated the principles on which a natural classification was finally to be established, and thereby showed that Ray and Linnæus had both foreseen them. He formed a system which was modified and improved by De Candolle and his successors, aided by the vastly and rapidly increasing knowledge of species. All botanists, however, were not so discriminating as these chiefs of the science, and the new clue was not immediately recognised, although placed in a prominent position. Like all truths, it met with resistance at first, and it remained for the authority of Robert Brown* to establish it in this country.

The objectors to the natural system—and there yet remain some, on the ground of its incompleteness and imperfection—must bear in mind that of the 200,000 which I have supposed to constitute the entire series, only about 100,000 are yet known and described, and of these many but imperfectly, and therefore uselessly in a practical point of view.† The remainder lie scattered abroad in the rich but unexplored regions of America, Africa, India, China, and Australia, as well as entombed in the bowels of the earth—from the Lepidodendron of the lower old red sandstone to the Protolarix of the upper tertiary. All these must be compared and understood before a perfection of system can be reached, and the absolute unity of the whole plan fully demonstrated.

The limits of a lecture will not permit of more than an allusion to the two remaining branches of botanical inquiry—viz., the geographical distribution of plants and the geology of Botany. These two subjects bear intimately upon one another, and it will be convenient to refer to them in the same connection. The first thing which strikes the student of botanical geography is the universality of the vegetable creation. While the tropical heat of the globe is most productive of the rank and luxurious vegetation so picturesquely described in the works of Humboldt and Waterton—unless, indeed, as in the African deserts, totally unaccompanied by moisture—there is scarcely any spot of land in the frigid polar regions where some member of the kingdom does not exist. It may be only a humble moss, or a crustaceous lichen, whose tough, coriaceous epidermal covering resists the utmost degree of cold, and with no soil except that which it makes for itself on the adamantine surface of the bare granite rock, holds its ground, and proclaims the plastic hand of Nature, where all else is rude, primitive, and chaotic. Nay, according to Humboldt,‡ the simple living cells of Discerea (Protococcus) Nivalis "exist in the polar snow as well as in that of high mountains." Between these two

* While these sheets were in the press, this venerable philosopher, "Botanicorum facilè princeps," has passed away from the scene of his unwearied labours.

† Meyen's Geography of plants, p. 4., Ray. Soc.

‡ Cosmos, Vol. I., p. 353. Bohn's Edition.

extremes of conditions what infinite diversity of forms give a distinctive physiognomy to every zone, from the vast foliar expansions of the equinoctial plantains to the needle-shaped leaves of the pine-trees of the north. But it is not merely the zonal gradations of heat which determine this diversity, but the geognostic nature of the soil plays an important part in producing conditions favourable or unfavourable to particular classes of vegetation. Again, the unevenness of the surface of the earth, the result of geological changes of past epochs, modifies in all parts of the globe the nature of its flora; and, just as the same cause has disturbed the uniformity of the strata, and by their dip brought all to the surface, so as to be readily inspected by man, so the elevation of mountain ranges within the tropics, as well as in more temperate regions, has caused the existence of floras which in the space of a few miles epitomise the productions of vast latitudinal areas, and in any given country bring before the attention of the observer diversities which are only more extensively illustrated in the transit from the equator to the poles. The original distribution of plants is by the same influences so modified that it becomes difficult for the botanist, even with the aid of the physical geographer, to determine whether primary specific centres existed which have since been broken up by geological convulsions, and by a total alteration of the conformation of the land, have become scarcely distinguishable in the present day; or whether the same species of plants in the beginning were generally distributed over different and far distant localities, where similar conditions of temperature and soil permitted them equally to grow and flourish. The former theory is a favourite with geologists, and De Candolle, in his Essay on Botanical Geography, admits that though a certain degree of analogy, aspect, and even structure, might very possibly be discoverable between the plants of two distant localities presenting the same circumstances of temperature, altitude, soil, and humidity, nevertheless the *species* would in general be different.*

The discovery of vast accumulations of vegetable remains in a fossil state gives rise to considerations bearing intimately upon

* See Lyell's Principles of Geology, Vol. III., p. 4.

botanical geography. How is it that among these remains we find structures in high temperate latitudes which in our own day are only developed under the influence of a tropical sun? In considering this question we must bear in mind the general nature of those remains. In the beds of coal which exercise such a vast influence upon modern civilisation, and which extend up to a high degree of latitude, "the flora," says Lyell, "consisted almost exclusively of large vascular cryptogamic plants,"—Equisetaceæ upwards of ten feet high, and from five to six feet in diameter; tree-ferns, forty to fifty feet high, and arborescent Lycopodiaceæ from sixty to seventy feet high. This is a scale of vegetation not reached in equinoctial temperatures now, and presupposes an amount of heat and humidity in former ages of the world which we can hardly appreciate in the present day. Such degrees of heat, however, are reconcileable with other phænomena, and the vast impregnation of the humid atmosphere with carbonic acid is indicated by the prevalence of limestones at a contemporary period.* If, however, these giant forms of cryptogamic vegetation grew upon the spots where they are entombed, we cannot imagine them to have had an amount of light such as in lower latitudes accompanies intense heat, inasmuch as light being derived solely from the sun, must in the most favourable circumstances vary with latitude; whereas the heat of the earth was something inherent in itself, or at all events would vary with the disposition of the land. It becomes probable then that the rank luxuriance of the vegetation in the carboniferous era was due to the peculiar physical conditions of the earth at that period, when the waters under the heaven were gathered together into one place, and the dry land first appeared; but *before* the lights in the firmament of the heaven had so penetrated through the dense and humid atmosphere of waters which were above the firmament as to divide the light from the darkness, and to be for signs and for seasons, and for days and for years.† In such a period of the earth's physical history the lately formed dry land would have been subject to constant volcanic paroxysms, which might be supposed to have been accompanied by the disengagement of carbonic acid in quantities which would be fatal to animal life, but which

* Lyell, Princ., Vol. III., p. 301.
† Gen. i., 9, 14, 15.

would result in a degree of luxuriance of vegetation such as now, on a smaller scale, is illustrated in the remarkable volcanic district of Auvergne.

Dr. Carpenter, in a paper before referred to, suggests that "in making use of the stores of coal which have been prepared for his wants by the luxuriant flora of past ages, man is not only restoring to the atmosphere the carbonic acid, the water, and the ammonia which it must have contained in the carboniferous period, but is artificially reproducing the light and heat which were then expended in the operations of vegetable growth." Nothing, indeed, is lost in the economy of Nature—materials the most fleeting and impalpable once generated, we cannot conceive to be annihilated. Changed they may be by new combinations, fixed into solidity, set free and restored by decomposition into their primitive tenuity and subtlety—but lost, never. Dr. Carpenter further observes, "that the relative proportion of the light and heat thus restored should be the same as that which they originally bore to each other is by no means necessary; since each (according to Professor Grove's views) is convertible into the other;" but without thus having recourse to any operations which may complicate these views, it will readily appear, from the view of the case just now propounded, that the amount of *light* which these carboniferous floras received bore but a small proportion to the *heat* to the action of which their production was due.

If, however, it should really be the fact that the gas-illumination of our streets and our dwellings, our domestic fireside, our vast manufactures, our appliances for the production of force, by which time is reduced, space abridged, and labour economised—if all these should be but the fruition of the accumulated physical forces and agents, as well as changes and combinations, which have occupied the vast interval during which the earth was preparing—no less than the stores of solid material in the shape of iron, of metals, of stone, on which these impalpable and immaterial forces were destined to act when the human era arrived—to what wonder-inspiring thought does it not lead us! And what a lofty idea does it afford us of the power, the knowledge, and the benevolence of the Creative Intelligence, who could with a comprehensive glance through the dim vista of Time, even before the foundations of the earth were laid, foresee the mutations, the instabilities, and changes—the decay, death, and extinction, which should reign for ages unchecked, and should so order and arrange them all, that the result should be, not chaos and confusion, which to a finite mind would appear inevitable, but harmony and unity, adaptation and subserviency to the abundant and ever increasing requirements of rational man. Man, indeed, is the last actor upon the cosmical scene—a being endowed on the one hand with instincts of such an order as teach him to reap the advantages of these ages of preparation, and on the other with Intelligence which inspires him with the desire to aim at the discovery of the modes by which these wonders have been achieved. Worthy indeed are such inquiries of the loftiest intellects, and to such may be applied the words of one who was himself a divinely-taught Naturalist, and the wisest of mankind—

"IT IS THE GLORY OF GOD TO CONCEAL A THING;
"BUT THE HONOUR OF KINGS IS TO *SEARCH OUT* A MATTER."

Proverbs xxv., 2.

THE END.

W. FEARNALL AND CO., PRINTERS, CHURCH LANE, LIVERPOOL.

THE FAUNA

OF

BLACKHEATH AND ITS VICINITY.

PART I.—VERTEBRATE ANIMALS.

BEING

THE FIRST REPORT

OF THE ZOOLOGICAL COMMITTEE

OF THE

Greenwich Natural History Club.

LONDON:
PRINTED BY WILLIAM CLOWES AND SONS,
STAMFORD STREET AND CHARING CROSS.
1859.

PREFACE.

The Greenwich Natural History Club was established in April, 1852, as a Society of Field Naturalists. Although it has held meetings regularly since its institution, at which many excellent Papers have been read, the smallness of the subscription has hitherto precluded the possibility of accomplishing much in the way of publishing its Transactions.

In the spring of 1857, it was resolved that information should be collected relating to the Natural History of a certain district round Blackheath, and a Committee was appointed for the purpose of carrying out that Resolution so far as regarded Zoology.

The limits of the district were defined as follows:—By a line commencing at the point of junction of the Rivers Thames and Ravensbourne, following the course of the latter to its source on Keston Common; thence in a straight line to the source of the River Cray, near Orpington; from thence along the course of the Cray to its junction with the River Darent; along the course of the Darent to its junction with the Thames; and finally up the Thames, to the starting-point at its junction with the Ravensbourne.

The writer was elected Chairman of the Zoological Committee, and at the request of the other members he prepared the following Report and Catalogue, which was approved by the Committee, and presented to the Club at its meeting at Greenwich, January 9th, 1858. It includes the Vertebrate division as far as at present ascertained; and inasmuch as no animal has been admitted into the list without express authority, it will be readily understood that others may yet be added, as the fruit of more extended observation.

The writer desires to take this opportunity of expressing his thanks to the Rev. A. Rawson, of Bromley Common; to Mr. G. B. Wollaston, of Chiselhurst; to Mr. Mills, of the Moat, Eltham; and to Mr. Hutchinson, of the Paragon, Blackheath, for interesting facts relative to the Birds, which will be found duly acknowledged in the text; and to Mr. W. H. Tugwell for an original list of Vertebrata. For the rest the writer is responsible, and will be very glad to receive any additions or corrections which it may be in the power of any one to make into whose hands this Report may fall.

CUTHBERT COLLINGWOOD.

Blackheath,
January, 1858.

Postscript.—Owing to circumstances into which it is not necessary to enter in this place, the publication of this Report has been delayed until the month of June, 1859.

46, *Nelson Street,*
Liverpool.

REPORT ON THE VERTEBRATA.

In pursuance of the resolution unanimously agreed upon at the meeting of the Society on April 4th, 1857, a Zoological Committee was nominated for the purpose of collecting information upon subjects connected with the Fauna of the district, and the following Report has been drawn up by its Chairman, and adopted by the Committee in council.

The results of all the inquiry and research which we have hitherto been able to bring to the subject are embodied in the accompanying Catalogue, which is not a mere list of animals, but describes, as far as possible, the comparative frequency or rarity of their occcurrence, and, in the case of less frequent ones, gives all the particulars which could be collected concerning their capture. This Catalogue contains notices of 236 Vertebrate animals, distributed as follows: Mammalia, 39; Birds, 156; Reptiles, 10; and Fishes, 31. The Report consists of a *résumé* of each class, offering generalizations and comparisons by means of which a clearer insight may be obtained into the position and relations of the British Fauna generally, and of our *local* Fauna in particular.

The nomenclature adopted in the accompanying Catalogue of Animals has been uniformly that of the admirable manuals of Professor Bell on Quadrupeds and Reptiles, and the lamented Yarrell on Birds and Fishes; works to which I stand greatly indebted, and which have been examined with reference to any incidental mention of localities falling within the strict limits of our district.

The undoubted occurrence of an animal *once* within the district has been deemed sufficient reason for including it in the list, especial notice being always taken of the occasion, and the date and circumstances of the occurrence being fully given, where practicable. It has appeared that this rule of the admission of visitors into local Faunas, so usual among Zoologists, should by no means be infringed, so long as the proper qualifications are given to the statements, and so long as no one is led to suppose that an animal is *tolerably common*, when perhaps only one notice is extant of its occurrence; just as an illustrious French Naturalist (Duvernoy) is reported to have spoken of a certain Bat,* as "assez commune en Angleterre," because it had once been taken near Dover. To omit, however, such accidental visitors from a local Fauna, would be to destroy at once its unity and its interest; and, moreover, it would be difficult, nay, impossible, to draw the line accurately between *periodical* and strictly *occasional* visitants. The insular position of this country, to a certain extent, keeps our Fauna distinct. Our Quadrupeds can scarcely cross the barrier which separates us from the continent of Europe, except in the case of some of the smaller of them, which may be introduced amongst merchandise, and whose extraordinary powers of reproduction will establish them wherever they may once find a footing. Such is undoubtedly the case with our common brown Rat (*Mus decumanus*), which in an unlucky hour, dating little more than a century back, made its appearance upon these shores, and has since treated its English relative—itself an interloper of an earlier century—much as the Danes did the Britons of old. Other Quadrupeds at a more remote period may have been similarly imported, while, on the other hand, we all know that the Bear, the Wolf, and the Beaver—animals which are now banished far from us—roamed freely through our island within historic times. With Birds the matter is different. Their powers of locomotion permit of their crossing our narrow Channel with facility; and thus we find each new edition of the British Birds requires enlargement for the admission of errant species. Reptiles come under much the same category as Quadrupeds, allowance being made for the rapid diminution of species with the increase of latitude; and Fishes resemble Birds in their powers of locomotion, and in the wide-spread expansion of the medium through which they move.

But the district to which we confine our research must be viewed from peculiar aspects. No physical boundary cuts us off from the limited extent of country in a southerly, westerly, and easterly direction, and we are liable, therefore, to the irruption of terrestrial visitors from those points. Our proximity to the south-east corner of England places us in a position most favourable to the visits of birds from the continent of Europe; the presence of a large navigable river on our northern side, brackish even within our limits, affords opportunity for Cetaceans which have lost themselves in its estuary to reach our district while searching for an exit to the ocean; and at the same time attracts marine fish riverwards, and fresh-water fish seawards, either accidentally or for the purpose of spawning. Lastly, and by no means the least important element in our topographical position, is our vicinity to the metropolis, which, while it undoubtedly prevents certain animals from being found with us, is, I am led to imagine, in the main, favourable to the abundance as well of species

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* *V. emarginatus*, Bell, 45.

as of individuals. In support of this conclusion, I would call attention to Appendix A, which contains a list of rare birds taken in the immediate vicinity of London, and which would tend to prove that, for birds at least, such a vicinity is very attractive; while of our British species of Bats, two have only been taken in London, and a third has not hitherto been found except in its immediate neighbourhood. If such an attraction for birds do exist, however, we can scarcely imagine it to be extended by the waters of the Thames to their aquatic analogues, the Fishes.

If with these advantages it be remembered that we occupy one of the most favoured parts of our island with respect to temperature and climate, it will not appear surprising that we are able to reckon so many animals in our list; and it will be a matter of pleasing interest to the Zoologist to find among them so many representatives of typical families, and so many genera and species themselves typical. So that not only is our Fauna a well-stocked one, but, if I may be permitted such an expression, it has the additional advantage of being exceedingly well-selected.

It remains for me, in these preliminary remarks, only to add a few words concerning the *systems of classification* adopted. For the Mammalia, Professor Owen's admirable arrangement, recently promulgated before the Linnean Society, so far excels the old systems in its conformity with nature, that I adopt it unhesitatingly.* For the Birds, the universally accepted Cuvierian arrangement, with slight modifications in the heterogeneous Passerine order as used by Yarrell, has been considered most convenient. Our Reptiles are so few, that the simple division into four orders has seemed most adapted to our purpose, especially as Erpetologists are not quite agreed as to the classical or ordinal value of the Amphibia; and for Fishes, the Cuvierian arrangement need not be superseded by any less authoritative system.

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* Professor Owen divides Mammalia into four great subclasses, according to the cerebral development. The first, *Archencephala*, or highest type of brain, includes only Man. The second, *Gyrencephala*, the members of which have the brain more or less convoluted, embraces the clawed and hoofed animals, as well as the Cetacea. The third, *Lissencephala*, or smooth-brained subclass, includes the Bruta, Bats, Insectivores, and Rodents; and the fourth, *Lyencephala*, the Marsupials, whose brains exhibit a peculiar loose and disconnected condition.

MAMMALIA.

When we consider that the Zoologist finds himself obliged to fill up the gaps in his series of typical forms from the denizens of an extinct world (a strong presumptive argument, by the way, against the recent *Omphalic* theory of creation),* we cannot be surprised that in so small a patch of earth as our island, many important families, and indeed *orders* of Mammalia should be unrepresented. Our climate and geographical position prevent any of the highest of Owen's second brain-type (*Gyrencephala*) from being numbered in our Fauna. I refer, of course, to the Quadrumana (monkeys). The Proboscidian ungulates (Elephants, &c.), belonging to the same cerebral type, are similarly excluded, and the herbivorous Cetacea (Dugong, &c., the *Sirenia* of Owen and others) have only been occasionally found in a putrid condition, stranded upon our coasts. In the third type (*Lissencephala*), the order Bruta, including the Edentulous animals,† but scantily distributed anywhere, find no representatives in Britain; while the fourth (*Lyencephala*), or non-placentals, including the Marsupials and Monotremes, are, with the exception of a single American genus (*Didelphys*), confined to one antipodal continent and its adjacent islands.

A notable fact which I have remarked with relation to the missing orders is so interesting, and bears so directly upon our *local* Fauna, that I think it should not be passed over in silence. It is that, although missing in a recent and living state, an examination of the earth's crust reveals to us the remains of their representatives, which once existed in this island—if island it then was—and that our own district contains some of these remains; so that, as the general Zoologist fills up his series of types from extinct races, so *we* can (nearly) represent all the Mammalian orders by calling as witnesses the buried forms which lie within a few miles of us. Thus, the missing order Quadrumana is represented by two species of Macacus (called respectively eocænus and pliocænus), the latter of which lies no further off from us than the pliocene beds of Grays, in Essex, and the former in blue clay at Kyson, in Suffolk. The Proboscidian

* Since writing the above, I have perused "Omphalos," and was surprised to find this very argument adduced in favour of the theory; a signal proof of the oblique reasoning into which an able and accomplished naturalist may be led in his ardour to support a preconceived opinion.

† The Edentata are distinguished by the absence of canine and incisor teeth. They are represented in America by the Ant-eater (*Myrmecophaga jubata*), and by the gigantic fossil Megatherium, whose skeleton is so conspicuous an object in the Museum of the College of Surgeons.

ungulates are represented by the extinct Mammoth (*Elephas primigenius*), whose remains lie in the Pleistocene deposits of the valley of the Thames within our district, as well as in many other places; and by the Mastodon angustidens of the Crag at Thorpe, in Norfolk. I am not aware of any trace of an edentulous animal, either recent or fossil, herbivorous or insectivorous, having been hitherto discovered in this island, or, indeed, in Europe; for the most part, both the extinct and living species are natives of the great continent of America; but of Marsupials we find several species, chiefly if not entirely confined, however, to the greater oolite at Stonesfield, in Oxfordshire. Here Buckland first discovered his Didelphys (*Phascolotherium Bucklandii*), and here two species of Amphitherium have since been discovered; so that with the exception of the Edentulous Bruta, and the anomalous Monotremes,—which last order contains but two genera (*Ornithorhynchus* and *Echidna*), each of a single species, and strictly confined to Australia and New Zealand,—all the great orders of Mammals exist, either recent or fossil, in our little island.

The absence of these orders from our *recent* British Fauna, however, and the scanty representation of some others, would seem to imply that a small circumscribed district, like our own, would only contain a few waifs and strays of species, insufficient to build up anything like a series, or from which to derive any results. This, however, is not the case. The British Fauna can boast of 76 Mammals, (of which 10 are in a domesticated or semi-domesticated condition,) distributed through 39 genera. Of these, at least one-half are found within the few square miles of our research, viz., 39 species, comprised in 27 genera, which include all the domesticated species, excepting only that I have rejected the guinea-pig (*Cavia aperea*), whose right of admission may be questioned. True, Mammals are not readily spared from the British list; but I will hereafter propose an exchange for one of a class far more slenderly represented. Among these 39 species, we possess some of the most typical which our island contains. In the sub-class Gyrencephala we have among those typical Carnivora, the Digitigrades, examples of the three great families which compose them; the Mustelidæ offering us three out of seven species, and most probably several more; the typical Felidæ being represented by the domestic Cat, and the Canidæ by the varieties of Dog. Not far off, at Erith, buried Hyenas (*H. spelæa*) of a past age add another genus to the canine family; and even within the last two hundred years the ravenous wolf has howled in Britain. The last wolf on record was killed by Sir Ewen Cameron of Lochiel in 1680. It is much to be regretted that we cannot with certainty record the existence of the Badger (*Meles taxus*) within our district. It is the sole Plantigrade Carnivore which Britain now produces, though up to the time of the Norman conquest, the Bear itself (*Ursus arctos*) was an indigenous brute. Of Pinnigrade Carnivora (the Seals), five of which are described by Bell, and one more (*Phoca cristata*) since discovered in the Orwell, none are recorded to have found their way up the Thames.

In the Ungulate subdivision, the even-hoofed order (*Artiodactyla*) is represented by the domestic Hog (*Sus scrofa*) in the Omnivorous tribe, the only true Pachyderm of this country now extant. We were rich in Pachyderms once, and we are yet rich in their remains. Witness the Mammoth and Mastodon just referred to, the Rhinoceros (*tichorrhinus*) at Chartham, near Canterbury; the Coryphodon in the London clay at Camberwell, the Hyopotamus, Chæropotamus, Hyracotherium, Dichodon, and other extinct genera. In the Ruminant tribe our domestic animals furnish us with the three most important groups: the Cervine, represented by the deer in our Park; the Bovine, by our domestic cattle; and the Caprine, or perhaps, more properly, the Antilopine, of which our Sheep and Goat are but aberrant forms.

The Perissodactyl order is represented in the solid-hoofed division by our domestic Horse and Ass, there being no native European genus of solidungulous quadrupeds. In the Pleistocene beds at Grays Thurrock, however, previously referred to, a Horse occurs (*Equus fossilis*), and a second species (*E. plicidens*) also exists.

One side of the triangle which comprises our district being washed by a large river like the Thames, which brings with every tide the brackish waters of its estuary within our limits, we have thus an opportunity of including in our list several species of true Cetacea, which have at different times found their way, or rather, perhaps, lost it, as high at least as Gravesend. The British coasts are visited by 13 species of Cetacea, comprised in 9 genera; and of these at least 5 species, of 4 genera, may be included (with one exception, *strictly*) in our list of visitors. The Porpoise (*Phocæna communis*) I have often seen rolling his unwieldy form in front of Greenwich Hospital, and a summer seldom passes without their visits; a Grampus (*Phocæna orca*), one of six, and measuring 31 feet long, has been harpooned in the same spot; a Bottlehead (*Hyperöodon Butzkopf*), 21 feet long, has passed unmolested still higher up the river; and at least two Spermaceti Whales (*Physeter macrocephalus*) have been taken as high as Gravesend, the exception to our strict limits just referred to. The notice of one of these, together with nine others, stranded on the east coasts of England, six of them on the coast of Kent, is now, for the first time, recorded. And lastly, though by no means least, a young individual of the most colossal animal known, the northern Rorqual (*Balænoptera Boops*), was taken by the harpoon at Deptford as recently as 1842. Full particulars of these remarkable occurrences will be found in the accompanying Catalogue.

In the sub-class Lissencephala, the Cheiroptera are well represented in the insectivorous division, for we have no frugivorous Bats in this country. Out of 17 species of Bats included in 4 genera, described by Bell, and one, if not two species (*V. pruinosus* and *V. dasycnemus?*), since discovered,* we possess at least 7 species of those 4 genera. Of these the most common are the Pipistrelle (*V. pipistrellus*), and the Long-eared Bat (*Plecotus auritus*). Of the others, some are worthy of especial notice. The Serotine Bat (*V. serotinus*) has hitherto been only found in the neighbourhood of London. The Great Horse-shoe Bat (*Rhinolophus ferrum-equinum*) and the Barbastelle (*B. Daubentonii*) were first described as British —the one by Dr. Latham, and the other by Sowerby—from specimens found in our district, viz., in the powder-mills at Dartford; and the chalk cavern, situated in a shaft 70 feet deep, at Chiselhurst, has yielded to the explorer two rare Bats (*V. Nattereri* and *V. mystacinus*), as well as the Barbastelle just mentioned. Of the remaining bats included in the British list, Vs. Leisleri, discolor, pygmæus, Bechstenii, emarginatus, and Plecotus brevimanus, have only yet been represented by a single specimen, or taken in a single locality: V. Daubentonii occurred at Islington, and V. murinus has hitherto shown its appreciation of our national collection by only allowing itself to be taken in the gardens of the British Museum. It is hardly to be imagined that the weak gyrations of the *Flittermice* would leave room for temptation to cross the Channel; and this occurrence of at least half of our British species of Bats as unique specimens, coupled with the fact, that thirty years ago only 6 species were enumerated where we now have 19, points to the high probability that it is the nocturnal habits of these animals, and the inaccessibility of their refuges during the period of hybernation, which cause them to be so little studied, and opens up a field of research in British Natural History as interesting as it is unpursued.†

In the next order, that of true Insectivora, the three great families are well represented by our commonest wild animals: the Talpidæ by the Mole, the Erinaceidæ by the Hedgehog, and the Sorecidæ by the Shrews, of which we possess 1 at least of the 3 British species.

The last order is that of the Rodents, and here the two great divisions of claviculate and non-claviculate have each their representatives. Among those Rodents which possess clavicles, we have the typical family Muridæ supplied with all the 5 British species, the most abundant being, here as everywhere, that interloping foreigner, the brown Hanoverian (*Mus decumanus*); the Castoridæ in the same division contain 2 species of Arvicola, but the typical genus Castor is now absent. Up to the year 1188, the Beaver, or *broad-tail*, as our forefathers termed it, had held possession of our fens and rivers' banks; and the bones of Castor Europæus, an extinct species, may

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* The *V. ædilis* of Jenyns appears to have been only a variety of *V. Daubentonii.*

† Gilbert White says: "At present I know only two species of bats, the common V. murinus (*V. pipistrellus*), and V. auribus" (*Plecotus auritus*). He himself added a third, and his editor in 1835 enumerates seven species.

still be found in the river's bank at Grays; the Sciuridæ have 2 species, the Squirrel and Dormouse. The typical family Leporidæ, containing 2 species, represents the division of Rodents unprovided with clavicles; and the rejected Cavia would likewise take his place here.

Catalogue of the Mammalia.

Subclass. **GYRENCEPHALA.**

Division. UNGUICULATA.

Order. *CARNIVORA.*

Suborder. Digitigrada.

Family. *Mustelidæ.*

Weasel (*Mustela vulgaris*), common.

Stoat (*Mustela erminea*), not uncommon.

Polecat (*Mustela putorius*), sometimes killed by keepers in the Crown and West woods. (Mr. Tugwell.)

Family. *Felidæ.*

Domestic Cat (*Felis* ——).

Family. *Canidæ.*

Dog (*Canis familiaris*).

Fox (*Vulpes vulgaris*), not uncommon. A fox took up his abode voluntarily in Mr. Newman's garden at Peckham, remaining there until it was destroyed by hounds six weeks afterwards.

Division. UNGULATA.

Order. *ARTIODACTYLA.*

Suborder. Omnivora.

Family. *Suidæ.*

Domestic Hog (*Sus scrofa*).

Suborder. Ruminantia.

Family. *Cervidæ.*

Fallow Deer (*Cervus dama*), common in a semi-domesticated condition, as in Greenwich Park.

Family. *Bovidæ.*

Ox (*Bos Taurus*).

Family. *Capridæ.*

Goat (*Capra hircus*).

Sheep (*Ovis aries*).

Order. *PERISSODACTYLA.*

Suborder. Solidungula.

Family. *Equidæ.*

Horse (*Equus caballus*).

Ass (*Asinus vulgaris*).

Division. MUTILATA.

Order. *CETACEA.*

Family. *Delphinidæ.*

Porpoise (*Phocæna communis*). This is by far the commonest Cetacean we can include. A season seldom passes without their appearance at Greenwich and Deptford, and they occasionally pass much higher up the river. I never heard of one being captured.

GRAMPUS (*Phocæna orca*). The particulars of the capture of one of these animals in the Thames, opposite Greenwich Hospital, were collected by Sir Joseph Banks, and sent by him to Lacépède. Pennant refers to the circumstance ("Brit. Zool." i., 99) under the article "Gladiator Dolphin (*Delphinus Orca*)." It appears that six of these Cetaceans came up the Thames in 1793. The individual in question being struck by three harpoons, rushed off with the boat containing the fishermen who had harpooned him, towed it twice to Greenwich, and once as far as Deptford, against a strong tide running eight miles an hour, and notwithstanding the repeated pike wounds it received whenever it appeared above water. It was finally killed opposite Greenwich Hospital, and its expiring struggles were so violent, that no boat dared to approach it. It proved to be a very large individual, being no less than 31 feet in length, and 12 in circumference.

BOTTLE HEAD (*Hyperöodon Butzkopf*). In the "Philosophical Trans." for 1787, in the paper by Hunter "On the Structure and Œconomy of Whales," is a meagre account of a "bottle-nosed whale with two teeth," with a figure of the animal. Hunter adds that "it was caught above London Bridge, in the year 1783, and became the property of the late Mr. Alderman Pugh, who very politely allowed me to examine the structure and take away the bones. It was 21 feet long." (Op. cit. p. 447.) Bell's figure is a reduced copy of our Whale, as given by John Hunter. Hunter was doubtful of its species, saying that it resembled *Delphinus Tursio* (the bottle-nosed dolphin) but was of a different genus, having only two teeth in the lower jaw, concealed by the gum. The belly was white, shaded off by the dark colour of the back. He, however, rightly conjectured that it was the species described by Dale (Harwich 411, pl. 14), viz., *Hyperöodon Butzkopf*, and supposes it to have been a young one, as he mentions a skull which must have belonged to one 30 or 40 feet long. The editor of Pennant, I may observe, has fallen into a great error about the size of this specimen: he says, it "did not exceed 11 feet," while Hunter expressly tells us it was 21 feet long.

FAMILY. *Physeteridæ.*

COMMON CACHALOT, or Spermaceti Whale (*Physeter macrocephalus*). I am glad to be able here to resuscitate a still-born record of the Spermaceti whale in our river. The following is an extract from a document I found in Sir Jos. Banks's copy of the "Phil. Trans." in the British Museum.

"Extract from a letter from Walberswick, on the coast of Suffolk, dated March 7, 1788.

"A whale appearing on our coast is a rare phænomenon. The most extraordinary instance that ever happened of this sort was in February, 1763, after a hard gale of wind northerly, when no less than twelve whales, which undoubtedly came out of the Northern Ocean, were towed and driven on shore at the following places, all of them dead, and in a high state of putrefaction, excepting one." (This notable exception is) "One at the Hope Point in the River Thames. This was the only one seen alive. He ran aground, and smothered himself in the mud, and was afterwards made a shew of, in the Greenland Dock. These were all of the Spermaceti kind, and of the male gender," and it is remarkable that out of the twelve, (or rather ten, for two stranded on the Dutch coast,) six were found upon the coast of Kent. From an old engraving of the above specimen in my possession, to which a scale is attached, it appears to have been near 60 feet long.

Within a much more recent period a small Cachalot was captured in the Thames near Gravesend, but I am not in possession of any particulars of the event.

NORTHERN RORQUAL (*Balænoptera Boops*). On Sunday, October 23rd, 1842, a whale was observed in the Thames, opposite Deptford Creek. Five men put off in a boat, and attacked it with a large bearded spear, and having pushed it immediately under Deptford Pier, they overcame and despatched it. Having by mechanical appliances raised it upon the pier, its dimensions were ascertained to be—

	Ft.	In.
Total length	14	6
Length from nose to angle of mouth	3	10
Tail from fork to fork	3	10

A full account of this whale is to be found in the "Zoologist" for 1842, with a figure; also an account of its capture, with a sketch of the animal, is to be seen in the "Illustrated London News," vol. i., p. 388.

It was a young individual of the Great Northern Rorqual, or Fin Whale (from his dorsal razor-like fin), the largest of existing animals; in its adult state reaching to the extreme length of 120 feet, with a girth of 30 or 40 feet.

Subclass. LISSENCEPHALA.

Order. *CHEIROPTERA.*

Family. *Vespertilionidæ.*

Common Bat (*Vespertilio pipistrellus*). The commonest of our indigenous bats. Very common.

Serotine Bat (*Vespertilio serotinus*). This bat, it is well known, is only found round London.

Reddish-gray Bat (*Vespertilio Nattereri*). Perhaps no limited district in Great Britain has yielded more Vespertilionidæ to the explorer than has ours. Dr. Waring, of Marlings, near Chiselhurst, found three living specimens of the present species in company with others at that place. They were discovered in a large chalk-cavern at the bottom of a shaft 70 feet in depth. He sent them still living to Professor Bell, who kept them alive for a short time, and described them in his "British Quadrupeds," p. 43.

Whiskered Bat (*Vespertilio mystacinus*). A specimen of this Bat was taken in the same cavern, and from this specimen Bell's figure is taken.

Long-eared Bat (*Plecotus auritus*). This, next to the Pipistrelle, is our most common Bat, though far less numerous than the latter. It was taken in the Chiselhurst cavern.

Barbastelle (*Barbastellus Daubentonii*). In Sowerby's "British Miscellany," p. 9, pl. 5, is to be found the first figure and description of this Bat as a British species. Mr. Sowerby's specimen was taken in the powder-mills at Dartford. A specimen was also found in the chalk cavern at Chiselhurst.

Family. *Rhinolophidæ.*

Greater Horse-shoe Bat (*Rhinolophus ferrum-equinum*). This is another species first observed as a British Bat within our district. It was discovered by Dr. Latham at Dartford, in the saltpetre-houses belonging to the powder-mills. Pennant, to whom he communicated his discovery, says that "they are found (there) in the greatest numbers, and frequent them during the evening for the sake of the gnats which swarm there. They have been also found during the winter in a torpid state, clinging to the roof."—*Brit. Zool.*, vol. i., p. 180.

Order. *INSECTIVORA.*

Family. *Talpidæ.*

Mole (*Talpa vulgaris*). Abundant.

Family. *Erinaceidæ.*

Hedgehog (*Erinaceus Europæus*). Common.

Family. *Sorecidæ.*

Common Shrew (*Sorex araneus*). Common.

ORDER. *RODENTIA.*
SUBORDER. CLAVICULATA.
FAMILY. *Sciuridæ.*

SQUIRREL (*Sciurus vulgaris*). Not uncommon in woods. Shooter's Hill. It has been seen in Greenwich Park.

DORMOUSE (*Myoxus avellanarius*). Common.

FAMILY. *Muridæ.*

HARVEST MOUSE (*Mus messorius*). Not uncommon.

LONG-TAILED FIELD MOUSE (*Mus sylvaticus*). Abundant.

COMMON MOUSE (*Mus musculus*). Abundant.

BLACK RAT (*Mus rattus*). There appears to be some doubt concerning the occurrence of this species, some good authorities having informed me that it only exists in a few houses in London. It may, however, be found on ship-board, and no doubt occasionally finds its way on shore, though possibly it may soon be overcome by its congener, the next species.

BROWN RAT (*Mus decumanus*). Most abundant.

FAMILY. *Castoridæ.*

WATER VOLE (*Arvicola amphibius*). Common.

FIELD VOLE (*Arvicola agrestis*). Common.

SUBORDER. NON-CLAVICULATA.
FAMILY. *Leporidæ.*

HARE (*Lepus timidus*). Common.

RABBIT (*Lepus cuniculus*). Very common.

BIRDS.

We next come to the Birds, by far the most important class of animals with which we have to do, and containing nearly twice as many species as the sum total of Quadrupeds, Reptiles, and Fishes, put together. The last edition of Yarrell's "British Birds," published just before its lamented author's decease, contains 354 species, distributed through 131 genera; and at least a dozen new species have occurred during the last few years, which are not included in that work, a list of which will be found in Appendix C. In our district, I have certified the existence of 149 species, distributed through 85 genera; and doubtless the list will be enlarged by continued research. Considering that there are known and described upwards of 6000 species of birds all over the globe, it will be at once apparent that we must not look in any one country for representatives of even every family. It is not, however, necessary to compare the British families with those of the whole world, but a glance at Appendix D will at once show the relations between the *represented* families and sub-families of Great Britain, and those which remain *unrepresented*. The number of the former is 82, while those of the latter amount to 104. The number of our sub-families, therefore, is less than one-half of those into which existing birds are divided, while of *families*, we possess 34 out of 49, or upwards of two-thirds.

It is necessary, however, to make a closer comparison of the birds of our district with those of Great Britain generally. All the great orders, or Raptorial, Insessorial, Rasorial, Grallatorial, and Natatorial birds, are found in Britain, and have their representatives in our list; but while the bulk of British birds is made up of the last two orders, the Grallatorial and the Natatorial, it is in those very two orders that *we* are deficient, and this for reasons which will be easily understood. Great Britain being everywhere surrounded by the sea, the extensive line of coast is fully as important as its comparatively limited inland parts, and the wading or littoral, and the true marine types, together constitute more than one-half of the entire number of species; and it is to be remarked, as shown by Appendix D, that Great Britain possesses all the eleven families of these two orders (except one, a Chinese family), and of the sub-families, 30 out of 44, that is, rather more than two-thirds. But we are here situated so far from the sea, that we are of course almost devoid of marine birds; and were it not for the Thames, which washes our northern side, the few stilted and swimming birds which occasionally visit us would not do so, for we have no large lake or pond to afford them cover. On the other hand, of the large tribe of Passerine birds, including 120 species, we possess by far the greater number; indeed, they constitute fully three-fourths of our indigenous birds. Of the remaining orders, which are comparatively small, the Raptorial, being for the most part boreal or littoral, are here only represented by one-fourth of the number of British species; and of the Rasorial, or game birds, a still smaller group, we possess one-half.

The birds of our district may be conveniently classified under four heads; it being borne in mind that this classification has especial regard to the circumstances of their occurrence within the boundaries of the Zoological district which we are describing. The first, largest, and most important division contains those birds which reside with us constantly, are found at all seasons of the year, and whose nests and eggs have been observed here. These I shall call our *resident* birds, for the list probably contains some which are not strictly *indigenous* with us. The second division includes those birds which visit us every summer, arriving from the south, for the purposes of nidification and rearing their young; and which, excepting in a few accidental cases, invariably quit us for their winter quarters. In the third division are included those birds, inhabitants of more northern climes, in which they have passed the summer and reared their young, and which they quit on the approach of winter, in order to spend that season in our less frost-bound climate; and the fourth and last section consists of such *occasional* visitors as are borne hither by accidental circumstances, whose advent can never be prognosticated with certainty, and which, according to their natural habits, may be summer, winter, or indiscriminate visitors.

The first list, that of resident birds, contains 60 out of the 140 enumerated by Yarrell in his last edition. It will be seen that the bulk of them consists of Passerine birds, and of these, 20 are songsters of greater or lesser merit. They are as follows, the songsters being marked with an asterisk :—

Kestrel.
Sparrow-hawk.
Barn Owl.
Tawny Owl.
Great Gray Shrike.
*Missel Thrush.
*Song Thrush.
*Blackbird.
*Hedge Accentor.
*Redbreast.
*Stonechat.
*Gold Crest.
Fire Crest.
Great Tit.
Blue Tit.
Cole Tit.
Marsh Tit.
Long-tailed Tit.
Bearded Tit.
*Pied Wagtail.
*Meadow Pipit.
*Skylark.
*Woodlark.
Bunting.
Black-headedBunting.
*Yellow Ammer.
Cirl Bunting.
*Chaffinch.
Tree Sparrow.
House Sparrow.
*Greenfinch.
Hawfinch.
*Goldfinch.
*Linnet.
*Bullfinch.
Crossbill.
*Starling.
Crow.
Rook.
Jackdaw.
Magpie.
Jay.
Green Woodpecker.
Great Spotted Woodpecker.
Lesser Spotted Woodpecker.
*Creeper.
*Wren.
Nuthatch.
Kingfisher.
Ringdove.
Stockdove.
Pheasant.
Partridge.
Red-legged Partridge.
Peewit.
Water Rail.
Moorhen.
Coot.
Mute Swan.
Little Grebe.

In the second list, that of summer visitors, we possess 30 out of the 63 described by Yarrell, nearly all (or four-fifths) being passerine birds. If our resident birds offer claims to our attention from their interest as a class, from their constancy to our changeable climate, and from the number, variety, and continuance of their songs, those of the present division are not less attractive from the regularity of their appearance and disappearance, the former in April and May, and the latter in September and October; from the fact of their residence with us occurring during the loveliest portions of the year; and from the number and rich quality of the notes of the songsters among them, whose music excels, for the most part, that of our resident choir. The following list of our summer birds of passage is arranged somewhat in the order in which they appear, dating generally from the first of April; and the songsters, twelve in number, are marked with an asterisk.

Chiffchaff.
*Redstart.
*Willow Warbler.
Wryneck.
*Blackcap.
*Whitethroat.
*Swallow.
*Whinchat.
Sand Martin.
*Tree Pipit.
*Nightingale.
Sandpiper.
Grasshopper Lark.
Cuckoo.
*Sedge Warbler.
*Reed Warbler.
Martin.
Yellow Wagtail.
*Lesser Whitethroat.
Wood Wren.
Spotted Flycatcher.
*Garden Warbler.
Turtle Dove.
Swift.
Red-backed Shrike.

Quail.
Landrail.
Goatsucker.
Wheatear.
Great Plover.

The last five are separated by a line from the others, because, owing to their limited numbers, I am not certain of the time of their arrival.

When these have all arrived, and swell the chorus of our native birds (in the month of May) our woods may truly be called vocal; the nightingale and blackcap leading the choir of 32 true song birds, besides the numerous chirpers and others whose limited notes do not admit them into that category.

On the departure of this summer crowd, the balance is somewhat restored by the influx of birds from the north, which, having finished their summer duties of incubation in their *native* climes, now retire before the approaching rigour of winter. For all migration is in one direction at one time, viz., southwards in autumn, northwards in spring. The *sun* is the ruling power over birds, and the *equinoxes* the signals for migration. The *advancing* sun impels the migratory herd before him—the *retiring* sun draws them back in his train. As soon as he has reached the equator in his return from the southern hemisphere, the birds of the middle region flee before the increasing power of his beams to our mild climate, and the boreal birds retire to the yet more temperate regions of Sweden and Norway; all equally bound on the same errand, all having the same purpose, and that is, to pair, to build their nests, and to rear their young. When the sun has reached the northern tropic, the full and complete geniality of the season induces a corresponding activity in these processes of ornithological economy. He retires southward, and no sooner has he passed the equator, severing, as it were, his close union with the northern hemisphere, than the feathered tribes prepare to follow him; those which have reared their young in the far north retire *with them* from the frost-bound days and iron nights of the advancing winter, and content themselves with the less dreary scenes of *our* climate; while those more tender birds which have enlivened us, and enhanced the smiling summer with their presence, go yet farther southwards to spend the hyemal months in a more equable temperature, and in a more genial clime.

Our winter visitors are 14 in number, out of the 48 enumerated by Yarrell, and are as follows, arranged somewhat in the order in which they appear:—

Golden Plover.
Snipe.
Jack Snipe.
Gray Wagtail.
Wild Duck.
Teal.
Wigeon.
Merlin.
Hooded Crow.
Fieldfare.
Redwing.
Lesser Redpole.
Mountain Finch.
Siskin.

Of occasional visitors, 103 are described in the "British Birds;" many of these have occurred but once, and of course in every possible section of the island. Of such visitors, the stragglers from the continent of Europe, we reckon 23. Of these, the following occur only in the summer months, being, in fact, birds of the middle region:—

Little Owl.
Pied Flycatcher.
Golden Oriole.
Black Redstart.
Savi's Warbler.
Thrush-like Warbler.
Rose-coloured Pastor.
Hoopoe.
Yellow-billed American Cuckoo.
Alpine Swift.
Glossy Ibis.
Wood Sandpiper.
Common Tern.

The following, being boreal birds, occasionally visit us in the winter:—

Ring Ousel.
Waxwing.
Parrot Crossbill.
Ruff.
Curlew Sandpiper.
Dunlin.
Woodcock.
Bean Goose.
Gadwall.
Pintail Duck.
Red-crested Whistling Duck.

It should be observed, that the Ring Ousel appears to have a peculiar double migration, arising from the fact of the bird appearing in spring and again in autumn. It is a boreal bird, and at these times visits us *en route* for other regions. A few more birds, although occasional visitors in our district, are in reality British residents, though *we* cannot include them as such. They are,

Dartford Warbler,
Heron,
Bittern,
Black-throated Diver,
Cormorant,
Gannet,
Kittiwake Gull,
Common Gull,

and a few other marine birds.

Having thus reviewed the birds of our district in a general way, I shall now proceed to a closer examination of their relations to the British birds in general, and at the same time point out those species which have especial claims to our attention in this place.

Of Rapacious birds, for reasons already given, we possess but few; and of the diurnal division less in proportion than of the nocturnal. Of the two families into which the former are divided, the first, or Vultures, are at best but occasional visitors to Britain, whereas, of the Falconidæ, Britain possesses 6 out of 7 sub-families, and to these our few Accipitres belong. We have but 5 of the 10 species of Nocturni at present recorded, and 2 only common; a poor Rapacious list, which I hope to see enlarged by further research. These nocturnal Owls, I doubt not, exist in greater numbers, but for the same reason as holds with the Bats, they are little observed.

Of the Dentirostral Perchers, we possess all the Shrikes and Fly-catchers, excepting the rare Woodchat (*Lanius rutilus*), which, however, may not be so rare as reported, being sometimes, perhaps, mistaken for its ruddy congener, the comparatively common Redback (*L. collurio*). The nest of the Great Shrike is reported by Mr. Wollaston to have been taken near Gravesend, which, although out of the strict limits of our district, is worth noticing, from the infrequency of the species, and from the fact of its being a winter visitor in this country.

Of the Merulidæ, the Dipper (*Cinclus aquaticus*) is one of those birds which is never found within a certain distance of London, the nearest spot to the metropolis at which it has been observed being Esher, where the form of the river is favourable to its habits. The rare White's Thrush has been reported to me by a gentleman as having been *seen* on Shooter's Hill; but such an observation is subject to so much fallacy, that I have not ventured to include it in the list. All the seven remaining thrushes we possess, the Ring Ousel and Golden Oriole being the least common; the former occurs at regular intervals on Blackheath, and the latter has been killed at Eltham.

Of the 29 species of Sylviadæ, we possess 23—a fair proportion—the 6 absentees being occasional visitants of rare occurrence. Two rare Salicarias are, however, numbered in our list, viz., Savi's Warbler (*Salicaria luscinioides*), and the Thrush-like Warbler (*S. turdoides*). Of the first of these, a bird of Southern Europe, and there a summer visitor of some rarity, a nest and five eggs were taken at Erith, on 28th May, 1853. The second, although occurring on the west coast of France, has only found admission into the last edition of Yarrell's "Birds," and has within the last few years been taken at Dartford, at Erith, and at Sevenoaks. A bird, however, which offers particular claims to our notice, occurs in this family, viz., the Dartford Warbler. This little bird, it will be remarked, is named from a well-known town within our limits. In fact, it was first observed upon Bexley Heath, in April, 1773; and specimens falling into the hands of the venerable ornithologist, Dr. Latham, he described them under the name of Dartford Warbler (*Sylvia Dartfordiensis*). Dr. Leach, however, separated it from the true Sylvias, and constituted it a genus, under the name Melizophilus. Although it has been spoken of as common even on Blackheath, it does not appear that it ever was really so, and certainly is at present rare in our district. Before I had received any information of its being obtained here, having sought in vain, an eminent ornithologist had expressed to me his conviction that it would not be found in this part of Kent, affirming that it was too near London; but I have since learned from the Rev. A. Rawson, of Bromley Common, that he has himself shot it *there*.

This family (the Sylviadæ) includes many of our most admired songsters, both resident and migratory; the Robin and Hedge-accentor being among the first, and the Nightingale and Blackcap in the latter class.

All the species of Parus, excepting only the occasional Crested Tit (*P. cristatus*), reside with us; but the Blue Tit (*P. cœruleus*) is the most common; and the Bearded Tit (*Calamophilus biarmicus*), not a genuine Parus, the least so, being confined to marshy districts beside the Thames.

The British representative of the family Ampelidæ, the Bohemian Waxwing (*Bombycilla garrula*), occurs not unfrequently in winter. Whether the Gray-headed Wagtail (*Motacilla neglecta*) visits us, I have not discovered. These Motacillidæ require much care in discrimination, from the general similarity of colouring in different species, and from the seasonal changes which their plumage undergoes. Although the White Wagtail (*Motacilla alba*) is reported as common, this must be a mistake, as it is a continental species of rare occurrence. Of Anthidæ, we have the ordinary species.

Among the Conirostal Insessores we possess the usual Larks and Buntings, but of the large family of Finches (*Fruigillidæ*) some require notice. Of the 17 species, we have all but 3 or 4 occasional or local birds. Among them, the Mountain Finch (*Fringilla montifringilla*), usually reckoned rare in these southern parts of England, appears to be a regular visitor to our district in winter; the Tree Sparrow (*Passer montanus*) likewise occurs; and the Hawfinch (*Coccothraustes vulgaris*), a local bird, is not uncommon, and has occasionally nested at Bexley. Of the Common Crossbill, likewise a local bird, precisely the same report may be made, for at Chiselhurst they are not uncommon, and their nests have been found near Dartford. The rare Parrot Crossbill (*Loxia pityopsittacus*) has been taken at Eltham.

Of the Sturnidæ it may be mentioned that the first British specimen of the Rose-coloured Pastor (*P. roseus*) was taken at

Norwood, and from it Pennant's figure was drawn. The Corvidæ require no particular mention.

In the Scansorial sub-order, we possess all the Picidæ, excepting the Great Black Woodpecker (*Picus martius*), a very doubtful British bird, which some would have expunged from the list; all the Certhiadæ, including the Hoopoe (*Upupa epops*), which has been taken in Greenwich Park — indeed, I may mention that of the 9 species of these Scansorial families, all (except the doubtful *Picus martius*) have been found in the Park, and, indeed, in that limited corner of it termed the *Wilderness*. Of the 3 Cuculidæ, 2 of which are very rare occasional visitors, we have 2, Mr. Wollaston having assured me that in 1831 he took four eggs of the Yellow-billed American Cuckoo (*Coccyzus Americanus*) from a chaffinch's nest in an elm half way between Dartford and Gravesend. This occurrence is worthy of notice, from the rarity of the species in question, only 4 of which have been taken in Britain.* The Fissirostral Hirundines all occur, except the American Purple Martin (*H. purpurea*), only once found in Britain, but then apparently hatched here.

The Rasorial Birds are few in number, and are represented by Doves, Pheasants, Grouse, and Bustards. Of the Doves we have the 3 common species; of the Grouse family, consisting of 8 species, we have only the Partridges and the Quail; the true black, gray, and white game being confined to more northern latitudes, and the Red Grouse (*Lagopus Scoticus*) being, as is well known, strictly a British bird, and found nowhere else in the world. Bustards we have none.

I have often speculated on the reason why the domestic birds were not included by Yarrell in his list. Professor Bell has described ten domestic animals in his "British Quadrupeds," being one-eighth of the whole number of species. Why should not our small number of Rasorial birds be enriched by the addition of the Peacock, the Turkey, the Guinea-fowl, and the various stocks of domestic fowls—the Malay, the Java, the Cochin China, and the Spanish?—birds which are as familiar to us all as the sparrows that hop about our path—nay, more so, for there are many persons who would not feel quite sure of a sparrow if they saw a *clean* one among a number of other birds, but who would feel no diffidence if called upon to discriminate between a peacock and a turkey, a guinea-hen and a cochin-china. The mute Swan, a domesticated species, is always included in British lists, but only on account of its tameness and domesticity, at least, I, for one, never heard of a *wild* domestic swan in England, though they occur in France and Holland. We have domesticated

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* If I fully understand Mr. Wollaston, he still possesses one of the eggs in question, by means of which any doubt upon the point might yet be cleared up. The remainder have been destroyed by an unfortunate accident.

examples of all the four classes of Vertebrata—domestic quadrupeds, domestic birds, a domestic reptile, and a domestic fish. "For every kind of beasts, and of birds, and of serpents, and of things in the sea, is tamed, and hath been tamed of mankind." (James iii. 7.) Of the domestic reptile I shall speak hereafter, and the fish I refer to is of course the Goldfish. I have therefore included the following Rasores, usually met with in a domesticated state—the Peacock, the Turkey, the Guinea-fowl or Pintado, the Domestic Fowl, and the Domestic Pigeon.

The Grallatorial or Wading Birds next claim our attention. Our list is, however, very small, for reasons already given; but it will, without doubt, be increased. Of the 12 Plovers, we have but 3; of the Heron family, numbering 14, we have also 3, viz., Herons, from the Cobham or the Penshurst Heronries (they being the nearest), which often forage within our limits; the Bittern sometimes visits our marshes; and the rare Glossy Ibis (*I. falcinellus*) has been taken near Dartford. Of the 34 Scolopacidæ, 8 are all I find at present recorded; amongst them, however, are some rare ones. The Wood Sandpiper (*Totanus glareola*), slightly more frequent of late years than formerly, was shot at Woolwich; and of the Curlew Sandpiper (*Tringa subarquata*), the second example known was shot at Greenwich, and called by Pennant the Pigmy Curlew (*Numenius pygmæus*). Another of Pennant's (or rather of Dr. Latham's) spurious species is a bird which he described in his Index Ornithologicus under the name of the Greenwich Sandpiper (*Tringa Grenovicensis*), from the place where it was shot. Here we might be inclined to consider Greenwich as ornithologically honoured as Dartford was by the Warbler before mentioned; but the *honour* proved as aërial and fleeting as Falstaff's, and the Greenwich Sandpiper finds no place in modern descriptions. It was not until after much search, both in men and books, for the real "daw in borrowed plumes," that I at length discovered the synonym in G. R. Gray's Catalogue of the British Birds in the Museum, from which it appears that some immature or anomalous condition of the Ruff (*Machetes pugnax*) was referred to, a bird not otherwise occurring in our district, though abundant in some parts of England,—and in Leadenhall Market in September.

Lastly, of Natatorial birds we have very few indeed. The only *two* which we can boast as residents with us, out of the 102 British species, are the Domestic Swan (*Cygnus olor*), and the Little Grebe or Dab-chick (*Podiceps minor*). No doubt a few occasionally visit our district in winter, for they are nearly all boreal birds, or winter birds of passage, and the occurrence of a score or so has thus been noticed; representing, indeed, all the British families, except the Alcadæ or Auks, short-winged swimmers, which could only reach us by sheer accident; but the bulk of the Anatidæ, containing about 46 species, and of the Laridæ, 36 species, which chiefly make up this order, are never seen within our limits, the fact being, as before stated, that in those orders in which Britain generally is richest, *we* are most deficient.

It would be, however, useless to endeavour to fill up these deficiencies (as we have done in the Mammalia) from the remains of extinct species, for it is well known that Ornitholites are extremely scarce in England, not more than a dozen having yet been discovered; while of this scanty list one half consists of mere Ornithichnites, or impressions of footsteps of birds, and no remain has, I believe, been found within our limits.

Catalogue of the Birds.

Order. *RAPTORES.*
Suborder. Plumicolles.
Family. *Falconidæ.*

Merlin (*Falco æsalon*). This species has been shot near Eltham. (Mr. Tugwell.)

Kestrel (*Falco tinnunculus*). Not uncommon. I have seen it in my garden, Wellington Grove, December, 1853.

Sparrow Hawk (*Accipiter nisus*). Not uncommon.

Hen Harrier (*Circus cyaneus*). Occasionally seen in the marshes beyond Greenwich. (Mr. Tugwell.)

Suborder. Nocturni.
Family. *Strigidæ.*

Long-eared Owl (*Otus vulgaris*). Shot at by myself, but missed, in Eltham. (Mr. Wollaston.) Has also been taken at Dartford.

Short-eared Owl (*Otus brachyotos*). I have seen a specimen of this owl, killed near Greenwich. (Mr. Tugwell.) Has been taken at Dartford.

Barn Owl (*Strix flammea*). Common. They breed in the east end of Eltham Palace.

Tawny Owl (*Syrnium stridula*). Less common than the last. I have seen one in my garden, which remained there several days, and swooped down upon persons who went out.

Little Owl (*Strix passerina*). Caught at Eltham by Mr. Mills, in the spring of 1857, and kept alive for some weeks.

Order. *INSESSORES.*
Suborder. Dentirostres.
Family. *Laniadæ.*

Great Gray Shrike (*Lanius excubitor*). Seen in Burnt-ash Lane by Dr. Gray. Shot near Bromley in January, 1854. (Rev. A. Rawson.) Taken at Eltham by Mr. Mills. Mr. Wollaston, of Chiselhurst, has seen a nest and young between Dartford and Gravesend. Within the last two or three years one was taken by a bird-catcher behind Mr. Spencer's house at Kidbrook. It pounced upon the lure-birds, and was killed by the net.

Red-backed Shrike (*Lanius collurio*). Not uncommon. Nests on Shooter's Hill. Regularly visits Eltham.

Family. *Muscicapidæ.*

Spotted Flycatcher (*Muscicapa grisola*). Common.

Pied Flycatcher (*Muscicapa atricapilla*). A young bird was shot at Bromley in the summer of 1856. Some others were with it, but I could not hear that the old birds had been seen. (Rev. A. Rawson.) Mr. Mills, of the Moat, Eltham, has twice, during the last forty years, seen the pied ~~flycatcher~~ wagtail bring up a young cuckoo.

FAMILY. *Merulidæ.*

MISSEL THRUSH (*Turdus viscivorus*). Common.

FIELDFARE (*Turdus pilaris*). Common in winter. The Rev. A. Rawson has observed it at Bromley as late as May 13th; probably a wounded bird.

SONG THRUSH (*Turdus musicus*). Common.

REDWING (*Turdus iliacus*). Common in winter.

BLACKBIRD (*Turdus merula*). Common.

RING OUSEL (*Turdus torquatus*). Mr. Hutchinson, of the Paragon, Blackheath, tells me that an occasional visitor has made its appearance in his garden, one at a time, for several seasons, both on their vernal and autumnal migrations.

GOLDEN ORIOLE (*Oriolus galbula*). This single European species of a large genus seems to favour the county of Kent with its presence more than any other. In the Blackheath district, one was shot by Mr. Joiner, of the Crown Manor Lodge, at Eltham, on 14th June, 1853.

FAMILY. *Sylviadæ.*

HEDGE ACCENTOR (*Accentor modularis*). Common.

REDBREAST (*Erythaca rubecula*). Common.

REDSTART (*Phœnicura ruticilla*). Generally distributed. Common in Greenwich Park.*

BLACK REDSTART (*Phœnicura tithys*). Seen between Widmore and Bromley. (Mr. Hutchinson.)

STONECHAT (*Saxicola rubicola*). Generally distributed on furzy commons.

WHINCHAT (*Saxicola rubetra*). Ditto.

WHEATEAR (*Saxicola œnanthe*). I have seen this bird on Blackheath and in Burnt-ash Lane, Lee. It is not common within the district.

GRASSHOPPER WARBLER (*Salicaria locustella*). I have heard this bird at Rushy Green, on Shooter's Hill, and in the fields behind Morden College.

SEDGE WARBLER (*Salicaria phragmitis*). Among reeds on the banks of the Thames. They generally frequent a small patch of reeds between Burnt-ash Lane and Hithergreen.—Lane between Charlton and the river. Not uncommon.

REED WARBLER (*Salicaria arundinacea*). By no means so generally distributed as the last species. They may be found in the marshes between Erith and Woolwich; but twenty years ago they existed in numbers on the banks of the Surrey Canal, near New Cross, and in marshy spots on the Lower Road, Deptford, but were driven from these haunts by the progress of building, and by the Greenwich Railway. *See* "Zoologist," p. 97.

THRUSH-LIKE WARBLER (*Salicaria turdoides*). This was recorded in the "Zoologist" (3476) as the Thrush Nightingale (*Philomela turdoides*). A specimen of this bird was killed at Dartford in May, 1852, and a second has been shot at Erith. One also occurred between Tunbridge and Sevenoaks. (Yarrell, 2nd Supp.)

SAVI'S WARBLER (*Salicaria luscinioides*). A nest and five eggs of this rare bird were taken at Erith on 28th May, 1853, by Mr. Green, of City Road. "Zool." 3945.

NIGHTINGALE (*Philomela luscinia*). Widely distributed; common on Shooter's Hill, and has sung on the south side of Blackheath within the last two years, and in Morden College gardens in the present spring.

BLACKCAP (*Curruca atricapilla*). Common.

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* When a particular locality is mentioned in connection with a not uncommon bird, it is because, as far as my experience serves me, it is certain to be found there at the proper season.

Garden Warbler (*Curruca hortensis*). By no means common. I have heard him singing near Morden College.

Whitethroat (*Curruca cinerea*). Common.

Lesser Whitethroat (*Curruca sylviella*). Much less common than the last. Regularly builds in my garden.

Wood Wren (*Sylvia sylvicola*). Tolerably common in Shooter's Hill wood. I have heard it also much nearer town; but they usually frequent high trees in woody places.

Willow Warbler (*Sylvia trochilus*). The most abundant of the summer warblers. Sings incessantly.

Chiff-chaff (*Sylvia hippolais*). Common. Love Lane. In my garden.

Dartford Warbler (*Melizophilus Dartfordiensis*). This bird was first made known as inhabiting this country by Dr. Latham, from specimens obtained at Bexley Heath in April, 1773. Mr. Rennie speaks of having observed it on Blackheath in 1830, but I have never been able to meet with it, nor could I hear of any one who had seen it of late years, until the Rev. A. Rawson, of Bromley Common, reported to me that he had himself shot this bird on Hayes Common. A writer in "Loudon's Magazine," thirty years ago, states that for many years he had diligently searched the neighbourhood of Dartford for them, but in vain.

Golden-crested Regulus (*Regulus cristatus*). Not unfrequent, especially where there are firs. Love Lane; Tanner's Hill; Chiselhurst; Wickham Wood, &c.

Fire-crested Regulus (*Regulus ignicapillus*). Mr. Hutchinson assures me he has seen this species in his garden.

Family. *Paridæ.*

Great Tit (*Parus major*). Common.

Blue Tit (*Parus cœruleus*). Abundant.

Cole Tit (*Parus ater*). Not common. Greenwich Park.

Marsh Tit (*Parus palustris*). Not common. Greenwich Park.

Long-tailed Tit (*Parus caudatus*). Not uncommon.

Bearded Tit (*Calamophilus biarmicus*). Charlton. (Mr. Hutchinson.)

Family. *Ampelidæ.*

Bohemian Waxwing (*Bombycilla garrula*). Not unfrequently taken in winter. A specimen was captured at Eltham in January, 1850. "Zool." 2767. Mr. Mills, of Eltham, also mentions one captured there, possibly the same specimen. Mr. W. Morris, Jun., informs me that this bird has been shot at Deptford and at Lewisham.

Family. *Motacillidæ.*

Pied Wagtail (*Motacilla Yarrellii*). Common.

Gray Wagtail (*Motacilla boarula*). Not uncommon in winter. Mr. Blyth once observed a pair on Penge Common, at the end of May, that evidently had a nest in the neighbourhood, but he was unsuccessful in his endeavours to find it. Dartford.

Ray's Wagtail (*Motacilla flava*). Common.

Family. *Anthidæ.*

Tree Pipit (*Anthus arboreus*). Not uncommon.

Meadow Pipit (*Anthus pratensis*). Common.

Suborder. Conirostres.

Family. *Alaudidæ.*

Skylark (*Alauda arvensis*). Abundant.

Woodlark (*Alauda arborea*). By no means common. Shooter's Hill and Eltham.

Family. *Emberizidæ.*

Common Bunting (*Emberiza miliaria*). Abundant in hedgerows.

Black-headed Bunting (*Emberiza schœniclus*). Not uncommon in marshy places. I have observed it in the small reed patch between Hithergreen and Burnt-ash Lane.

Yellow Bunting (*Emberiza citrinella*). Abundant in hedgerows.

Cirl Bunting (*Emberiza cirlus*). Mr. Tugwell informs me he has seen this species in fields between Eltham and Shooter's Hill.

Family. *Fringillidæ.*

Chaffinch (*Fringilla cœlebs*). Abundant.

Mountain Finch (*Fringilla montifringilla*). Common about Bromley in winter, where the Rev. A. Rawson has observed it as late as April 8th. Mr. Newman says ("Zool." 3982) that in March, 1853, he found several frozen to death in his garden at Peckham; and Mr. Tugwell has seen specimens shot near Greenwich.

Tree Sparrow (*Passer montanus*). The Rev. A. Rawson reports to me its existence about Bromley, but says it is uncommon.

House Sparrow (*Passer domesticus*). Abundant everywhere.

Greenfinch (*Coccothraustes chloris*). Common.

Hawfinch (*Coccothraustes vulgaris*). This sparingly-distributed species has been observed to exist in considerable numbers at Dartford. A nest, with three eggs and one young bird, was taken from a tall tree near Bexley (Yarrell, i. 532), although it is a winter visitor. Pennant also relates (i. 421, last ed.) that a Hawfinch was shot near Dartford in the summer months. Mr. Wollaston says: "They are in considerable abundance in this parish (Chiselhurst); more particularly in my garden, where they have once built." Mr. Hutchinson tells me he has seen flocks of these birds at Eltham Green; and the Rev. A. Rawson, of Bromley Common, informs me that the Hawfinch is in that locality very frequent in spring and summer. He adds: "I have counted seven at once in my garden, and have eggs from a neighbouring one."

Goldfinch (*Carduelis elegans*). Absent from the immediate neighbourhood of Blackheath; not uncommon in other parts of the district.

Siskin (*Carduelis spinus*). This I have seen once or twice near Lewisham. (Mr. Tugwell.) Common in winter about Bromley. (Rev. A. Rawson.) Between Lee and Eltham, in winter.

Linnet (*Linota cannabina*). Absent from the immediate neighbourhood of Blackheath; common in other parts of the district, especially on furzy commons.

Lesser Redpole (*Linota linaria*). Not uncommon in some parts of the district.

Bullfinch (*Pyrrhula vulgaris*). Not uncommon. I have seen this bird on Blackheath.

Common Crossbill (*Loxia curvirostra*). The editor of the last edition of Pennant's "Zoology" (i. 427) says: "I know but one certain instance of their breeding in England, and that on a pine-tree within two miles of Dartford, in Kent. The nest, almost the size of a blackbird's, was made on the lowermost fork of the tree, composed of dried twigs of a loose texture; however, no eggs were laid, for from the too great curiosity of frequent observers, the birds forsook it." He further goes on to observe, that "a female, shot at Erith in August, 1791, was bare on the breast; a circumstance common to sitting birds." I am not aware that this curious fact has since been paralleled in England. At Penshurst, near Tunbridge Wells, these birds, according to Yarrell, have appeared in such numbers that nine were killed at one shot. Mr. Wollaston says they are not unfrequent at Chiselhurst; and the Rev. A. Rawson informs me that a red male was taken on Bromley Common on March 9th, 1851.

Parrot Crossbill (*Loxia pityopsittacus*). This very rare British bird has been once shot, by Mr. Wollaston, at Eltham. It was a female.

FAMILY. *Sturnidæ.*

STARLING (*Sturnus vulgaris*). Abundant.

ROSE-COLOURED PASTOR (*Pastor roseus*). Judging from Pennant's account of this bird ("Brit. Zool.," i. 413), it would seem that it was first known as a visitant to Britain at Norwood. He says: "Mr. Edwards discovered this beautiful bird twice in our island; once near London, at Norwood, and another time in Norfolk." Though Norwood is not within the strict limits of our district, the circumstance is too interesting to omit. Pennant's plate was taken from the Norwood specimen.

FAMILY. *Corvidæ.*

CARRION CROW (*Corvus corone*). Not common. They may often be seen hovering over the river, and dipping *into* it in search of food.

HOODED CROW (*Corvus cornix*). I have seen this species on Blackheath. (Mr. Hutchinson.) Abundant in winter in the meadows between Lee and Eltham. (Mr. Wollaston.)

ROOK (*Corvus frugilegus*). Abundant.

JACKDAW (*Corvus monedula*). Common.

MAGPIE (*Pica caudata*). Not uncommon.

JAY (*Garrulus glandarius*). Not uncommon.

SUBORDER. SCANSORES.

FAMILY. *Picidæ.*

GREEN WOODPECKER (*Picus viridis*). Not uncommon. Greenwich Park.

GREAT SPOTTED WOODPECKER (*Picus major*). Rare. Greenwich Park.

LESSER SPOTTED WOODPECKER (*Picus minor*). Rare. Greenwich Park. (Mr. Tugwell.) Mr. Mills has seen it at Eltham.

WRYNECK (*Yunx torquilla*). Not uncommon. Greenwich Park.

FAMILY. *Certhiadæ.*

CREEPER (*Certhia familiaris*). Common.

WREN (*Troglodytes Europæus*). Common.

HOOPOE (*Upupa epops*). One was shot in Greenwich Park five or six years ago. Mr. Tugwell refers to another specimen, but I have no particulars.

NUTHATCH (*Sitta Europæa*). Not uncommon, but local. Common in Greenwich Park, near the Wilderness.

FAMILY. *Cuculidæ.*

CUCKOO (*Cuculus canorus*). Common. Greenwich Park, May, 1859.

YELLOW-BILLED AMERICAN CUCKOO (*Coccyzus Americanus*). Mr. Wollaston of Chiselhurst, in 1831, took from the nest of a chaffinch (?) between Dartford and Gravesend, in an elm-tree, about twelve feet from the ground, four eggs which long puzzled him, until he recognised them, from specimens in the British Museum cabinet, to be the eggs of this bird.

SUBORDER. FISSIROSTRES.

FAMILY. *Halcyonidæ.*

KINGFISHER (*Alcedo ispida.*) Banks of Ravensbourne and Cray. Occasionally seen in the Wilderness, Greenwich Park, but does not remain. It built its nest there a few years since, and apparently visited the river for food.

FAMILY. *Hirundinidæ.*

SWALLOW (*Hirundo rustica*). Abundant.

MARTIN (*Hirundo urbica*). Common.

SAND MARTIN (*Hirundo riparia*). Common, but more local than the preceding. They may generally be seen on Blackheath.

SWIFT (*Cypselus apus*). Generally distributed.

ALPINE SWIFT (*Cypselus alpinus*). Has been shot at Lewisham, as I am informed by Mr. W. R. Morris.

Family. *Caprimulgidæ.*

Nightjar (*Caprimulgus Europæus*). Not uncommon on the borders of woods. Shooter's Hill, where they were formerly abundant. Common near Bromley. (Rev. A. Rawson.)

Order. *RASORES.*

Family. *Columbidæ.*

Ringdove (*Columba palumbus*). Common in woods.

Stockdove (*Columba œnas*). Less common than the preceding.

Turtle Dove (*Columba turtur*). Not uncommon in summer.

Common Pigeon (*Columba* —— ?). The *C. domestica* of Pennant, and its varieties. Although some derive our domestic species from the Rock Dove (*C. livia*), there appears to be scarcely sufficient reason for so doing.

Family. *Phasianidæ.*

Pheasant (*Phasianus colchicus*). Common in the West and Crown Woods.

Peacock (*Pavo cristatus*). No doubt, originally from India, from the testimony of all ancient historians. They were first imported to Samos, and kept in the temple of Juno, whence has spread a notion that they were natives of that place. Athenæus, ix.; Ælian. Nat. Anim. v.

Turkey (*Meleagris Gallopavo*). Undoubtedly from America. Its name implies that it was supposed to partake of the nature of the Guinea-fowl, the domestic fowl, and the peacock.

Domestic Fowl (*Gallus* —— ?). An excellent authority, Mr. Blyth, considers the domestic varieties to be derived from the *Gallus ferrugineus* (Blyth), which is the *Gallus Bankiva* of Temminck, and inhabits the jungly districts of all N. India. (*See* Cat. Mus. Asiat. Soc. Calcutta.)

Guinea-fowl (*Numida meleagris*). Originally from the Guinea coast of Africa.

Family. *Tetraonidæ.*

Partridge (*Perdix cinerea*). Common. May be heard on the skirts of Blackheath.

Red-legged Partridge (*Perdix rufa*). Occasionally met with in company with the last. An introduced species.

Quail (*Coturnix vulgaris*). Not uncommon. Between Morden College and Eltham. They have been observed in the open square of Greenwich Hospital.

Order. *GRALLÆ.*

Family. *Charadriidæ.*

Great Plover (*Œdicnemus crepitans*). Not uncommon.

Golden Plover (*Charadrius pluvialis*). Fields and open places near Dartford. (Mr. Tugwell.)

Peewit (*Vanellus cristatus*). Not uncommon.

Oyster-catcher (*Hæmatopus ostralegus*). A notice of the capture of this bird near Dartford may be found in "Loudon's Magazine," iii. 435.

Family. *Ardeidæ.*

Heron (*Ardea cinerea*). Occasionally seen flying over. The nearest Heronries are at Cobham Hall, near Gravesend, and at Penshurst Park, near Tunbridge Wells. A heron run down by a boy near Bexley was found to have a good-sized water-rat in its crop.

Bittern (*Botaurus stellaris*). Mr. Tugwell says that this bird has been shot in the marshes between Erith and Dartford.

Glossy Ibis (*Ibis falcinellus*). A specimen of this rare visitant was shot in 1827 on the bank of a fish-pond at Blendon Hall Park, near Bexley.

FAMILY. *Scolopacidæ.*

COMMON SANDPIPER (*Totanus hypoleucos*). Not uncommon by streams.

WOOD SANDPIPER (*Totanus glareola*). A specimen of this rare bird was shot at Woolwich on June 1, 1850. ("Zool." 2853.)

RUFF (*Machetes pugnax*). This is the Greenwich sandpiper (*Tringa Grenovicensis*) of Dr. Latham and Pennant. (*See* Brit. Mus. List.)

WOODCOCK (*Scolopax rusticola*). Uncommon.

SNIPE (*Scolopax gallinago*). Marshes beyond Greenwich.

JACK SNIPE (*Scolopax gallinula*). Same as last.

CURLEW SANDPIPER (*Tringa subarquata*). Pennant gives the first notice of this bird under the name of pigmy curlew (*Numenius pygmæus*), and says: "Only one instance occurs of this rare bird having been observed in England, which was shot near Sandwich." The editor of the last edition appends in a note: "Another has since been met with at Greenwich, in August." (ii. 38.)

DUNLIN (*Tringa variabilis*). Visits the Kent Waterworks, Deptford. (Mr. Morris.)

FAMILY. *Rallidæ.*

LAND-RAIL (*Crex pratensis*). Not uncommon.

WATER-RAIL (*Rallus aquaticus*). Not uncommon.

MOORHEN (*Gallinula chloropus*). Not uncommon. Three or four years ago these birds bred on the round pond in Blackheath Park.

FAMILY. *Lobipedidæ.*

COOT (*Fulica atra*). Not uncommon. Ponds at East Wickham. (Mr. Tugwell.)

ORDER. *NATATORES.*

FAMILY. *Anatidæ.*

BEAN GOOSE (*Anser segetum*). Occasionally seen passing over in flocks at the beginning and end of winter.

DOMESTIC GOOSE (*Anser* ——?). Most writers derive this bird from the Gray-lag Goose (*Anser ferus*); but some are disposed to consider it as a cross between the Bean Goose and the White-fronted (*A. albifrons*).

HOOPER, or WHISTLING SWAN (*Cygnus ferus*). Has been taken in times past in Dartford marshes.

MUTE SWAN (*Cygnus olor*). On some pieces of water, semi-domesticated.

COMMON SHELLDRAKE (*Tadorna vulpanser*). Has been shot in the marshes near Dartford.

GADWALL (*Anas strepera*). This rare duck was shot on a pond at Bromley Common in company with tame ducks. (Rev. A. Rawson.)

PINTAIL DUCK (*Anas acuta*). This species occurs in winter along the Thames. (Mr. Tugwell.) Dartford marshes.

WILD DUCK (*Anas boschas*). Not uncommon.

DOMESTIC DUCK (*Anas* ——). Probably traceable to the Mallard, or Wild Duck. It may be remarked that several species of ornamental water-fowl may be seen at the Moat, Eltham, in the neighbourhood of the ancient bridge, as well as in Scott's Park, near Chiselhurst.

TEAL (*Anas crecca*). Not common.

WIGEON (*Anas penelope*). Not common.

VELVET SCOTER (*Oidemia fusca*). Has been shot in the marshes near Dartford.

COMMON SCOTER (*Oidemia nigra*). Ditto.

RED-CRESTED WHISTLING DUCK (*Fuligula rufina*). A specimen was killed, out of a flock of eighteen, on the Thames near Erith, and is figured by Gould in his "Birds of Europe."

SCAUP DUCK (*Fuligula marila*). Has been shot in the marshes near Dartford.

SMEW (*Mergus albellus*). Ditto.

GOOSANDER (*Mergus merganser*). Has been taken in Erith marshes; also in the marshes near Dartford.

Family. *Colymbidæ.*

Little Grebe (*Podiceps minor*). Not uncommon on secluded waters.

Black-throated Diver (*Colymbus arcticus*). A male specimen was killed on Jan. 21st, 1850, at the Saltings, near Purfleet, on the Thames. ("Zool." 2706.)

Family. *Pelicanidæ.*

Cormorant (*Phalacrocorax carbo*). One was taken in April, 1848, on the Thames at Swanscombe. ("Zool." 2149.)

Gannet (*Sula alba*). A Soland goose was captured by a shepherd in a turnip-field, three miles from Dartford, and five from the Thames. ("Zool." 1701.)

Family. *Laridæ.*

Common Tern (*Sterna hirundo*). Sometimes follows up the course of the Thames on their spring return.

Black-headed Gull (*Larus ridibundus*). Has been taken in Dartford marshes.

Great Black-backed Gull (*Larus marinus*). Ditto.

Kittiwake Gull (*Larus tridactylus*). I have seen this species flying over the Thames in rough weather during winter. (Mr. Tugwell.)

Common Gull (*Larus canus*). Not uncommon over the Thames. I have seen it in my garden, and over Blackheath.

REPTILES.

In Reptiles this country is extremely poor, and that probably for a reason hinted at in a former place. These creatures are found in their greatest abundance and variety in tropical countries, where the heat of the sun makes up for the deficiency of their animal temperature; and as we rise northwards through the temperate zone, they rapidly decrease in number. In Gilbert White's time, 12 species were mentioned, though that was a larger number than were really known; for we find, only twenty years ago, that 12 species were all that were described. The only difference made on the *last* edition of Bell's "Reptiles" is, that one species* described as such in the former edition is struck out, finally reducing the number of indigenous Reptiles to 15. And yet we are, zoologically, better off than our sister island, whence, as is well known, through the benevolence of St. Patrick, the snakes were long ago expelled.

Although Britain possesses only 15 species of Reptiles, distributed through 11 genera, it must not be supposed that our zoological good fortune has deserted us. Among these 11 genera are representatives of all the 4 great orders of Reptiles—the Chelonians, the Saurians, the Ophidians, and the Amphibians; and the 15 species they contain are, for the most part, typical of many of the most important Reptilian families.

In our immediate district we possess 9 of the 15 species, comprised in 7 genera; but among these we retain the types, as far at least as concerns the second, third, and fourth orders. Of Chelonian reptiles, the only specimens which have put forth any claims to admission into the British Fauna are two or three marine species, which have at rare intervals been taken on our coasts, wanderers from warmer latitudes. None of these have come within our limits; but there is within a short distance from us, viz., at Burham, three miles from Chatham, a Tortoise (*Chelonia Benstedi*) inclosed in the lower chalk, which in that district is so rich in reptilian remains. But, not to go so far even as Burham, we may find a Chelonian to represent the otherwise vacant rank; and here I must redeem my promise of introducing an animal in exchange for the Guinea-pig which was denied admission among our domesticated Mammalia. We have a domestic Chelonian which I think has claims to admission greater than those of the Restless Cavy, viz., the common Tortoise (*Testudo Græca*), one of the land family, whose frequent presence in our markets, and wide distribution in our gardens, whose tolerance of our climate, and

* *Rana Scotica*, only a large variety of the common Frog.

whose well-known habits, warrant its admission into our domestic British Fauna. Who has not had, at some time or other, a tortoise? or who has not (as Gilbert White would have said) "made acquaintance with" some tame one?

The order of Saurian Reptiles is large, and embraces a considerable diversity of forms. The gigantic reptiles of distant ages form 3 suborders in this division; and it is perhaps worth mentioning that, although we have no remains discovered up to the present time, within the strict limits of our district, yet within a very short distance from us are found the remains of all the three great extinct Saurian families. At Maidstone that gigantic Dinosaur, the *Iguanodon Mantelli*, lies imbedded in the lower greensand; the *Pterodactylus compressirostus* and *Pt. giganteus*, types of the anomalous Pterosaurians, are found at Burham and at Maidstone, in the strata before mentioned; and the same Burham chalk contains that strange Enaliosaurian, the Plesiosaurus. All these lie within 30 miles of us. But of recent Saurians we have a sorry list, our common *Zöotoca vivipara* being the sole representative; but we must not complain, for it is typical of the Lacertilian family. Loricated Saurians, of which the Crocodile is the type, are, of course, confined to tropical countries, and we must content ourselves with the extinct Crocodile, whose tomb is in the London clay at Hackney.

Of Ophidians we possess three, each of them representatives of a well-marked family. The false snakes (Saurophidia) are represented by the Slow-worm (*Anguis fragilis*), while the true serpentine character is possessed by the other two; one of which, the Viper (*Pelius Berus*), exhibits the venomous, and the other, the ringed snake (*Natrix torquatus*), the Colubrine, or non-venomous form; the latter representing, in addition, the aquatic family.

Among the Amphibia we possess but one of the two British species of Frog, the other being of very local distribution. We claim, however, both the British species of Toad, the Natter-jack (*Bufo calamita*) being peculiarly our property. These all represent the tail-less family of Amphibia. Of the family Urodela, or Salamandrine Amphibia, we possess one Triton and one Lissotriton of the two of each genus accounted British. All these five Amphibia belong, of course, to the Caducibranchiate form; and the remaining families are very anomalous, very rare, and contain very few species.

Catalogue of the Reptiles.

Order. *TESTUDINATA.*

Family. *Cheloniadæ.*

Common Tortoise (*Testudo Græca*). Common in a domesticated condition.

Order. *SQUAMATA.*

Suborder. Sauria.

Family. *Lacertadæ.*

Viviparous Lizard (*Zootoca vivipara*). Common on furzy heaths, and in gravel-pits. Blackheath, though not so abundant now as ten years ago.

Suborder. Saurophidia.

Family. *Anguidæ.*

Blind Worm (*Anguis fragilis*). Not uncommon in woods.

Suborder. Ophidia.

Family. *Colubridæ.*

Ringed Snake (*Natrix torquata*). Not common.

Family. *Viperadæ.*

Common Viper (*Pelius Berus*). This species is by no means common, or at all events shows itself but seldom. Mr. Tugwell has met with it in Westwood.

Order. *AMPHIBIA.*

Suborder. Anoura.

Family. *Ranadæ.*

Frog (*Rana temporaria*). Abundant in every pond.

Family. *Bufonidæ.*

Common Toad (*Bufo vulgaris*). Abundant.

Natter-Jack Toad (*Bufo calamita*). This toad was formerly common on Blackheath, and several other such spots in the neighbourhood of London. (*See* "Loudon's Mag.," vi., 185.) It is not so frequent in the former place now as it used to be. Bell says: "I have found it in considerable numbers near ponds and ditches, not far from Deptford, where they appear to have congregated for the purpose of breeding."—*Brit. Rep.*, p. 117.

Suborder. Urodela.

Family. *Salamandradæ.*

Common Warty Newt (*Triton cristatus*). Not uncommon in ponds and ditches.

Common Smooth Newt (*Lissotriton punctatus*). Abundant in ponds and ditches.

FISHES.

It was not originally contemplated to include the River Thames within the prescribed boundaries of our district; but on consideration it appeared to be a pity to omit any opportunity of adding to our stock of zoological information, or to pass over with neglect a branch of Zoology already too little studied; and I have therefore obtained, as far as possible, accounts of the fish which pass through any part of the Thames within our limits, it being obviously impossible to draw any other line of demarcation. It is true, we have the rivers Cray and Ravensbourne on either side of us, rivulets which produce about fifteen fishes of the ordinary brook species, which have supplied sport to the angler from time immemorial. It was supposed, however, that by including the Thames, many a sea-fish, as well as many fresh-water fishes which delight in broader and deeper-flowing streams than the brook-like Cray, would be included, and our Fauna somewhat swelled by the accession. For old Izaak, the father of the angle, speaks of the Thames as "the river of chiefest note in the nation," and Walton always had an eye to fish and fishing; the angler also will remember the Thames (*our* Thames) quoted by him for its piscine productiveness. Thus, speaking of the Roach, he says: "The Thames I believe to afford the largest and fattest in this nation, especially below London Bridge." And when we remember that the Thames ebbs and flows twice a day through upwards of sixty miles, the peculiar advantages of the situation of the river might make us expect abundance of fish. But it is at once her glory and her bane that she bears upon her bosom the great Metropolis. She is the main source of the wealth and commerce of London, and we repay the obligation by making her the receptacle of the foulest offscourings of the overcrowded city, the largest common sewer in the world. The consequences may easily be inferred. Fish which formerly were accustomed periodically to ascend high up the river in abundance, now never come at all, or only at rare intervals; regular fisheries have long since been abandoned, and London fishermen are a phenomenon. The Thames in the vicinity of London Bridge was formerly much frequented by amateur anglers, a fact which accounts for the number of fishing-tackle shops in Crooked Lane, leading to London Bridge; and within the memory of man, a person has gained a livelihood by attendance upon these Cockney anglers; but this is now a matter of history. Until recently, fishermen have pushed off by night from Greenwich, and brought ashore Flounders, or made a haul of Whitebait between Blackwall and Woolwich; but these are now rarities; flounders are not worth the looking after, and whitebait seldom appear above Erith.* The Thames shad, or Twaite shad (*Alosa finta*), was, a dozen years ago, abundant between Greenwich and Blackwall; and the wharf now occupied by Coles Child and Co., was formerly called *Shad Wharf*, from its being a favourite spot for these fish; but the fishermen must go far down the river now in search of Shad. Even eels have, of late years, not mustered in sufficient quantities to make the "fare" worth noticing. So it is with salmon and all other fish. And it is not alone the increase of the volume of London sewage which poisons the water, and renders it uninhabitable (and some would say, indeed, that this has little or no share in the matter), but the streams of noxious waste liquors from gas manufactories, and such like, on its banks for miles down on either side, the abundance of steam-boats, and the constant agitation and disturbance caused by them, all assist in preventing the access of fish, it being remembered that these latter are in the greatest crowd in the summer, a season when most fish would visit us, but which is holiday time for *Londoners* as well as for fishes. The only wonder, indeed, is, that any single fish should be found to adventure himself into so vile a compound as Thames water; and we should be inclined to make a prospective speculation in Geology, which is, that should our Thames at some future time dry up, and its bed be brought under the inspection of a future Agassiz, it would be found amazingly rich in ichthyolites, the remains of fish which have wandered into the poisonous fluid, and have there sunk helpless, to be imbedded in the mud and silt which will one day form so rich and fertile an alluvium.

In spite, however, of all these vital obstacles, fish *do* breathe the Thames, and live. We have seen that the large aquatic Mammalia reach us, not lately, it is true, except porpoises, which come up nearly every summer, and have been observed as high as Vauxhall; also a few of the fish in the accompanying Catalogue are from time to time likewise found.

Great Britain is well supplied with fishes; and not only is every section and every order represented by fishes which visit its extensive coast-line, but every family of fishes in the Cuvierian arrangement (adopted also by Yarrell), excepting only three of the Acanthopterygii, finds its representative on our shores, which are visited by

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* I am informed by my friend Professor Busk that he well remembers the time when Whitebait might be seen swarming about the 'Dreadnought,' and when the water pumped up into the ship contained abundance of shrimps. At that time, also, the bank opposite the 'Dreadnought' was thickly covered with vegetation—*Alisma plantago, Sagittaria sagittifolia*, &c.; and this was a favourite resort for flounder-catchers. The disappearance of all this animal and vegetable life the Professor attributes, not to the London sewage, but to the great increase of chemical works, gas-works, patent fuel-factories, &c., the evil effects of which will be just as great, and as much felt, after vast sums have been spent in merely diverting the comparatively innocuous house-sewage, as they are now.

254 species of fish. It cannot be expected that we should be able to include a member even of each order, as we are not near the sea; but we have both Osseous and Cartilaginous fishes, the former including both hard and soft-finned fishes, and the latter two of the three orders. The bulk of our fishes, however—viz., two-thirds—belong to the order of abdominal Malacopterygii; that is, flexible-finned fishes, having the ventral fins situated on the belly, without any connection with the bones of the shoulder.

It was said of the River Trent, that it was so named from its possessing *thirty* different kinds of fish, a number esteemed very considerable for a single river. Just this number are enumerated in the accompanying Catalogue, as inhabitants of the Thames and its tributaries in our district. Among these are the ordinary fish in request by the angler, and the following sixteen fish are taken in the Ravensbourne and Cray: perch, miller's-thumb, and two sticklebacks, in the hard-finned order; carp, gudgeon, tench, bream, roach, dace, chub, bleak, minnow, loach, pike, and trout, in the flexible-finned division.

Some of the Thames fishes deserve especial notice, and not the least remarkable is the dobule roach (*Leuciscus dobula*). The only specimen of this fish ever taken in Britain was captured near Woolwich by the late Mr. Yarrell himself in a whitebait-net. This fish is a native of the continental rivers—the Rhine, Elbe, Oder, and Wesel.

The last Salmon caught in the Thames was in 1833, and not forty years ago, as is stated in the "Curiosities of Natural History." It was formerly not uncommon to take a salmon in the spring, and the fishermen were generally on the look-out when the *salmon-bird*, as it was called (or common tern), made its appearance. It was a great prize, because a Thames salmon, from its freshness, fetched the highest price in the London market. Another of the Salmonidæ, which has much decreased of late, is the Smelt (*Osmerus eperlanus*), which formerly passed in great numbers up from the sea in the spring to the parts of the Thames above bridge, affording occupation for thirty or forty boats at a time. But perhaps the most noticeable fish of the Thames is one which was long esteemed peculiar to it, although it is now proved by Dr. Parnell that the Firth of Forth possesses it in considerable numbers; I allude to the Whitebait (*Clupea alba*), which has certainly not yet deserted us. These little celebrities come up with every flood-tide in the season (from April to September) as far as the limits of the brackish water, and are caught in a peculiar manner, described by Yarrell *in loco*. It appears that they were first observed and mentioned by Pennant; and his account is amusing, as read by the light of a wiser age and generation. He says: "During the month of July, there appear in the Thames, near Blackwall and Greenwich, innumerable multitudes of small fish, which are known to the Londoners by the name of whitebait. They are esteemed very delicious when fried with fine flour, and occasion, during the season, a vast resort of the lower order of epicures to the taverns contiguous to the places they are taken at." I have referred to the Thames Shad, formerly an important fish: besides this species, the Alice Shad (*Alosa communis*), or true shad, a far larger fish, occurs occasionally, though the Severn, on the other side of England, is a more favourite river of this species.

The migration of eels in the Thames has often attracted much attention, the myriads of small fry passing from the sea being observed moving upwards for days together, passing obstacles which would at first appear insurmountable, and constituting what is called "eel-fare." Nothing proves the foulness of the Thames more than this, that these bottom fishes, which feed among the mud (and thrive almost anywhere), and, consequently, are very tenacious of life (I say consequently, for this tenacity appears to be in inverse proportion to their proximity to the atmosphere, as surface-swimmers), that they should have diminished very materially, and are now, comparatively speaking, rare—is a striking proof of the effects of the foul water.

It is well known that a Sturgeon (*Acipenser sturio*) will occasionally pass up the river, and sometimes penetrates to a considerable distance above bridge. When this fish is taken in the Thames, it is considered a royal fish, and goes to the royal larder; but such a circumstance has not occurred now for some years. Lastly, river Lampreys, or lamperns (*Petromyzon fluviatilis*), formerly so abundant above Battersea Bridge, are now very scarce, and still more rarely come so low down the river as this; while the occasional visits of the sea Lamprey (*P. marinus*) are like those of angels, "few and far between."

But let us not despair. What has been once may be yet again; and when the good time comes that all abuses shall be rectified, and all nuisances abolished—ay, and sooner;—when the great drainage plan shall be carried into effect, which it inevitably *must*, sooner or later, the Thames shall once more be a limpid stream—and the fishes will not be the last to discover the change—and although it is true some adverse influences must increase, yet I am by no means persuaded but that the purification of the river would restore, in a great measure, to the angler, his sport,—to the fisherman, his occupation,—and to *us*, the lost members of our Fauna.*

* Since the above was written, affairs have come nearer to a crisis. During the very hot weather which occurred in the middle of June last year, the stench of the Thames was so intolerable, that fears were entertained of an epidemic arising from the foulness of the river. Happily, these fears were not realized; but already, before the middle of the present June, and while the weather is yet only moderately warm, the pestiferous odour has reappeared, imperatively warning the Legislature that some measures must be taken, without delay, for the purification of the river.

Catalogue of the Fishes.

Subclass. **OSSEI.**
Division. PECTINIBRANCHII.
Order. *ACANTHOPTERYGII.*
Family. *Percidæ.*

Perch (*Perca fluviatilis*). Common. Ravensbourne, &c.

Family. *Loricati.*

River Bullhead, or Miller's Thumb (*Cottus gobio*). Common. Ravensbourne, &c.

Smooth-tailed Stickleback (*Gasterosteus leiurus*). Common. Ravensbourne; also ponds and ditches.

Rough-tailed Stickleback (*Gasterosteus trachurus*). Common in the same situations.

Order. *MALACOPTERYGII.*
Suborder. Abdominales.
Family. *Cyprinidæ.*

Common Carp (*Cyprinus carpio*). Common. Ravensbourne, &c.

Prussian Carp (*Cyprinus gibelio*). In a pond at Kidbrook. (Mr. Tugwell.)

Gold Carp (*Cyprinus auratus*). Domesticated in ornamental ponds. A Chinese species.

Gudgeon (*Gobio fluviatilis*). Common. Thames and Ravensbourne.

Tench (*Tinca vulgaris*). Common. Ravensbourne, &c.

Bream (*Abramis brama*). Thames and Ravensbourne.

Roach (*Leuciscus rutilus*). Common. Thames; Ravensbourne. Donovan says the finest roach are taken in the Thames about the middle of May, or early in June. Izaac Walton speaks of 2 lbs. roach, but Mr. Jesse tells us of one that weighed 3 lbs., which was taken in the Thames; the largest on record, unless we may believe Pennant, who, on the authority of an "intelligent fishmonger," mentions one which weighed 5 lbs.

Dobule Roach (*Leuciscus dobula*). The only instance of this fish, which inhabits continental rivers, as the Rhine, Elbe, Oder, and Wesel, appearing in our own streams, fell under the notice of Mr. Yarrell himself, who says (i. 397), "While fishing in the month of August, 1831, in the Thames below Woolwich, with the mouth of a whitebait-net open against a strong flood-tide, I caught a single specimen of the fish above named, but have not been so fortunate as to obtain any more since."

Dace (*Leuciscus vulgaris*). Common. Thames and Ravensbourne.

Chub (*Leuciscus cephalus*). Not uncommon. Thames and Ravensbourne.

Rudd (*Leuciscus erythrophthalmus*). This fish is found in the Thames, and other waters round London.

Bleak (*Leuciscus alburnus*). Common in the Thames.

Minnow (*Leuciscus phoxinus*). Common. Thames and Ravensbourne.

Loach (*Cobitis barbatula*). Common. Ravensbourne.

Family. *Esocidæ.*

Pike (*Esox lucius*). Common. Thames and Ravensbourne.

Family. *Salmonidæ.*

Salmon (*Salmo salar*). This prince of esculent fishes is sometimes, though rarely, found in the Thames, and such a circumstance is now less common than formerly. Yarrell, whose "Brit. Fishes" was published in 1841, says that the last Thames salmon he had a note of was taken in June, 1833. The appearance of the common Tern, or sea swallow (*Sterna hirundo*), which on its arrival in May wings its flight for miles up the Thames, is the signal to the fishermen to keep a good look-out for a salmon. The occasionally coincident reappearance of a tern and a salmon has induced some of the Thames fishermen to apply to the former the name of the *salmon-bird.* A Thames salmon is a prize to a fisherman, which, like other prizes, occurs but seldom; for in the London market a Thames salmon fetches the highest price, on account of the proximity of its place of capture to the place of sale, and its consequent freshness.

Common Trout (*Salmo fario*). Thames and Ravensbourne.

Smelt (*Osmerus eperlanus*). These, like their congeners the Salmon, ascend rivers, especially the Thames and Mersey. "The Thames and Medway fishing with small-meshed nets for smelts is permitted under the jurisdiction of the Lord Mayor of London, from St. Augustine's day (28th August) till Good Friday. Formerly the Thames from Wandsworth to Putney Bridge, and from thence upwards to the situation of the present suspension bridge at Hammersmith, produced abundance of smelts, and from thirty to forty boats might be seen working together; but very few are now to be taken; the state of the water preventing the fish from advancing so high."—Yarrell, ii., 13.

Family. *Clupeidæ.*

Whitebait (*Clupea alba*). Pennant's description (before quoted) of a kind of *bleak,* as he called them, which he met with, in his "Journey to Dover" (i. 23), is amusing to read in the present days of ministerial and municipal banquets. These dainty fishes were long supposed to be the peculiar property of the Thames, but Dr. Parnell, in his "History of the Fishes of the Firth of Forth," says: "I have found it to inhabit the Firth of Forth in considerable numbers during the summer months. From the beginning of July to the end of September they are found in great abundance." In the Thames they begin to make their appearance, very small, about the end of March or beginning of April, and the season lasts from the beginning of April to the end of September, when they are taken at every flood-tide. Yarrell says: "When fishing as high as Woolwich, the tide must have flowed from three to four hours, and the water become sensibly brackish to the taste before these fishes will be found to make their appearance. They return down the river with the first ebb-tide, and the various attempts to preserve them in well-boats, in pure fresh water, have uniformly failed." (Yarrell, ii., 204.) Some have held that these fish are the young state of other fishes; and Dr. Fleming, that they are the fry of the Alice shad, to be mentioned presently. This theory is not accepted.

Twaite Shad (*Alosa finta*). This is the common Thames shad, another sea-fish, which enters our rivers about May to deposit spawn, returning about the end of July. "Twaite shads appear during these three months in abundance in the Thames from the first point of land below Greenwich, opposite the Isle of Dogs, to the distance of a mile below, and great numbers are taken every season." (Yarrell.) They are usually twelve or sixteen inches long, weigh half a pound to two pounds, which it never exceeds, and are said by Pennant to be "esteemed a very insipid, coarse fish." Fishermen are prohibited from taking shad in the Thames after June 30th, in order that the remaining fish may be allowed to spawn without interruption.

Alice Shad (*Alosa communis*). This is the Severn shad, or true shad, and weighs from four or five to eight pounds. It is taken, though rarely, in the Thames. A specimen was brought to Yarrell, caught, in 1831, above Putney Bridge, and another is mentioned by Jesse ("Gleanings," 3rd Series, p. 147) as having been taken in 1833, June 25th, opposite Hampton Court Palace.

Suborder. Subbrachiales.

Family. *Pleuronectidæ.*

Flounder (*Platessa flesus*). The Thames fishermen take abundance of these fish from Deptford as high as Teddington and Sunbury.

ORDER. *APODES.*
FAMILY. *Murænidæ.*

SHARP-NOSED EEL (*Anguilla acutirostris*). Multitudes of these fishes pass up and down the river in their periodical migrations, constituting the "eel-fare" or fair; little eels to the size of three inches proceeding from the sea (or, rather, brackish water) upwards, passing even the locks in their undeviating course. This generally takes place in the spring. In the autumn the old eels pass in the contrary direction towards the sea. Dr. Roots, of Kingston, relates (Jesse's "Gleanings") that as many as sixteen to eighteen hundred small eels were observed to pass through a given space in one minute, and the fair lasted five or six days.

BROAD-NOSED EEL (*Anguilla latirostris.*)

SUBCLASS. CHONDROPTERYGII.
ORDER. *ELEUTHEROPOMI.*
FAMILY. *Sturionidæ.*

COMMON STURGEON (*Acipenser sturio*). Taken occasionally, but rarely.

ORDER. *CYCLOSTOMI.*
FAMILY. *Petromyzidæ.*

LAMPREY (*Petromyzon marinus*). A marine Lamprey travels up the Thames from time to time, in the face of all difficulties. Broderip says one was taken in June, 1834, and another as high as Sunbury weir in 1835.

LAMPERN (*Petromyzon fluviatilis*). The river Lamprey abounds in the Thames, and although best between October and March, they are to be obtained, says Yarrell, every month in the year. They were formerly much used as bait for other fish, and were sold for that purpose to the Dutch. Yarrell says that the Thames alone supplied from one million to twelve hundred thousand annually. These were chiefly taken between Battersea Reach and Taplow Mills.

Having thus completed a general survey of the animals of our district, as far as at present known, it only remains for me to add my conviction that very much yet remains to be done in the way of additions to the foregoing list. Should any one think that the subject is exhausted, let him bear in mind what one of the most intelligent, as he was one of the most indefatigable, field-naturalists (Gilbert White) says on this subject. In the 20th letter to Pennant, he exclaims: "I find in Zoology, as it is in Botany, all Nature is so full that *that* district produces the greatest variety which is the most examined." And this is the experience of all whose pursuits lead them to such investigations; and while it spurs on the adept to the acquisition of knowledge from the open volume of nature, it should at the same time encourage the tyro to observe for himself, and to cast aside the excuse of indolence, that there is nothing left for him to do. The smallest fact, *accurately* noted—for accuracy is indispensable—may be useful, may supply a link, or confirm a supposition; and the field of nature is inexhaustible. "Life," says Hippocrates, at the opening of his Aphorisms, "is short, Art is long;" * but he might have added, "Nature is longer, more boundless, and more pervading, for Nature is the Mother and Instructress of Art."

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* Ὁ βίος βραχὺς, ἡ δὴ τέχνη μακρὴ.

Appendix A.

The following list of rare Birds, which are recorded as having been captured in the immediate vicinity of London, has been collected from various sources.

Hobby (*Falco subbuteo*). Clapham.

Great Gray Shrike (*Lanius excubitor*). Picked up in Kentish Town; also at Kilburn.

Little Owl (*Strix passerina*). In London, and at Lambeth.

Black Redstart (*Phœnicura tithys*). At Shepherd's Bush, and in Regent's Park.

Richard's Pipit (*Anthus Ricardi*). Copenhagen Fields and Bermondsey.

Ortolan (*Emberiza hortulana*). Marylebone fields.

Gray-headed Wagtail (*Motacilla neglecta*). Finsbury. Yarrell's figure is from it.

Hoopoe (*Upupa epops*). Fulham.

Bohemian Waxwing (*Bombycilla garrula*). Kilburn and Clapton.

Red-winged Starling (*Aglaius phœnicurus*). Shepherd's Bush.

Great Black Woodpecker (*Picus martius*). Battersea fields.

Little Crake (*Crex Porzana*). Chelsea.

Gray Phalarope (*Phalaropus lobatus*). Battersea.

Red-breasted Merganser (*Mergus serrator*). Thames, Putney Bridge.

Eared Grebe (*Podiceps auritus*). Pond near Hampstead.

Common Tern (*Sterna hirundo*). Bushey Park.

Richardson's Skua (*Lestris Richardsoni*). Thames at Battersea.

Pomarine Skua (*Lestris pomarinus*). Hackney marshes.

Little Gull (*Larus minutus*). Thames near Chelsea. The first British specimen. (Montagu.)

Great Black-backed Gull (*Larus marinus*). Putney.

Stormy Petrel (*Thalassidroma pelagica*). In Old-street Road; also, one was shot from a coal-barge between Blackfriars and Westminster Bridges.

The remaining Birds are only described as having been captured "near London," and I have no clue to the exact locality.

Rough-legged Buzzard (*Buteo lagopus*). Penn.

Scops-eared Owl (*Scops Aldrovandi*).

Pied Flycatcher (*Muscicapa atracapilla*).

Lapland Bunting (*Emberiza lapponica*).

Mealy Redpole (*Linota canescens*).

Purple Heron (*Ardea purpurea*).

Night Heron (*Nycticorax Gardeni*). The first British-killed specimen.

Red-breasted Goose (*Anser ruficollis*). The first British-killed specimen.

Fork-tailed Petrel (*Thalassidroma Leachii*).

Appendix B.

The following rare Birds have been observed in the Poulterers' shops in London, especially in Leadenhall Market.

Tengmalm's Owl (*Noctua Tengmalmi*).
Bearded Tit (*Parus biarmicus*). Brought alive from Holland.
Crossbill (*Loxia curvirostra*). Alive.
Parrot Crossbill (*Loxia pityopsittacus*). Alive.
Capercaillie (*Tetrao urogallus*).
Ptarmigan (*Lagopus vulgaris*).
Quails (*Coturnix vulgaris*). In February.
Gray Plover (*Squatarola cinerea*).
Sanderling (*Calidris arenaria*). In January.
Purple Heron (*Ardea purpurea*) and eggs, from Holland.
Spotted Redshank (*Totanus fuscus*).
Greenshank (*Totanus calidris*).
Avocet (*Recurvirostra avocetta*). Twenty specimens in one month.
Bar-tailed Godwit (*Limosa rufa*).
Black-tailed Godwit (*Limosa melanura*). Living, from Holland.
Black-winged Stilt (*Himantopus melanopterus*).
Brown Sandpiper (*Macrorhamphus griseus*).
Ruffs and Reeves (*Machetes pugnax*).
Little Stint (*Tringa minuta*).
Dunlin (*Tringa variabilis*).
Spotted Crake (*Crex Porzana*).
Little Crake (*Crex pusilla*). The second specimen known.
Gray-lag Goose (*Anser ferus*).
Pink-footed Goose (*Anser brachyrhynchus*).
White-fronted Goose (*Anser albifrons*).
Brent Goose (*Anser torquatus*).
Whistling Swan (*Cygnus ferus*).
Polish Swan (*Cygnus immutabilis*).
Gadwall (*Anas strepera*). A specimen of which Montague tried in vain to procure.
Bimaculated Duck (*Anas glocitans*). The only known specimen since the first.
American Widgeon (*Anas Americana*). Male and female, the first specimens known in this country.
Eider Duck (*Somateria mollissima*).
Velvet Scoter (*Oidemia fusca*).
Red-crested Whistling Duck (*Fuligula rufina*).
Pochard (*Fuligula ferina*).
Ferruginous Duck (*Fuligula nigroca*).
American Scaup (*Fuligula mariloides*). The first of the only two specimens seen in this country; in Leadenhall Market.
Long-tailed Duck (*Fuligula glacialis*).
Goosander (*Mergus merganser*).
Sclavonian Grebe (*Podiceps cornutus*).
Black-throated Diver (*Colymbus arcticus*).
Little Auk (*Mergulus alle*).
Glaucous Gull (*Larus glaucus*).
Common Skua (*Lestris catarractes*).
Fork-tailed Petrel (*Thalassidroma Leachii*). One alive.

Appendix C.

List of Birds which have been recently noticed in England, but are not included in the last edition of Yarrell's "British Birds" (1856).

Australian Spine-tailed Swallow (*Acanthylis caudacuta*). In Essex.
Red-billed Whidah Bird (*Emberiza vidua*).
Crimson Weaver-bird (*Euplectis ignicolor*). Coast of Kent.
Minor Grackle (*Gracula religiosa*) a pair. Norfolk.
Great Northern Shrike (*Lanius borealis*). Aberdeen.
Red-breasted Tanager (*Ramphophis purpurea*). Cheltenham.
Yellow-backed Whidah Finch (*Vidua chrysonotus*). Oxfordshire.
Hairy Woodpecker (*Picus villosus*).
Summer Duck (*Dendronessa sponsa*). Coast of Kent.
Swift Tern (*Sterna velox*). Dublin.

N.B. There are, besides, some other accidental visitors, a list of which will be found in Gray's "Museum Catalogue."

Appendix D.

A Comparative List of the Families and Subfamilies of the Birds of Great Britain with the rest of the world, arranged according to Gray and Mitchell's "Genera of Birds."

FAMILIES.	Number of Sub-families represented.	Number of Sub-families *unre*presented.
I. *Acciptres*—		
i. Accipitres diurni—		
Vulturidæ . .	2	2
Falconidæ . .	6	1
ii. Accipitres nocturni—		
Strigidæ . . .	4	0
II. *Passeres*—		
ia. Fissirostres nocturni—		
Caprimulgidæ .	1	2
ib. Fissirostres diurni—		
Hirundinidæ . .	2	0
Coraciadæ. . .	1	3
Trogonidæ . .	0	1
Alcedinidæ . .	1	3
Meropidæ . . .	1	0
ii. Tenuirostres—		
Upupidæ . . .	1	1
Promeropidæ . .	0	2
Trochilidæ . .	0	3
Meliphagidæ . .	0	3
Certhiadæ . .	2	5
iii. Dentirostres—		
Lusciniadæ . .	5	2
Turdidæ . . .	2	3
Muscicapidæ . .	1	5
Ampelidæ . .	1	4
Laniadæ . . .	1	1
iv. Conirostres—		
Corvidæ . . .	1	5
Paradiseidæ . .	0	1
Sturnidæ . . .	2	5
Fringillidæ . .	6	3
Colidæ. . . .	0	1
Musophagidæ . .	0	2
Bucerotidæ . .	0	1

FAMILIES.	Number of Sub-families represented.	Number of Sub-families *unre*presented.
III. *Scansores*—		
Rhamphastidæ	0	1
Psittacidæ .	0	5
Picidæ . .	2	5
Cuculidæ . .	2	3
IV. *Columbæ*—		
Columbidæ .	1	4
V. *Gallinæ*—		
Cracidæ . .	0	2
Megapodidæ .	0	2
Phasianidæ .	4	1
Tetraonidæ .	2	3
Chionididæ .	0	2
Tinamidæ . .	0	1
VI. *Struthiones*—		
Struthionidæ .	1	2
VII. *Grallæ*—		
Charadriadæ .	5	1
Ardeadæ . .	3	2
Scolopacidæ .	6	0
Palamediadæ .	0	2
Rallidæ . .	2	0
VIII. *Anseres*—		
Anatidæ . .	5	3
Colymbidæ .	2	1
Alcidæ . .	2	2
Procellaridæ .	2	0
Laridæ . .	2	1
Pelicanidæ .	1	2
Total . .	82	104

A COMPARISON

[illegible]

ANCIENT AND MODERN VIEWS

[illegible]

MIGRATION AND HABITS

[illegible]

BIRDS,

BY CUTHBERT COLLINGWOOD, M.A.,
M.B., F.L.S., &c., &c.

READ BEFORE THE LITERARY AND PHILOSOPHICAL SOCIETY OF LIVERPOOL,
ON THE [illegible] DECEMBER, [illegible]

LIVERPOOL:
PRINTED BY HENRY GREENWOOD, 32, CASTLE STREET.

[illegible]

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1859.

A COMPARISON BETWEEN ANCIENT AND MODERN VIEWS OF THE MIGRATIONS AND HABITS OF BIRDS.

THE object of the following paper is two-fold, namely, first, to collect the opinions of various ancient writers upon certain ornithological theories, and secondly, to examine how far we have improved upon these up to the present time. In doing this, two things have particularly forced themselves upon my attention. The first of these is the near approach to truth, and the great amount of good sense exhibited by the naturalists of antiquity — the extravagances coming, not from their pen, but rather from those who incorporated their ideas with religious systems. The second remark to which I would direct special attention, is, how modern theorists have, in endeavouring to establish novel ideas, gone back to those of the ancients, and reproduced hypotheses long since exploded, by the natural advance of knowledge; and besides this, it will appear how much we, in the nineteenth century, have in common with the people of 2000 years ago, not only in science, but in the ordinary affairs of every-day life. Customs which we regard as characteristic of our own generation, and even particular modes of thought, which we might imagine to be as ephemeral as ourselves, are indeed not unfrequently traceable to a high antiquity, showing the common bond which unites the human race in all ages — the common source of our human nature — whether Greek, or Roman, or English — whether it be in the Iron, the Augustan, or the Victorian Era.

The migration of birds was a phenomenon which could not fail to be remarked from the very earliest times, and has ever excited a degree of attention commensurate with its singularity. In that infant period of society, when men had no almanacks to guide them to the changing of the seasons, and no calendars to direct them in the planting out of their fields and gardens, it is not surprising that the arrival and departure of birds should have called forth their wonder and admiration, and at once have suggested itself as an index to direct them in their agricultural operations. We are most of us familiar with the regularity which marks the recurrence of these migrations, especially in the case of certain common birds; and it is not necessary in these times that a man should be an ornithologist, in order that he may notice when the swallows arrive, or when the well-known voice of the cuckoo is first heard. How much more, then, must the ancients have attended to these signs, which were to them most important guides in those operations on which their whole existence depended. Hesiod indeed, the most ancient Greek writer and one of the earliest Greek astronomers, informs us, in his "Works and Days," that husbandry was in great part regulated by the blooming of plants and by the coming and going of birds; and although this poet lived in the very mists of antiquity (nearly 900 years B.C.), it is not unlikely that this had been the case long before his time. As men, however, became acquainted with the means of more accurate astronomical observation, this primitive natural calendar passed out of repute, and gave place to something more exact and of more general application. Aristophanes, who flourished B.C. 400, speaks of it as a thing of the past in his renowned comedy of "the Birds," where it is said (l. 499), that "in former times the Kite ruled the Grecians;" for his commentator tells us, that by this the poet meant, that formerly the Kite was looked upon as the sign of Spring. Then again, he informs us (l. 505), that the Cuckoo, in like manner, governed all Phœnicia and Egypt, because when it cried "kokku," they considered it was time to reap their wheat and barley-fields.

This remarkable comedy of Aristophanes gives us (l. 693) a scheme of cosmogony, in which the birds play a very prominent part. The Chorus (which consisted of Birds) tells us that in the beginning were Chaos, and Night, and Erebus, and Tartarus, and that there was neither water, nor air, nor sky. What there could have been in those early days it is difficult to conceive, before these important materials existed; and the picture thus afforded is superbly blank and chaotic. The next step in the Aristophanic cosmogony is at least remarkable — "Blackwinged Night" proceeds the Chorus, produced a self-formed egg, whence, after a time, sprang Eros the much-desired, or plastic Love; and then follows the parentage of the Birds — for Eros, in conjunction with Chaos, produced the bird-kind, and before these, was there no race of immortals. The benefits they conferred upon mankind were commensurate with this high and ancient lineage:— "the greatest blessings," say they (l. 708), "which can happen to mortals, are derived from us; first, we show you the seasons, viz. — spring, winter, autumn; the Crane points out the time for sowing, when she flies croaking into Libya; she bids the sailor put away his rudder, and take repose, and every prudent man provide himself with an upper garment. Next, the Kite appearing, proclaims another season, viz.,—that it is time to shear your sheep. After that, the Swallow informs you when you may sell your cloak, and buy light summer clothes."

Although these phenomena had ceased in the time of Aristophanes, to carry with them all the significance claimed by the speaker, it is remarkable, that even to this day, men whose pursuits are of an agricultural nature, are more or less guided by these mysterious reappearances of the feathered tribes. Thus the shepherds of Salisbury Plain say—

> When dotterel do first appear,
> It shows that frost is very near;
> But when that dotterel do go,
> Then you may look for heavy snow.

It is needless to multiply such proverbial sayings, which are indeed pretty numerous, nor are they confined to this country. Dr. Solander tells us, that the peasants of Upland have this saying, "When you see the white Wagtail, you may turn your sheep into the fields; and when you see the Wheatear, you may sow your grain," for in Upland, says the same authority, there is seldom any severe frost after the Wheatear appears, and sheep are housed all the winter in that inclement climate.

Although we can infer from no writer after Hesiod, that birds were looked upon as capable of directing the husbandman in his agricultural operations, still we are not to suppose, that after that time, they lost their influence and dignity. On the contrary, they appear to have gained a most extraordinary ascendancy over the minds of men, which increased to such a wonderful pitch, that at length, no affair of moment, either public or private, was entered upon without first consulting them. And the reasons of this growing reliance upon them, arose chiefly out of their curious migrations.

When thinking men meditated upon these remarkable movements, how they all disappeared at a certain time, as if by common consent, and then reappeared after a regular interval, they mistook cause for effect, and not unnaturally, regarded the birds as regulating the seasons, instead of the seasons as directing them. And since no man could say, with certainty, whither they went, or what became of them during the interval of their absence, it was no great wonder that they should imagine them to have retired somewhere beyond the sphere of the earth, and perhaps (who could tell?) might approach the region of Olympus, where they could hold converse with the very gods, and be enabled, by them, to predict future events. And when, in later times, it became known to travelled philosophers, that some of them might be seen high up the Nile during winter, that fact, instead of shaking the confidence of those who credited their prophetic gifts, only served to confirm their faith. For, if so, why should they not make periodical visits to Æthiopia, and even to Ammon, where they might meet Jove himself, and receive from him an annual ratification of their powers, and new messages from the counsels of the gods. The very foresight of the birds, as shown by the regularity of their times of departure and reappearance, seemed to have something of a divine nature in it, although Virgil, as in duty bound, being an Epicurean, disputes this matter, and declares that he believes it to be mere instinct. Still others believed it was not so; and thus it was almost natural for a superstitious people to believe that birds were the interpreters of the gods, *Aves internunciœ Jovis* (Cic de Nat. Deor: lib. ii. c. 34), as soon as any one boldly stood up and announced it as a fact. Hence arose Augury, one of the most ancient species of divination. "We are to you," exclaims the Chorus of Birds in Aristophanes, "Ammon, Delphi, Dodona, and Phœbus Apollo, for after consulting us, you undertake every thing—commerce, purchases, and matrimony." (l. 716).

Augury, by which was meant a forewarning notice concerning future events, derived from prophetic birds, was invented, according to various authors, by Prometheus or by Tiresias: Pliny says (vii. 55) by Car—and Pausanias (in Phocicis), attributes it to Parnassus, son of Neptune. However that may be, it was Calchas (Homer Il. A. 69) who did most to raise the art to perfection, although he was finally beaten in a trial of skill with Mopsus. In such honour were the augurs held, that at Lacedæmon the king had always one by his side to consult with, who, when he sat in his divining seat to observe the birds, was clothed in white, and wore a crown of gold upon his head; and thus placed with his face towards the north, and having the east upon his right hand, the signs which occurred on that side were esteemed fortunate, and those upon the opposite or western side, unlucky. But the Roman custom was different; clothed in purple or scarlet, the Roman augur regarded the south, and his right hand pointed west, and thus has arisen that confusion in the two languages by which δεξιόν in Greek, and *sinistrum* in Latin, equally mean *fortunate*, though the first signifies the *right*, and the second the *left* hand; nevertheless, the Latin poets often adopted the Greek form, and the right hand was usually accounted lucky; hence wine was always passed from left to right, as were also lots. Birds then were lucky or unlucky, according to the circumstances under which they appeared, but a flock of all sorts of birds (Diodorus); an Eagle (frequently in Homer); a Dove or a Swan (also in Homer);—a Kingfisher and a Circus or Harrier (according to Pliny) were, under most circumstances, a happy presage. Equally *un*lucky were the following—Vultures, Hawks, Kites, and Buzzards, and indeed most birds of prey (according to Aristotle and Pliny); Owls (according to Ælian, though Plutarch accounted them lucky); Bats, "the onely bird that suckleth her little ones" (Pliny x. 61), and Swallows. This last may appear surprising, and they must in later times have been accounted more fortunate, but in Darius's Scythian expedition, they are said to have presaged the destruction of his army, and Tzetzes, the commentator on Hesiod, as well as Apuleius (Golden Ass), enumerate the Swallow in their list of inauspicious birds.

But there was another reason why birds were regarded as possessed of a supernatural knowledge of human affairs. As they were continually flying about, they were supposed to "observe and pry into mens' most secret actions, and to be acquainted with all accidents." Thus Peisthetærus in the Birds (l. 601) says, "No one knows of my treasure, except indeed *some bird;*" and Sophocles, in the Œdipus Tyrannus (l. 310), makes Œdipus say to Tiresias the augur, "If you have received any information concerning the death of Laius from the prophetic birds, divulge it." There was also a Greek proverb, to the effect that when they were engaged in any secret action, no one knew what passed, πλήν γε εἴτις ὄρνις (except perhaps some bird). It will at once be recollected that we have to this day an analogous expression, inasmuch as we say, "A little bird told me," when we wish to affect mystery as to the true source of our information. (Compare Andersen's Märchen, "Der Tannenbaum").

Particular birds have, in all ages of the world, been the subjects of special worship, on account of some property or quality which has rendered them fit symbols of divine attributes. Thus the Ibis was worshipped in Egypt, as we learn from many writers, and the reason given by a great number is, that of Herodotus (ii. 75), viz. — that it fed upon winged serpents, which came out of Arabia in the spring. A score of ancient writers, nay two score, might be cited in support of this opinion. Another reason, however, says Maurice, in the Appendix to the "Ruins of Babylon," was founded upon the Egyptian love of geometry, because (according to Plutarch), the space between the legs of the Ibis when parted asunder as it walks, together with its beak, forms a complete equilateral triangle. The white Ibis, or Abou Hannes of Bruce, was pronounced by Cuvier to have been a weak-billed bird, quite unfit for destroying any serpents ; moreover, such winged species as are referred to never had a real existence. Herodotus mentions two kinds of Ibis, the white, and the *black* one which was the species said to feed upon the serpents, but it is remarkable that this black species is never found in an embalmed condition. Some have therefore imagined, that ἶβις originally meant "a crane," which is a truly reptile-eating bird. In modern times, a somewhat analogous respect is paid to birds in many parts of the world. Thus the Storks are respected in Holland and Germany, and accommodation is provided for them on house-tops, of which if they avail themselves they are supposed to bring luck. Marabout Cranes are protected in India ; and in Egypt large bronze vases of food are placed upon the roofs of certain ancient mosques for the use of the birds ; the Pondicherry Vulture is venerated in the East, as the type of Vishnoo ; a Cuckoo, the *Cuculus honoratus* of Linnæus, is so called from the honours it receives ; and various birds are still employed in China to distinguish the different grades of Mandarins, who by law are obliged to have their particular bird embroidered upon their breast.

But the superstitious and uneducated of all ages have been more or less under the dominion of the birds, and the present age is no exception. Bishop Hall, describing the superstitious man says, "If a bittourn fly over his head by night, he makes his will ;" and the importance attached by some to the ominous screech of the owl, is well known. The sight of a crow through a window in the morning is sufficient to deter some from going abroad, even to prosecute important business ; and the words of presage —

"One, sorrow,
Two, mirth,
Three, a wedding,
Four, death,"

are applied to the poor inoffensive Magpie. It is said that Cicero, flying from the emissaries of Antony, was warned by the noise of Ravens, that his end was near, and in the "Popular Antiquities" may be found the following:—"I have likewise a late example of a young gentleman, Mr. Draper, my intimate friend, who about five or six years ago, in the flower of his age, had on a sudden one or two ravens in his chamber, which had been quarrelling on the top of his chimney; these he apprehended as messengers of his death, and so they were, for he died shortly after." Pliny in his account of the Raven (x. 12) says, that their ominousness arose from their harsh note, which sounded not unlike a person in a choaking condition. The same author tells us (x. 32), that the Kingfisher was a bird of good omen, and at breeding-time foretold tranquil and calm weather; and still the fisherman and sailor look upon the Halcyon with a benevolent eye, and regard him as the harbinger of days, whose beauty has become proverbial.

Although the principles of migration are better understood by us than they were by the ancients, we are but little better acquainted with their winter retreats. We have seen how the ancients imagined them to quit our sphere, and to show how fond men are of going back to old and exploded theories, and how much pains a really well-informed person may take to uphold a favourite absurdity, I shall notice a theory, a full account of which may be found in that curious repertory, the Harleian Miscellany (vol. ii. p. 583). The writer of this paper, which bears no name nor date, but must have been penned about the middle of the last century, appears to have been Charles Morton, M.D., Secretary to the Royal Society. It is stated to be the production of an "eminent professor, for the use of his scholars, and now published at the earnest desire of some of them;" so that his theory, wild as it was, found supporters. It is entitled "An Inquiry into the Physical and Literal Sense of that Scripture, Jeremiah viii. 7, 'Yea, the stork in the heaven knoweth her appointed time; and the turtle and the crane and the swallow observe the time of their coming.'" Examining the passage critically, the author calls attention to the expression, the stork *in the heaven*, and remarks that the time of their coming might more properly be rendered *tempus itineris*, the time of their journey. Then reminding the reader, that birds had never been seen upon that journey, he deduces this marvellous result; "Therefore the Stork (and the like may be said of other season-observing birds, till some place more fit can be assigned to them) does go unto, and remain in some one of the celestial bodies; and that must be the moon, which is most likely because nearest, and bearing most relation to this our earth, as appears in the Copernican scheme; yet is the distance great enough to denominate the passage thither an itineration or journey." Truly, one would imagine so; the last inference may be safely granted. It must not be supposed, however, that objections did not present themselves to the mind of the astute professor, but he meets them manfully, and answers them boldly, if not scientifically. And first, the distance. The distance is undoubtedly formidable; it is calculated however, that the extreme velocity of a bird's flight would accomplish it in two months—they would spend three months in the lunar world, two months on the return journey, and the remaining five they could pass with us. Objector remarks that they would surely starve! Why, no—for it must be observed, that "at their departure they are very succulent and sanguine, and so may have their provision laid up for the voyage, in their very bodies ;" besides, he adds, they would probably be *asleep* all the way, " which spares provisions." But they could never fly for two months at a stretch! Well, it does appear an extraordinary flight, but let us meet that objection by supposing that there are, between this and the moon, many " globules or ætherial islands" of which we can take no cognizance. But the moon revolves round the earth every twenty-eight days, the poor birds would never catch it! Dolt! *do* you not perceive that if they set out at full moon, and are two months on the journey, they will arrive also at full moon, when the satellite is just in the same position with regard to the earth as when they started? And so the eminent professor has it all his own way, and his pupils " earnestly desire" that his extravagance may be immortalized.

A theory, little less physically impossible, has found acceptance with dispassionate and scientific observers, and that is, that in winter, some birds, at all events Swallows, retire to the bottoms of lakes and rivers, and pass the dead months in a torpid state under water. Olaus Magnus was one of the earliest, if not the first to adopt this strange theory. He was followed by Etmuller, and afterwards by Derham, who quotes a communication to the Royal Society, in 1713, from a Doctor Colas, " a person very curious in these matters, who saith, that he saw sixteen swallows drawn out of the Lake of Samrodt, and about thirty out of the king's great pond at Roseneilen; and that at Schlebittin, near a house of the Earl of Dohna, he saw two swallows just come out of the water, that could scarce stand, being very wet and weak, and that he hath observed the Swallows to be often weak for some days after their appearance." The Swedish naturalist, Alexander Berger, in the Calendar of Flora, published in the *Amœnitates Academicæ*, speaks of the Swallow retiring under water as a matter of course, and as much to be looked for as any every-day event. On September 17th, he enters "*Hirundo submergitur*," and that wise and good old naturalist, Gilbert White, although he does not say it in so many words, seems half inclined to put in his adherence to "the northern opinion (strange as it is), of their retiring under water." (Letter XII). It has been suggested, that the Upsal naturalist spoke of *leeches (Hirudo)*, and not of *swallows (Hirundo)*, in the entry in question, but this perhaps is scarcely probable. Even the illustrious Cuvier appears to have added the weight of his authority to the notion of submergence—speaking of the Martin he says, "That it bcomes torpid during the winter, and even passes that season under water in the bottom of marshes, appears to be certain."

It had been my purpose summarily to dismiss this part of the subject as not requiring any effort on my part to disprove it, but a correspondent has lately called my attention to the fact, that even in the present year, there are some who believe that it is not only possible, but that they themselves have been eye-witnesses of this long-current phenomenon. A lady, known to my correspondent, and living at Stockton-on-Tees, wrote to the *Darlington and Stockton Times*, declaring, that without any preconceived opinions concerning the submergence theory, she was herself a witness of the fact; and goes on to relate, that she and a person with her, saw a number of Swallows dip under the water, at Middleton, a village on the banks of the Tees, *never rising from under it again*. She watched them most closely for a great length of time, and was certain of the fact. Now here we have a positive observation, made by an educated lady, who however confesses, that she is no adept in natural history

— and nothing can convince her that she was in any way deceived, inasmuch as she not unnaturally prefers the testimony of her own senses to the dictum of closet naturalists.

Now in examining into this statement, the first thing which strikes us is the positiveness of the observation. It is not easy to prove a negative. We may say that the thing is impossible — that no air-breathing animal *could* exist beneath an element so unfitted for its respiration as water — we may strengthen this argument, by calling to mind the active respiration of the class of Birds, and their very exalted animal heat — we may dwell upon the necessary suddenness of the change from air to water — we may argue, that no animals known to hybernate, are believed to submerge themselves — and we may clench the matter, by appealing to John Hunter's assertion, that independent of any observation, the submergence of birds in a living state was not possible; still, if any properly authenticated case, which when examined, proves to be out of the reach of fallacy, should occur, then must theory fall before it like ice before the sun. Let us therefore briefly examine the circumstantial account given by a credible witness, and corroborated by another. Is it possible that it can be without foundation? Imperfect observation, arising from a want of special information upon the subject observed, has perpetuated many an error, and retarded many a truth. Let us only recall the circumstantial account given us by good old Gerarde, who gravely tells us "What our eyes have seen, and what our hands have touched, we shall declare;" and then proceeds, in all good faith, to describe how Bernicle Geese grew upon trees, and fell thence into the water. Bearing in mind then, that the fair disputant disclaims any special knowledge of Natural History, let us hear her further. She goes on to say, triumphantly, "I can give you the exact day indeed—it was the *6th September*." Now here she has proved *too much* in her anxiety to support the credit of her statement. In the Swedish calendar of Alexander Berger, kept at Upsal, in lat. 60°, it is not pretended that the Swallow goes under water until September 17th. Why should *our* Swallows take to their water-bed eleven days sooner than their brethren do, six and a-half degrees further north? Indeed, it is well known to ornithologists, that the Swallow does not leave us until the beginning of October. Jenyns, from twelve years' observation, deduces a mean of October 14th—the *earliest* date being September 28th.

Let me then offer an explanation of this and other stories of the kind which are prevalent among certain classes in this country, and which are widely spread and deeply-rooted among the common people of Sweden; notwithstanding, that the University of Upsal has long offered large rewards to the discoverers of submerged birds, in vain. That Swallows dip in the water in their rapid flight is certain, and it is said, on the authority of Mr. Couch, though I cannot personally vouch for its truth, that they are capable of resting, for a few seconds, with outstretched wings, upon the still surface of the water, and then flying off again. Let us suppose now that it is late on an autumnal afternoon—the shades of evening are gathering round, and the active birds are skimming the surface of a quiet pool, crossing and recrossing, interweaving and intertwining in the mazes of their rapid flight. Under the most favourable circumstances, it is difficult to trace the course of any particular bird; but if dusk imperceptibly steals over such a scene, how easy would it be for an observer to imagine, that the birds, when they dipped or rested upon the water, really submerged themselves;—it would be next to impossible to recognise these birds upon resuming their flight;— while, as they retired by degrees to their roosting places for the night, the gradual diminution of their numbers would most readily confirm the impression, that those birds which were really only momentarily lost to view, had sunk beneath the protective bosom of the still, deceitful pool.

The simple hiding and hybernation of birds being a doctrine less extravagant, and more in analogy with recognised phenomena, has obtained wider credence. It is as old at least as the days of Aristotle, who tells us, that "many birds, and not a few as some imagine, hide themselves in holes," and he enumerates the Swallow, Kite, Thrush, Starling, Owl, Crane, Turtle, Blackbird, and Lark, as undoubtedly hiding themselves thus. Pliny also infers (x. 10) that Kites lie concealed in holes for some months. This doctrine of the hybernation of birds has received strong support from more modern naturalists. Schæffer, Hevelius, Derham, Ellis, Daines Barrington, Pennant, Gilbert White, and the Swedish naturalists, Klein and Kalm, were all more or less in favour of their hiding rather than migrating; and the great Linnæus himself lent them his countenance. It became, in the last century, a common mode of expression among those who were accustomed to derive their ideas from contemporary authorities; thus Sturm in his Reflections for April 28, says, "The mild air of spring awakens the Swallow from his benumbed state." But although numerous stories are recorded of torpid birds being turned up from their winter retreats, it is to be remarked, that they are always, or nearly always, upon hearsay, and doubtless have lost nothing in the transmission from one person to another. There is scarce an instance of a person describing such a circumstance from his own observation. "No man" says Gilbert White, a supporter of the theory, "no man pretends to have found any of them in a torpid state in the winter." (Letter XII). White himself dug out the nests of Sand-Martins from the holes in a bank, and satisfied himself that they were entirely deserted. Swallows are reported to have been found between roofs in the winter, which revived upon being brought to the fire. But such stories require the confirmation which we anticipate they will never receive, before they can be recognised as scientific truths. That it happens frequently that a bird has been seen long after his companions have quitted their summer residence, there can be no doubt — such a circumstance, indeed, is one of those exceptional cases which prove the rule. Some defect of flight may have prevented it from accompanying its congeners, and we may safely conclude, that such a bird, if it remained, would not be able to exist through the winter. Late broods of Swallows are not unfrequently left behind, if the impulse of migration come upon the parents before the young are ready to fly with them. In these cases, they are pitilessly deserted, and necessarily and rapidly perish, and their putrid carcases, or mouldering skeletons may be sometimes found on searching the nests in late autumn; but torpid and living birds, never.

Aristotle was much puzzled with the phenomena of migration, and besides accounting for the absence of some birds, by supposing that they hid themselves in holes, he imagined that others changed in their form and appearance at different seasons of the year. Thus he supposed the Redstart changed into the Redbreast, and the Blackcap into the Beccafico. But the fact was, that these birds appearing at alternate seasons, the one became visible just as the other took his departure, and hence arose the error. The country-folk of our own day have a similar notion, and we have been soberly informed, that in winter the Cuckoo changes into a Hawk, a popular error arising from the strong similarity existing between the Cuckoo and the female Sparrow-Hawk, which is really remarkable. Aristotle took pains to refute this very error.

The Stagyrite was not unacquainted however with the true causes of the phenomena of migration, and he knew that some birds, when they quitted him, visited warmer climates. Thus (Hist. An. l. viii. c. 12), he says, "Both the Swallow and the Turtle leave us to spend the winter in other climes." Even so far back as the days of Homer, indeed, some isolated facts were known, though no generalization was arrived at. Herodotus is the only ancient writer who gives us definite information on the subject; and in his invaluable second book, he tells us that Swallows and Kites continued all the year round about the springs of the Nile. Ælian also says, they remain in the northern latitude but six months. And it is surprising how few new facts have come to light in the twenty-three centuries which have elapsed between the time of Herodotus and the present. Up to about a century ago, we have seen that the majority of naturalists doubted the fact of Swallows quitting the country at all; and it was not until M. Adanson announced in his "Voyage to Senegal," that he had seen European Swallows in that locality in winter, that the matter was considered as demonstrated. He says, that late in 1749, European Swallows lodged on the vessel in which he travelled from Goree to Senegal, and that they are never seen there except at that time of the year, along with Quails, Wagtails, Kites, and some other birds of passage; and further, that they do not build their nests there. But this observation of Adanson's is open to many objections, and even in the last century, there were not wanting ornithological writers who attempted to prove that no reliance could be placed upon a general and vague remark made by a person, who however great might be his scientific acquirements in other respects, was himself no ornithologist. Gilbert White mentions his observation only to cast doubt upon it; and Daines Barrington wrote an elaborate paper in the 62nd vol. of the Philosophical Transactions, in which he proves pretty satisfactorily that M. Adanson had no specific knowledge of birds in general, nor of Swallows in particular, and that he probably mistook an African species for British Swallows. Although however it is highly probable, that the remark of Adanson is not entitled to the weight usually attributed to it, it does not militate against the fact that Swallows *do* migrate, and we must of course dissent from the conclusions which Barrington arrives at in the ingenious essay referred to, namely, that the Swallow tribe do not quit us, but remain in a torpid condition during the winter, in the immediate vicinity of those localities which they frequent in summer.*

There are a few references scattered through ancient writings, relating to the exact time of appearance or disappearance of some birds; and first, with regard to Swallows. These birds have in nearly all ages excited attention, and numerous are the allusions to them in ancient writings, from the φίλη χελιδὼν of Anacreon downwards. A mere list of them would be too long for this place, and it would be more easy to give a list of the writers who have omitted to mention these favourite birds. Herodotus is almost the only author who mentions Swallows as seen anywhere in winter, and he speaks positively of both Kites and Swallows wintering about the springs of the Nile; though of course we cannot be certain that these were our Swallows. It is remarkable that Anacreon, writing a hundred years earlier, suggests the same thing (Ode 32) —

* I would refer the reader for what I conceive to be the true principle of Migration, to an abstract of a paper upon that subject which I read before the British Association at Leeds, in 1858, which will be found in the Volume of Reports, and in the Athenæum, October 30, 1858. — C. C.

Χειμῶνι δ' εἷς ἄφαντος,
Ἢ Νεῖλον, ἢ 'πὶ Μέμφιν.

According to Ptolemy, Swallows returned to Egypt (the Delta) about the latter end of January. Theophrastus (B.C. 320) in his Treatise on the Winds tells us, that between February 28 and March 12, the Ornithian winds blew and the Swallow re-appeared at Athens. These winds were called Ornithian, from their blowing at that time when the migratory birds began to make their appearance, and were (no doubt correctly) believed to assist them in their passage. They were also called Chelidonian winds, having special reference to the coming of the well-known Swallow We thus trace these birds from their winter residence as far as Athens ; and their passage to England and the more remote northern localities which they visit in summer, may no doubt be pretty correctly filled up by modern observations. Thus we find that they arrive at Rome March 3rd, at Bruges April 5th, and in England about April 15th, while the Swedish calendar of Alex. Berger, in the Amœnit. Academ. informs us that they are seen at Upsal, on 9th May; and they are even said to visit the southern parts of Siberia. Their arrival was, in ancient times, welcomed as the harbinger of spring: —

"jam veris prænuncia venit hirundo
Tum blandi soles. — Ovid.

and although we may in the present day eagerly look for the first Swallow as a ratification of the opening season, there is no doubt that our enthusiasm was exceeded by the ancients. They greeted him with a song; and the Swallow-song or χελιδόνισμα which the Rhodian boys sang, going about in troops from door to door, with a captive bird in their hand, has been preserved by Athenæus (viii. 60). It begins

Ηνθ' 'ῆνθε χελιδὼν —

"The swallow is come!
The swallow is come!
O fair are the seasons, and light
Are the days that she brings
With her dusky wings,
And her bosom snowy white."

The whole song contains nineteen lines in the original.

But although the ancients regarded the Swallow as the harbinger of spring, they well knew that it was *only* a harbinger. The fact that a Swallow or two will make its appearance prematurely, and be forced to withdraw for a time from the inclement season into which it had ventured, was doubtless observed by them; and perhaps no proverb is more universal, or more ancient, than that homely one, that "one Swallow does not make a summer." It was known, and moreover in precisely the same words (spring being substituted for summer), to the Greeks and Romans, and is used by Aristotle and Horace; and doubtless Aristophanes referred to it, or the observation which gave rise to it, when Peisthetærus says (in the Birds l. 1415). "He seems to me to sing a song for his own coat, which is so threadbare, that he has need of not a few Swallows" (*i.e.* to keep him warm). Besides the English—the French, Germans, Dutch, Swedes, Spanish, Italians, and other nations, use the proverb in precisely the same terms.

The Cuckoo was another bird much observed and well known. The Greeks called it the "Turtle-Leader," from its arriving shortly before the Turtle-Dove, just as our own countryfolk at this day call the Wryneck the "Cuckoo's Mate." The note of the Cuckoo, according to Aristophanes (Birds, l. 505), was the signal to the Phœnicians to reap; but Hesiod tells us (Works and Days, 484), that the Cuckoo came to Greece just as the husbandman had finished ploughing. Hence, perhaps, Horace (Sat. I. vii., 30) makes a passer-by call "cuckoo" to a lazy vinedresser. According to Aristotle, who had noticed the failure of its vocal powers (Hist. Anim. ix. 49), the Cuckoo disappeared at the rising of the dog-star ("canem illum, invisum agricolis sidus," as Horace calls it in the Satire referred to), that is, towards the end of July; and this is confirmed by Theophrastus, who tells us that the Cuckoo disappeared at Athens, July 30th. The parasitic habit of the bird was well known to Aristotle, who says (lib. ix. c. 29), "that the Cuckoo does not build a nest itself, but most commonly makes use of that of the Wood-Pigeon, Hedge-Sparrow, and Lark, which are built on the ground, as well as the Greenfinch, whose nests are in trees." Considering when this extraordinary man lived (he was a pupil of Plato, and preceptor to Alexander the Great), it is really astonishing how much of truth there is in his remarks; for except that the Wood-Pigeon (if our British species be meant) does not build on the ground, nor do we usually find Cuckoo's eggs in its nest, the statement is quite correct. Moreover, the great naturalist was aware that some species of Cuckoo built a nest for itself. The parasitic habit of *our* Cuckoo is incontestable, and the Hedge-Sparrow is most commonly the dupe, although Daines Barrington, an accomplished naturalist of the last century, has been at some pains to prove that Aristotle was altogether wrong. His paper upon this subject will be found in the 62nd vol. of the Phil. Trans.

Between March 11th and 26th, says Theophrastus, the Kite and Nightingale appear. Kites and Swallows are usually mentioned as arriving together, as by Herodotus above; and the same circumstance is remarked in the Calendars of Geminus (B. C. 57. Phenomena), and Ptolemy. Homer (Odyssey xix. 519) connects the Nightingale's voice with returning spring — ἔαρος ἱσταμένοιο. Quails arrived at Athens, August 19th, according to Theophrastus; and Cranes Sept. 20, indicating, says Hesiod, the season of ploughing and the time of rain. This same season, Virgil informs us (Georgic I.) was denoted at Rome by the raven —

"Tum cornix plenâ pluviam vocat improba voce."

It is not surprising that the ancients were well acquainted with the remarkable habit some birds have of performing their periodical flight, ranged in a more or less regular figure. Cicero alludes to it (de Nat. Deor. ii. 49). Such a singular appearance as is presented by a number of large birds, impelled as it were by a single will, floating away in an unbroken figure, through the higher regions of the atmosphere to their mysterious destination, is striking in the extreme, and sets the spectator musing upon the wondrous instinct which guides them, and the marvellous regularity of the uninterrupted lines which they then assume, and which fade away in the distant horizon, till they appear like a spider's thread, never losing their wonderful symmetry and distinctness of outline, till the failing eyesight can follow their track no longer. What the object of this symmetrical arrangement really is, it is difficult to say. Buffon imagined, that the strongest naturally keeps in front, and the others are necessarily obliged to follow behind, but this would by no means account for the perfect regularity of their flight. The probability is, that Cicero's explanation, in the passage referred to, is the correct one, and that when flying in large bodies, they assume the V form, from an instinctive knowledge that it offers less resistance to their rapid flight; and one, possibly a strong-pinioned bird, is selected by them as their leader, though it is probable, that in turn, he gives place to others during their progress.

Certain customs relating to birds, and commonly regarded as modern, are nevertheless of very ancient date.

Thus the habit gamekeepers have of nailing up their spoil against a barn-door, must have been remarked by every one. Not only are vermin, such as weasels, stoats, and polecats, thus impaled, but a stray Crow, or an unhappy Magpie, or even nobler birds, if they have roused the guardian's jealousy for the safety of his game, swell the number of his trophies. Such a collection was aptly called by Gilbert White, "the countryman's museum." This method of disposing of such evil creatures is perhaps a remnant of that custom which Apuleius mentions; (Metamorph, lib. 3.) "Why do we not see that these birds of night, when they have got into any house, are eagerly seized and nailed to the doors, in order that they may atone, by their torments, for the evil destiny which they portend to the family by their inauspicious flight?"

The common and popular schoolboy's joke, of sending a new comer for *Pigeon's milk*, might possibly be considered as essentially English, did we not know that the expression "bird's milk" (᾽ορνίθων γάλα) was of great antiquity. It was used, anciently, to imply some extraordinary good fortune, or some marvellous and unheard-of dainty, and is found several times in Aristophanes, as in the Wasps (508, &c.) The same thing was also implied by the term "ass's wool" (ὄνου πόκαι), which expression is used by Charon, in the Frogs (186). The connection in which "bird's milk" is used by Aristophanes, may be best judged of from a passage in the Birds, which also shows the esteem in which the feathered race was held—

All gifts we bring to you —
Wealth and peace, and flowing treasure;
Health, and joy, and youth, and pleasure;
Love and laughter, smiles and silk;
Song, feast, dance, and *pigeon's milk*.
Aves: Act i. sc. 6 (Cary's trans.)

[From the Proceedings of the Liverpool Literary and Philosophical Society. Read April 15th, 1861.]

CONTRIBUTIONS TO BRITISH ORNITHOLOGY;— THE NOTES OF BIRDS.

By CUTHBERT COLLINGWOOD, M.A., F.L.S., &c.

The subject of the present paper, if it possess no other merit, is, at least, appropriate to the season, since our woods already resound with the songs of our indigenous birds, while the first instalment of the more musical band of foreign visitors has already appeared among us.

I hardly think, however, that the subject needs any defence, inasmuch as it is one of considerable interest to the general naturalist, and, to the ornithologist, *essential.* It is, moreover, a subject which, in my opinion, is singularly neglected. True, that in most ornithological works, a few pages are devoted to the notes of birds; but, as far as my experience goes, the cursory remarks found in these works are of a very general nature, and, in most cases, mere repetitions, copied from one author into another. In scarcely any work that I am acquainted with, is the subject fully entered into as a matter of personal knowledge, and when descriptions *are* given of the notes of particular birds, they are most frequently of so diffuse and general a character as to have but little practical value.* Doubtless, there are many who have a profound acquaintance with the voices of birds, even approaching that of the Grand Vizier, in the *Spectator*, who, indeed, is not so fabulous a personage as at first sight he would appear to be; but these persons do not give the benefit of their experience for the guidance of others, and the subject is so purely one of experience, that it is only those who *can* give useful information upon it.

The language of birds is, then, only to be learned in the woods and fields—only to be taught by Nature herself; at the same time, however, the hints of experience should not be neglected, for although it is useless to remain *satisfied* with these, and suppose *them* sufficient in themselves for a knowledge of the subject, still they may greatly assist the student of ornithology in his endeavours to identify the various birds by their multifarious notes; and let no one think that such a study is altogether useless. I have before said, that for the ornithologist, properly so called—not the ornithologist who is content with books and plates, however elegant, but for him who goes out into the native haunts of birds, and enquires for knowledge at the fountain-head—for such an one, a knowledge of bird-language is indispensable, and of constant application. It is a *specific* character which thrusts itself upon the attention, and appeals to the ear resistlessly. By means of it, in our own country, the arrival of foreign visitants and of migratory birds is readily noted, and a clue is obtained to

* There is much interesting information in Barrington's well-known article (Phil. Trans., 1773); also in Bolton's "Harmonia ruralis;" Gardiner's "Music of Nature," &c., but these are of old date, and Kircher's quaint remarks in "Musurgia" are more curious than practical. There are many interesting notices scattered through Loudon's Magazine of Natural History; and the general reader will find much information in the "Domestic Habits of Birds" (Library of Entertaining Knowledge); and also in an article on the songs of birds by the late P. B. Duncan, in the "Literary Conglomerate."

the habits and existing conditions of indigenous birds; while in foreign countries, a careful attention to the voices of birds not only would greatly facilitate the discovery of new species, but the detection of European birds, or, indeed, the negative knowledge—the absolute certainty that such a bird is not the European species—would assist greatly in elucidating the phenomena of migration.

I have called it language, for such indeed it is, which, like its analogue, human speech, has undergone a Babel-like confusion; nevertheless, each species comprehends the notes uttered by its own, but these notes do not influence another species. Indeed, the analogy may be carried even further. The human voice utters certain sounds which, by a national freemasonry, are understood by all alike, however different their tongue—so with birds, there are certain sounds which are understood by all birds in common—the sounds, that is, which indicate the near approach of common danger. Besides all this, it must ever be borne in mind that birds are, next to man, most gifted with the power of expressing by sounds the feelings and impulses which arise under the various conditions and circumstances in which they are successively placed. Although, however, I purpose, in the present paper, to address myself more particularly to the warble, or love-song, of birds, it must not be imagined that they have no other vocal gifts. The male, the female, and the young, all have their peculiar notes, a knowledge of which may be of service, as it cannot fail to be of interest, to the ornithologist. The male has his defiant note, or battle-cry—his loud outcry when danger approaches—the call he possesses in common with the female, by means of which they are constantly informed of each other's whereabouts—the soft note which he employs when feeding the sitting hen, as well as the more or less brilliant serenade with which he, perhaps, banishes her *ennui;* the female has her complacent chuckle, when surrounded by her little brood—the notes of invitation when food is forthcoming —of alarm on the approach of danger; while the young have their infantine squeal,—their strengthening notes before being fully fledged,—and their gradually perfecting recording notes thereafter. All these are distinct from one another, as well as different in each species of bird. All these notes, therefore, if known, give certain indications to the listener—all assist in the investigation of habits; and a person armed with such knowledge is in a position to study their habits immensely superior to that of one who is ignorant of them. The value of such knowledge may be better inferred from the fact mentioned by a writer in the Quarterly Review (vol. xviii., 1817), who states, on personal authority, that one individual, who had passed much of his time, in boyhood, alone, in lonely situations, had, by close attention, acquired such a knowledge of this language, that from the song of the parents, he knew where the nests were situated, whether they contained eggs, or whether the brood was hatched, knowing even the number of young birds, and their eggs before he saw them. Incredible as this may appear, we can readily imagine its possibility.

I need not dwell longer upon the uses of this kind of knowledge which I have sufficiently indicated. As for its *pleasures*, no one but those who have tried them can by any means appreciate them; not only that the voices of birds give a general delight which the educated and uneducated can alike appreciate, but I will venture to say, without fear of contradiction, that a knowledge of the meaning of each note as it strikes upon the ear—the power of identifying each song with the particular species that utters it, affords a delight and recreation—keeps the mind constantly employed—and relieves the tedium of many an otherwise dreary, solitary walk, substituting for *ennui* and weariness, a pleasure only known to the true ornithologist.

But the subject is so extensive, that I shall in vain endeavour to compress its principal salient points into the compass of a single paper; and must pass over some of them rather hastily.

For this reason, I shall not dwell long upon the anatomy of the organs of voice, which may be found described in many places. The trachea and its appendages are the organs which produce these various sounds; but the trachea differs from that of man by possessing a double larynx, and two rimæ glottidis, the upper of which is at the upper end of the trachea, and is not furnished with an epiglottis. The lower or bronchial larynx is situated at the bifurcation of the trachea, and contains also a *rima glottidis*, formed by tense membranes, which may be compared in many cases (particularly among aquatic birds) to the *reed* at the mouth of musical instruments. These membranes, susceptible of various tensions and vibrations, constitute a true glottis, provided with everything necessary to produce sound. This is an abstract of the results arrived at by the dissections of Blumenbach, and by Cuvier, detailed in the *Journal de Physique* (I. 142); and his experiments prove that the voices of birds are produced in fact by this *lower* glottis at the base of the trachea; while the upper glottis contracts and widens for the modification of the sounds, and the muscles, along the trachea, from time to time, vary the length of that instrument, producing the same effect as long or short organ pipes. The trachea thus becomes an instrument to conduct *sound*, instead of a mere tube to conduct *air* from and to the lungs. Cuvier further adds that he found this organ absent in *one bird only* of those he dissected, viz., the King of the Vultures (Vultur papa). The organs of voice of birds, therefore, most resemble French horns in their general structure.

Some doubt appears to rest upon the real object of the long circumvoluted trachea in certain Natatores, but I imagine that this singularly developed organ has other uses than for singing or screaming. In singing birds, generally, it is short, and lengthens with age. But I think old Kircher was probably right in connecting these circuitous tracheæ and their osseous chambers or ampullæ, so common in the Anatidæ, with their aquatic habits, supposing them to be reservoirs of air for the use of the bird when feeding under water.

The question now comes—since every bird, as I have already said, possesses some kind of voice, and more or less notes, but all kinds do not sing—What, then, is *singing*, and how defined? The most original writer upon the singing of birds is certainly the Hon. Daines Barrington, the well-known correspondent of Gilbert White, an accomplished naturalist, to whom I shall have again to refer. His experiments, which are the groundwork of all the subsequent remarks on this subject, are detailed in a paper *On the singing of birds*, read before the Royal Society, and published in the sixty-third vol. of Phil. Trans. There are many curious observations in this paper well worthy attention, though there is much besides which must be referred to the eccentricity of its author. In this paper, he defines song to be, "A succession of three or more different notes, which are continued without interruption, during the same interval with a musical bar of four crochets in an adagio movement, or whilst a pendulum swings four seconds." With the former part of this definition, I perfectly agree. I certainly do not consider a bird in the light of a *song-bird* unless he has at least three distinct notes. Less than these would be a mere *call;* and even three notes sometimes appear to be uttered by some birds which have no claim to the title of singing-birds; but such birds constantly *repeat* their limited notes with an execution anything but musical, as, for instance, the domestic cock; while the tits, for example, have but two or three notes, which, however, they vary infinitely, and give with great sprightliness and effect. But I think Barrington errs in favour of a prejudice which I shall speak of later, when he says that a true song must last at least four seconds; for that would exclude such birds as the hedge-sparrow and chaffinch, whose songs I have frequently timed, and found them barely to extend through the stated period, although a great number of notes are uttered, and those, too, given with considerable execution. I am not aware of Barrington's reason for assigning four seconds as the smallest limit; but I fancy it is because of his musical ideas of the notes of birds, as though they should sing in *common time*. But I know no other reason, beyond an arbitrary one, why three seconds should not be the limit, or even less. For a bird will crowd a great many notes into a very brief space, as my own observation has shewn me. Thus, I have counted twenty notes in the song of a hedge-sparrow which did not exceed two seconds in duration, though the ordinary length of its song is nearer four seconds. But the gold-crest and creeper, which generally utter twelve to fifteen notes, scarcely ever come up to the limit of three seconds.

All birds have some *language*, emphatically speaking, by means of which they may communicate with one another of the same species; and there are even some notes which every species appears to understand in common—an universal language, comprehensible by all. The amatory warble, or song, however, is confined to comparatively few; but of all the various notes of birds, *that*, perhaps, is the least like language; for, if a bird utters his song at all, it is performed with more or less of liveliness and cheerfulness; whatever may be the external circumstances, it appears to indicate happiness; but those birds which possess far inferior powers of voice can, nevertheless, modulate it, and give it character and meaning to a truly wonderful extent. The single *caw* of a rook can be varied infinitely, so as to express every possible emotion; and a person who listens for the first time, will be astonished at the variety which he will discover in the meaning of a single note. This gift, which may thus be compared to *speech*, is universal among birds, whereas, song is the attribute of only a small portion of the feathered creation, and these are all included within the single order of Insessores, which, however, includes a vast assembly of birds. An exceptional instance certainly occurs in the case of a Raptorial bird, viz., the Falco musicus (Daudin) or Fauçon chanteur; but these Raptorial birds are in general by no means melodious. The eagles and falcons utter a shrill or wailing scream—the vultures are capable of nothing beyond a "gruff caw," and the owls give forth a melancholy hoot or shriek which may well scare a benighted traveller.

The Scansorial birds, in general, utter the most hideous shrieks, and the shrillest and most discordant noises, though, at the same time, among these are found those birds which, owing to their docility, and peculiar structure of tongue, &c., are most capable of uttering articulate sounds. The Gallinaceous birds have generally the most powerful voice, though unmelodious and unmusical in the extreme, as the peacock and Guinea fowl. The Waders can do nought but scream discordantly, though in this accomplishment they are certainly outdone by the Natatory, or swimming birds.

But, with the single exception before referred to, all singing-birds, properly so-called, are to be found in the ranks of the Insessorial, or perching birds; and among *these*, but a very small minority are so gifted. Indeed, with one or two exceptions, only five families out of twenty-five, into which the Insessores have been divided, are singing birds. These families are the following—Of the tribe Dentirostres, the Merulidæ (thrushes), Sylviadæ (warblers), and such Ampelidæ (chatterers) as compose the genera Vireo and Pachycephala. The other two families belong to the tribe Conirostres, and are the Fringillidæ (finches), and Sturnidæ (starlings). Striking exceptions occur in the case of the swallow, a Fissirostral, and the wren, a Scansorial, with which last also the creeper (Certhia) claims to be associated.

Perhaps there is no question relating to birds which has been more frequently debated than the *reason* of their song. It has long been a generally received opinion, for which De Buffon is quoted as an authority, that the song of birds is wholly and solely intended as a solace to the female during the tedious period of incubation. This, it has been urged, is the only object of their melody, as the poet of Nature, generally truer to Nature than to prejudice, expresses it (Spring, 614)—

> " 'Tis *love* creates their melody, and all
> This waste of music is the voice of love."

Now, it is certain that the time when birds, in their natural state, are in most perfect song, is just that period when the business of pairing, and nidification, and incubation, is going on; but although birds sing strongest then, it must be clear that that is not the only time when their voices are heard. After the brood is hatched it is true that most birds cease singing, for they have more serious business to attend to, viz., the feeding of young ravenous creatures, which require a fresh supply every two or three minutes, or even oftener, during the entire day. As the parent bird usually can only carry sufficient for one young one at a time, and there are generally four or five of them, the male and female are equally busy in the search for grubs or seeds, and no time is left for the cock to sit upon a spray and warble his ditty. But in the autumn, when all nidification and incubation is concluded, the song reappears in many indigenous birds, and even in several visitors. Of those that remain, some have already winged their way south, doubtless to expend their music upon some boundless and uninhabited solitude. Again, if song is such a consolation and solace to the sitting hen, why is it confined to so small a minority of the feathered tribes? Why should so many be deprived of that solace? These questions must be answered by the upholders of such a theory. Caged birds, when abundantly fed, and kept warm and clean, sing all the year round—except during the autumnal moult—become, in fact, perennial, instead of annual songsters; and Swainson says that "in more genial climates, and especially between the tropics, the forests resound all the year round with the notes of birds, both before and after incubation;" * and, indeed, we see a similar phenomenon occur even in this northern latitude; not only do many birds resume their songs in autumn, but some, for instance, the robin and the wren, sing the whole year, with the exception of the moulting season, even during frost and snow. Thus, in 1854, I missed the red-breast's voice only three weeks in the whole twelve months. I have heard him in frost and snow, again and again; and on one of the most arctic days we have experienced in this climate (occurring in January), I have heard the wren and the bunting singing merrily. Now, as nidification only takes place in spring and summer—this autumnal recommencement, and this winter display of song, shew pretty clearly that it is not dependent *only* on amorous feelings; nor is it intended *only* as an address to the female. What, then, is the object of song? It may be a complex one, and this question, perhaps, will best be answered by a relation of the conditions under which birds sing. These are truly numerous and diverse. Col. Montagu, indeed, asserts that whenever, and at whatever time of the year birds sing, their testes will be found enlarged; but to prove this satisfactorily, would, I imagine, require larger data than is likely to have fallen to the lot of that accurate observer.

One of the chief conditions under which birds sing, next

* I am informed, however, by Mr. Charles Waterton that, in the South American forests, there are periodical intervals of silence, corresponding with the rainy season.

to those we have just referred to, is *a spirit of rivalry*. Thus, Barrington, in his paper on the singing of birds, says that the bird-catchers lay considerable wagers whose call-bird will jerk the longest, as that determines the superiority. "They place them opposite to each other by an inch of candle, and the bird who jerks the oftenest before the candle is burnt out wins the wager. We have known a linnet, on such a trial, persevere in its emulation till it swooned from its perch." Mr. Sweet, in his "British Warblers," gives instances of birds falling dead from their perch when trying to outrival some other bird confined with it in the aviary.

Another condition under which birds sing is in the excitement of an unusual noise. Thus, a caged bird will sing when a noise is made, whether harmonious or discordant; and I have heard a nightingale sing continuously in a bush within half-a-dozen yards of the Great Western Railway, while a long and heavy goods train has been thundering past at dead of night.

Some birds sing immediately that they are disturbed. Instead of being frightened and silent, a sudden disturbance will set them singing. This is especially the case with the nightingale, and the sedge-warbler, both nocturnal birds; and many a time I have discovered the presence of the latter, when silent, by throwing a stone into the willow-patch where I supposed him to be concealed, and he has forthwith commenced his lively song.

No external circumstance of weather will prevent a bird from indulging in song. The most miserable degree of cold or wet, or both, only seems to animate him. Thus, I have frequently remarked in early morning, when the singing of the birds has induced me to expect bright weather, on looking forth, the utter wretchedness and cheerlessness of the scene has disappointed and surprised me. Indeed, some birds seem to rejoice in these sorts of miseries. The missel-thrush is well known under the name of *storm cock*, from his habit of singing loudest when the wind and storm are highest; and I have remarked the wild warble of the blackbird to be exultant all through a sharp storm of thunder and lightning.

Again, birds have been known to sing under circumstances which, according to our pre-conceived notions would be discouraging in the extreme, and little incentive to any expression of love or joy. Birds which have been taken by the bird-catchers often sing the instant they are trapped. Barrington says a nightingale was brought to him which had only been a few hours in the cage, when it burst out into a roar of song; and even more striking instances have been related.

Amongst birds which have no song, properly so-called, some use their notes in a peculiar and characteristic manner. Thus, pheasants always crow when they go to roost, as though to give a premium for poaching. Swifts are very clamourous just before they retire for the night; and the same thing must have been observed by every one in relation to sparrows and rooks. The loud cries, too, of birds, especially aquatic birds, which travel overland during the darkness of the night, are evidently uttered for the purpose of keeping together the members of the travelling party; while, in like manner, birds which have paired, or which have a brood capable of joining them in their flight from bush to bush, constantly utter a complacent chirp, which serves as a notice of their proximity, and keeps the whole party together.

A very interesting question in connexion with the singing of birds is, whether their song is innate or acquired. A great deal has been written upon this subject, and the Hon. Daines Barrington made several patient experiments in order to satisfy himself upon it; the result of his observations being to convince himself that "notes in birds are no more innate than language is in man;" but, without entering into a critical examination of all his data, I must confess that I see cogent reasons for dissenting from his conclusions. Regarding, as I do, the song as a specific character of a bird, and variable, like other specific characters, within definite limits, it appears to me to be contrary both to analogy and experience to imagine that it depends upon any accidental circumstance whether a bird shall have the song of its own species, or that of some other which it may happen to have heard. If the notes of birds were simply *acquired*—if *teaching* were necessary—it could hardly be otherwise than that some birds, deprived of their parents at an early period of their existence, should grow up either with no notes at all, or with the notes of some other species which happened to be in nearest proximity. But are there any instances on record of birds in the wild state using notes other than those of their own species? I know of not a single one; nor, indeed, does Barrington pretend that he ever met with, or heard of, such an instance. It is true that, in confinement, birds may be taught to pipe the notes of another species; but this only proves that they possess powers of imitation, which, added to a docility of disposition, render them easy of education. The song of a canary which has been educated under a titlark, for instance, is, in this point of view, strictly analagous to the pipe of a bulfinch which has been taught to whistle "God save the Queen." Both are examples of education only.

It may even be conceded that some birds in their natural condition, possess imitative faculties which render them capable of mocking other birds; but such birds either do not confine their mimicry to the notes of one species (as the American mocking bird) or they only give here and there a snatch from the song of another bird, mingling it up with the unmistakeable notes of their own species. Such birds (which White designates *polyglots*) may be indeed innocent of even that amount of imitation, and probably are so, the resemblance to certain strains of other birds being perfectly natural. But the constancy of all birds in a state of nature to the pipe of their own species—a constancy which no observed fact has ever been brought forward to shake—is, to my mind, irrefragible proof that those notes are, if not absolutely innate, at all events so strongly impressed on the bird's nature, that, under ordinary and normal conditions, it would attempt no others. All the instances of birds singing other notes than those of their own species are related of *caged* birds, and Barrington admits that, under these circumstances, it is "very uncertain what notes the nestlings will most attend to, and *often their song is a mixture.*" In a natural state, on the contrary, it is very *certain* what notes a bird will sing; as Barrington expresses it in the next paragraph, "in a wild state, they adhere steadily to the same song, insomuch that it is well known, before the bird is heard, what notes you are to expect from him." *

Having thus touched upon the questions, how, when, and what birds sing, I will now dismiss these general considerations, and in what follows, shall devote more particular attention to our British birds of song. It is generally admitted by those who have paid attention to ornithology, and who have heard the vocal exhibition of foreign countries, that we have, in our own island, a chorus of song-birds second to none. The plumage of our songsters is in general nothing to boast of, but the sweetness and variety of their tones carry off the palm. Indeed, song and plumage, as a general rule, are inversely proportioned to one another, and the gayest birds have often the vilest voices. According to the restricted definition of song given above, we may reckon as many as thirty-six singing birds, of which twenty-three are indigenous,

* Barrington also admits elsewhere, "that the bird called a *Twite* by the bird-catchers commonly flies with the Linnets, yet those two species of birds never learn each other's notes, which always continue totally different."

and thirteen, summer visitors.* The notes of these are each characteristic, and although space will not allow me to describe them individually, I shall, by arranging them in a tabular form, endeavour to convey some idea of their affinities and mutual relations.

Barrington has given in a note, a table which professed to shew the comparative merit of our song birds; the idea of which, he tells us, he borrowed from Mons. de Piles, in his "Cours de Peinture." This table, although well-known, I shall, for the sake of illustration and comparison, introduce in this place:—

DAINES BARRINGTON'S TABLE OF THE COMPARATIVE MERIT OF BRITISH SINGING BIRDS.

20, the Point of Absolute Perfection.	Mellowness of Tone.	Sprightly Notes.	Plaintive Notes.	Compass.	Execution.
Nightingale	19	14	19	19	19
Skylark	4	19	4	18	18
Woodlark	18	4	17	12	8
Titlark	12	12	12	12	12
Linnet	12	16	12	16	18
Goldfinch	4	19	4	12	12
Chaffinch	4	12	4	8	8
Greenfinch	4	4	4	4	6
Hedgesparrow	6	0	6	4	4
Aberdavine (or Siskin)	2	4	0	4	4
Redpoll	0	4	0	4	4
Thrush	4	4	4	4	4
Blackbird	4	4	0	2	2
Robin	6	16	12	12	12
Wren	0	12	0	4	4
Reedsparrow	0	4	0	2	2
Black-cap, or the Norfolk Mock Nightingale	14	12	12	14	14

* There are, in addition to these, nine or ten other birds which enjoy the reputation of singing birds, but as these only visit us in the *winter*, they are not often heard in this country. Such are the Siskin, Redpoll, Brambling, Grey Wagtail, &c. If to these be added the Tits (Parus,) which some may consider as worthy of admission into the list, we have then about 50 songsters in our Avi-fauna.

There are few, I fancy, who will be disposed to agree in this estimate of the powers of our feathered favourites, and although the table is frequently cited, it is always done under protest, and rather as a curiosity than for any intrinsic merit. For my own part, I have often wondered that so acute an observer, and ardent an admirer of our song-birds as the Hon. Daines Barrington undoubtedly was—one, too, who was evidently possessed of a musical ear—should have so far erred in his estimate; and it is not easy to discover the principle which he employed in the construction of the foregoing table. He says, indeed, "I shall not be surprised, however, if many may disagree with me about particular birds," but, still, I cannot believe that the subject is so much a matter of caprice as this would indicate, or as the table would appear to prove. I think it may be partly owing to the fact that Barrington was accustomed to judge of birds, not in their wild state, but as "cribbed, and cabined, and confined," having received more or less *instruction*, and more or less of what he would have called *opportunities of improvement*. In these respects, he was an artificial ornithologist, one who delighted not in what he called "the *rank* song of a nightingale in spring," but made all his observations upon caged birds, which had been duly educated by art, and sung, in spite of nature, all the year round. If we compare, in his table, the voices of the Thrush and Robin, or those of the Blackbird and Greenfinch, it will be at once apparent that it is largely defective, and except in its form, solely a curiosity.

Mr. Barrington does not appear to have attributed perfection to any bird, even though nature and art should combine to attain it; in which I think he errs. He has given 20 as the point of perfection, but no bird is so gifted as to reach it, not even his favourite Nightingale, which "sings with superior judgment and taste," and again, with "a most astonishing effect, which eludes all verbal description," &c. Surely, in the works of Nature, perfection is somewhere reached, and the

Teacher of our woodland vocalists would never pause at 19 in his masterpiece, when 20 was attainable. Further, Mr. Barrington seems to have had a partiality for particular numbers, and an analysis of his table shews, that out of 76 numerals employed, the number 4 occurs 29 times, and the number 12 seventeen times; these two numbers thus comprising together 46 out of 76, of which the table is composed.

I have often been surprised that this table, formed by Barrington in 1773, although it has attracted much attention, has never been imitated with a view to improvement and perfection. Such an improved table would naturally be a source of much amusement in its formation, as well as of some interest to those well acquainted with the varied voices of British birds, in the comparison of its results with their own ideas and feelings. I venture therefore to offer the following, not as a perfected, but as a somewhat improved scheme upon that of Barrington's, founding its claim for improvement upon the following considerations:—

In the first place, the numbers are derived from a careful observation of the birds in their native haunts in spring, when their powers of song are in the most perfect natural condition. Secondly, I have introduced a considerably larger number of birds than those referred to by Barrington, in fact perhaps all those which have any claim, when judged by our definition to be regarded as British singing birds, and numbering 36. Thirdly, I have made 24 the point of perfection, instead of 20; because I thought that by so doing, the facilities for comparison among a so much greater number of birds would be proportionately increased, without incurring any loss in the general plan. Fourthly, I have admitted that the point of perfection is attained by at least some one bird in each of the qualities, considering the bird against which 24 is marked as the type of that quality. Fifthly, I have superadded to the five qualities mentioned by Barrington, a sixth, viz., power or strength of voice, as decided by the distance at which it can be heard; in my humble opinion, a very essentia element of a fair judgment in the consideration of tones as sonorous as those of the Missel-Thrush, and again as weak and feeble as those of the Goldcrest. And, lastly, the whole has been framed with a due regard to a strict comparison between birds most allied to each other in the nature and quality of their notes, by which any great discrepancy is necessarily avoided.

TABLE OF THE COMPARATIVE MERITS OF BRITISH SONG BIRDS.

(IMPROVED AND CORRECTED.)

No.	24, the Point of Perfection.	Mellowness of Tone.	Sprightliness.	Plaintiveness.	Compass.	Execution.	Strength of Voice.
1	Dipper	10	18	6	18	16	20
2	Missel Thrush	8	2	12	5	4	24
3	Song Thrush	17	14	8	16	14	20
4	Blackbird	24	6	14	16	10	18
5	Hedgesparrow	6	8	12	18	9	8
6	Redbreast	10	15	20	10	9	12
7	Redstart	8	12	10	12	12	8
8	Stonechat	6	10	7	9	9	7
9	Whinchat	8	12	8	10	12	10
10	Wheatear	6	14	6	10	10	10
11	Sedge Warbler	4	15	10	14	16	12
12	Reed Warbler	10	16	10	18	18	14
13	Nightingale	22	14	24	24	24	17
14	Blackcap	22	18	14	20	22	16
15	Garden Warbler	20	15	16	18	17	17
16	Whitethroat	6	16	10	15	16	12
17	Lesser Whitethroat	6	14	8	10	12	10
18	Willow Warbler	10	16	14	10	8	14
19	Goldcrest	0	11	6	8	6	4
20	Pied Wagtail	9	14	10	12	10	10
21	Tree-pipit	6	12	14	16	14	16
22	Meadow-pipit	8	14	15	17	15	16
23	Skylark	6	20	4	18	18	23
24	Woodlark	20	16	20	12	18	15
25	Black-headed Bunting	4	8	4	6	6	10
26	Cirl Bunting	2	7	6	5	6	14
27	Chaffinch	14	16	12	13	17	15
28	Tree-sparrow	0	4	2	5	5	12
29	Greenfinch	10	12	8	10	14	10
30	Goldfinch	11	14	10	14	17	16
31	Linnet	15	12	15	12	16	9
32	Bullfinch	7	5	6	8	8	7
33	Starling	8	12	14	16	12	6
34	Creeper	0	9	5	6	5	4
35	Wren	0	24	0	12	16	16
36	Swallow	12	18	16	16	17	10

An analysis of the foregoing table shews that the Blackbird has been selected as the type of the quality of mellowness of voice, the Wren for sprightliness, and the Nightingale for plaintiveness—the last, of course, carrying off the palm in compass and execution. For strength of voice the Merulidæ are all remarkable; the loudest, perhaps, being the Missel Thrush, though the Lark nearly approaches him in this particular.

In this table the birds are arranged according to their *families*, but the sum-total of the figures appended to each bird will give the following *scale of superiority* in song:—

	Bird.	Total.		Bird.	Total.
1	Nightingale	125	19	Sedge-warbler	71
2	Blackcap	112	20	Starling	68
3	Garden Warbler	103	21	Wren	68
4	Woodlark	101	22	Pied Wagtail	65
5	Skylark	89	23	Greenfinch	64
6	Song-thrush	89	24	Redstart	62
7	Swallow	89	25	Hedge-sparrow	61
8	Dipper	88	26	Lesser Whitethroat	60
9	Blackbird	88	27	Whinchat	60
10	Chaffinch	87	28	Wheatear	56
11	Reed-warbler	86	29	Missel Thrush	55
12	Meadow-pipit	85	30	Stonechat	48
13	Goldfinch	82	31	Bullfinch	41
14	Linnet	79	32	Cirl-bunting	40
15	Tree-pipit	78	33	Reed-bunting	38
16	Redbreast	76	34	Goldcrest	35
17	Whitethroat	75	35	Creeper	29
18	Willow-wren	72	36	Tree-sparrow	28

In order still further to exhibit the comparative powers of our British birds, and at the same time to arrange their numerous notes in something like an orderly series, the following system is offered, which shows the *type* to which each song-bird belongs, and locates each bird in an ascending series, according to such type, beginning with those whose notes are least numerous and varied, and gradually rising to the most powerful and accomplished vocalists.

First—Birds which possess but a single note or *call*.

The greater number of birds, by very far, as I have before observed, come under this category, and therefore, however much this call may be varied in *tone*, they are necessarily excluded from the rank of *singing* birds.

Secondly—The first approach to song occurs when this single note is repeated several times without an interval, constituting a *prolonged call*, as I will designate it, as in the case of

1 Wryneck,	4 Swift,
2 Woodpecker,	5 Wood-warbler
3 Nuthatch,	6 Grasshopper Lark, &c.

Thirdly—The next advance is when, instead of a single note, the bird is capable of producing two notes, which Barrington designates the *varied call*. Such birds are the

1 Cuckoo,	3 Common Bunting, &c.
2 Chiff-chaff,	

According to that part of Barrington's definition, which I am willing to accept, we now arrive at true singing birds, having three or more notes. These may be arranged as follows:—

Fourthly—Birds which sing short passages, which they repeat frequently, but from time to time vary,

A. with an interval between each repetition, as

1 Missel Thrush,	3 Blackbird.
2 Golden Oriole,	

B. without such interval,

1 Blue Tit,	3 Song-thrush.
2 Great Tit,	

Fifthly—Birds which have a *definite number of notes*. This includes all the poorer song-birds, which have but few notes, as well as some of the better class. These birds sing their song round, and then repeat it, singing nearly the same notes each time; so that when the observer has once mastered the passage, he cannot well be deceived in the bird; such are

1 Tree-sparrow,	9 Hedge-sparrow,
2 Creeper,	10 Redstart,
3 Reed-bunting,	11 Greenfinch,
4 Cirl-bunting,	12 Wren,
5 Gold-crest	13 Willow-wren,
6 Stonechat,	14 Tree-pipit,
7 Wheatear,	15 Meadow-pipit,
8 Whinchat,	16 Chaffinch.

And *Sixthly* and lastly, are those birds which possess an *indefinite number* of notes, so that no two passages are precisely alike, and the observer judges more by the *quality of the tone* than by the *identity of the passages*. This class includes the greater number of our true singing birds, and may conveniently be divided into two groups, viz:—

A. Those whose song is uttered in what the bird-catchers call *jerks*, that is, passages more or less brief, but always varied, and separated by an interval; such as—

1 Redbreast,	3 Lesser Whitethroat,
2 Whitethroat,	4 Blackcap,

5 Nightingale.

B. Those whose song is *long sustained*, without any rest or interval, as—

1 Pied Wagtail,	6 Reed Warbler,
2 Starling,	7 Linnet,
3 Goldfinch,	8 Garden Warbler,
4 Swallow,	9 Wood-lark,
5 Sedge Warbler,	10 Sky-lark.

Our indigenous birds appear, some of them at least, to be capable of singing nearly the whole year, excepting only during the moulting season, and this is certainly an argument against the sexual cause of song. The Robin, the Wren, the Starling, &c., may be heard through the frost and snow of January, although it is quite true that they improve greatly in their qualities of voice during the breeding season. Other birds gradually take up their song as the spring advances. The Missel and Song Thrush also usually sing in January. In the course of February, the Chaffinch, Hedgesparrow, Lark, Greenfinch, Goldcrest, &c., gradually chime in. The Blackbird is rarely heard till March, when he is accompanied by the Linnet and Goldfinch.

The month of April, however, brings with it a great accession of song, on account of the arrival of the exotic songsters which make our spring woods so vocal. These arriving, one after another, from the first week in April till the first week in May, very rapidly swell the chorus. Both indigenous and exotic songsters are, indeed, early in May, in full song—a marked improvement in tone and execution being observable even among those we have been accustomed to hear already for several months past. Thus, the Redbreast's note becomes full and sonorous, often rivalling the wild note of the Blackcap in some of its passages. The warble of the Chaffinch becomes more liquid, and an accession of power is generally noticeable. After the beginning of June, however, this climax begins to show symptoms of a decline: one by one, birds' voices are missed, or the rich tones deteriorate, and this process going on through June and July, it at length becomes the *exception* to hear a bird's song, instead of the rule; till at length, in August, a dead silence reigns in the woods and fields, and the birds are then as dumb as they are musical in May.

Whether this gradually increasing vocal power be due to a corresponding increase of pliability in the larynx, induced by practice, or to some correlative periodical change in the constitution of the bird, I cannot now enquire. Probably both causes are concerned, for we must take the analogous phenomenon of the decrease and disuse of song into consideration in any such enquiry.

Another question, too, presents itself, viz., what is the condition of migrating birds as to song, when they arrive among us? I think there can be little doubt that their vocal organs have previously reached their full pitch of power at that time, for several reasons.

First. They remain with us, in song, for so short a period (about six weeks) that time is scarcely allowed for any very great change; nor do we notice any in fact, the summer birds of passage being in good voice from the time they arrive till the time when their song begins to deteriorate.

Second. A careful observer will almost as soon learn by the *ear* as by the eye the arrival of summer birds, which announce their advent by their characteristic notes. I say *almost*, because it has several times occurred to me to see the bird only on one day, and to hear him on the next, and this under such circumstances as to leave no doubt that the fatigue of their journey only prevented them singing. On one occasion, in Kent, early in April, watching for the Willow-wren, not the slightest trace of which I had yet seen or heard, I espied one, which, while under my observation, uttered a mangled note, more like a recording note in autumn, and which I should scarcely have recognized. This was the only indication I had of the bird's arrival; but *next day* every tree-top resounded with the incessant warble of the species. A similar remark I have made with regard to the Redstart.

Thirdly, judging from analogy, we arrive at the same conclusion, for our winter birds of passage, which quit us in the spring, sometimes favour us with an audience before leaving.

After the period of silence, which marks the month of August, we often hear many species resume their song, but in a manner very far inferior to that of the spring months. The notes strike upon the ear like those of long absent friends, and as it always occurs to me, like those of friends just risen from a bed of sickness. Instead of the round, full, careless song of spring, we hear weak, vacillating and imperfect notes, which tell either of a loss of power, or of a newly commencing accomplishment. I certainly incline to the opinion expressed by White, and corroborated by the Rev. L. Jenyns, that these autumnal songsters are young cocks of the year. Without stopping to ask why the old birds should attempt to do that which they have not power to execute, it is to be borne in mind that this recommencement takes place at a time when we should look for the first indications of song in the young birds; at a time, that is, when they are fully fledged, and perfectly able to shift for themselves. But if it should prove that the weak notes heard in autumn, are produced by young cocks of the year, it will be a strong argument in favour of the *innate* character of song, and its specific nature. For the old birds have confessedly ceased for some weeks or months, and therefore it cannot be contended that the young are being instructed by them. Moreover, in any case the spring song ceases, as a rule, before the young are in a position to profit by it as an example, unless, indeed, it be hardily imagined that they bear in their remembrance the notes they heard many weeks before.

As there is an *annual* or seasonal cycle in the powers of singing-birds, so also there is a *diurnal* one. The daily cycle has, however, this peculiarity, that it reverses the annual one in its character—the earliest beginning of the day presenting a climax, which subsides before mid-day. It is not a little interesting to watch, in a spot thickly populated by birds, for the moment of their awakening. Long before sunrise, even in the longest days, and when only an uncertain glimmer of twilight exists, scarcely sufficient to read the time by a watch, a sudden awakening takes place. A single bird, more wakeful than his fellows, commences singing; but he does not long sing alone. Birds of the same species, as though awakened by the familiar sounds, almost instantly reply. By degrees, other species commence in the same manner; at first one individual, rapidly followed by others of the same species. A solitary thrush, for example, breaks the silence, and before five minutes have elapsed, a dozen thrushes may be heard singing in all directions, springing into life all around, as if by magic. The effect is most startling and curious.

The following extract from a carefully observed occurrence of the kind will illustrate this circumstance (May 18th) :—

Hrs.	Min.	
3	5 (a.m.)	A Blackbird singing.
3	6 „	A Robin singing.
3	6¼ „	Two or three Blackbirds and Robins singing.
3	7 „	A Thrush singing.
3	7½ „	A Ringdove cooing.
3	11 „	Ringdoves cooing; Blackbirds, Thrushes, and Robins singing *everywhere*.

No other time of the day can compare with this for the loudness and richness of the song of birds; and no one can have an idea of what a chorus of song-birds means, who has not heard it between three and four o'clock of a May morning.

There is a remarkable constancy, almost to a minute, in the awakening of birds at the same place and season; and in two observations made within three days at the same spot, the difference of time in the awakening of several of the commoner species was not more than a minute or two.

Much difference of opinion has existed as to what bird commences this morning chorus. Several writers who have touched upon this subject, have done so evidently without any special observation upon it with a view to determine the truth. In the "Journal of a Naturalist," the author gives the Rook the credit of being the first awake, and says the Robin is next. Jenner, in the Phil. Trans. (1824, p. 37), "On the Migration of Birds," says—"First the Robin, and not the Lark, as has generally been imagined, as soon as daylight has drawn the impenetrable line between night and day, begins his lonely song." Messrs. Sheppard and Whitear, in their paper "On the Birds of Norfolk" (Linnean Trans., vol. xv., p. 18), say, that the Redstart is the earliest bird, but without observation to back the assertion. For my own part, I distinctly dissent from all these, and in company with the poet, generally so true, and with the Rev. L. Jenyns, I believe that the Lark is, after all, the first to awaken and lead the choir. Thomson truly says—

> "Up springs the Lark,
> Shrill-voiced, and loud, the messenger of Morn."

And Jenyns, in his "Observations in Natural History" (pp. 95, et seq.) gives detailed results of his morning remarks upon that subject, which precisely correspond with similar observations which I have myself made with care. On all these occasions the Skylark has been fully half an hour carolling in the air before any other bird shewed symptoms of awakening. The Robin usually follows the Thrush, and the Cuckoo is one of the very earliest birds.

As the morning advances, the birds cease their song, and in the heat of the day there is as little music as in August; but as the sun declines many birds recommence, and even continue singing after the sun has absolutely set, as the Thrush and Robin; and the Cuckoo, as it is one of the earliest, so also it is one of the latest birds to retire.

Some birds, however, do not find a May day long enough to exhaust their powers, but are as vocal at midnight as at mid-day,—of such birds, the Nightingale, Woodlark, and Sedge Warbler are well known—but besides these the following have been occasionally heard during the night, viz. the Hedgesparrow, the Skylark, the Reed Warbler, the Robin, the Whinchat, and the Cuckoo.

Lastly, there are many birds whose characteristic mode of delivering their song is on the wing—such are the Skylark, Woodlark, Tree Pipit, Meadow Pipit, Whitethroat, Swallow, and Wagtail. To these may be added the following, which do not, as a rule, sing as they fly, but occasionally do so, viz., the Blackbird, the Wren, the Titmice, the Greenfinch, the Chaffinch, the Dartford Warbler, the Goldcrest, the Willow Wren, the Blackcap, the Missel Thrush, the Dipper, the Wheatear, and the Linnet.

There are many other points of great interest in connexion with this subject, to exhaust which would demand a volume. The musical aspect of the songs of birds is one of those which I should have liked to touch upon, but it is too extensive; the curiosities and abnormalities of song—the docility and flexibility of the vocal organ of birds—their powers of uttering articulate sounds, &c. It is possible that I may resume the subject, however, on a future occasion.

[*From the* ANNALS *and* MAGAZINE *of* NATURAL HISTORY *for June* 1859.]

THE ESTUARY OF THE MERSEY

CONSIDERED AS A LOCALITY

FOR

NUDIBRANCHIATE MOLLUSCA.

BY

CUTHBERT COLLINGWOOD, M.A., F.L.S. &c.

ALTHOUGH every district has its variety of natural productions, whether terrestrial, fluviatile, or marine, still there is usually some family which predominates in each locality, giving it a peculiar character, and in which it may be regarded as, at least comparatively, rich.

The marine fauna of Liverpool is by no means destitute of interest in other families, and possesses an ample share of zoophytal productions in particular; but it is more especially in the Nudibranchiate Mollusca that its riches appear. Of this remarkable and lovely family it may be said to possess more than an average share, including some of unusual interest. The present paper will only take cognizance of the Mersey mouth and estuary; but by extending our researches to the neighbouring estuary of the Dee, we find within ten miles of us fresh rarities and beauties. It must also be taken into consideration that the workers in this department are few, and perhaps do not number more than a dozen for the whole district, among whom Messrs. Price and Byerley and Dr. Edwards deserve honourable mention. I think I may say that a more systematic working of the coast is going on now than has been the case for some time past; and we may hope still to add to the following catalogue of 21 species. Already, in the present spring, two species have been added to the local list, and a third to the Mersey proper, notwithstanding that the weather has been most unfavourable for shore operations, the boisterous winds and cold conspiring to drive the animals to lower depths. To the record of each species are appended remarks and notices of peculiarities, whether local or otherwise.

Doris tuberculata.—This is perhaps one of the most unattractive, though nearly the largest of the Nudibranchs, and requires little remark. It is not uncommon upon the Cheshire side of the Mersey; and I have picked it up at Egremont, New Brighton, and Monk's Ferry from early spring to late autumn. Its usual size is three inches to three inches and a half, and its colour somewhat various, being either of a pure lemon-yellow, a bright orange, or sometimes blotched with green, pink, or brown. It is very sluggish, and seldom lives more than a few days in captivity.

Doris Johnstoni.—This is by no means a common *Doris* in any locality, and is here a very rare one. In company with Dr. Edwards, we found one at Monk's Ferry on August 12th of last year, the only one, that I am aware of, which has been taken in the Mersey. Our specimen was of a bright yellow colour, and about an inch and a half long. The only other recorded specimen from this neighbourhood was taken in the Dee estuary, at Hilbre Island. The spicula of this species are very elegant, consisting of a broad embossed plate with a double and beautifully serrated edge, terminating abruptly in a blunt apex.

Doris proxima.—This pretty little *Doris* is peculiar to the estuary of the Mersey, where it was first discovered by my friend Mr. Price. It is extremely like *D. aspera* in general aspect, and requires a critical eye to discriminate it at first; but a little practice makes them readily distinguishable with a lens; for the tubercles upon the cloak of the latter are more rounded and club-shaped,—of the former rather fusiform, especially towards the sides. But should there be any doubt from an external examination, the tongue presents so marked a difference in the two species that it would at once decide the question; and even when the animal has been far gone in decay, and the tongue difficult to find, I have been satisfied of the species from an examination of the spicula, having never seen in *D. proxima* the three-cornered spicula so characteristic of *D. aspera*. *Doris proxima* is scattered in considerable numbers all along the Cheshire shore of the Mersey estuary, from Monk's Ferry to New Brighton, but is nowhere very abundant. It is usually about half an inch long, though sometimes met with very minute, and varies in colour from white to various shades of yellow and orange. It spawns early in March. I do not think the *Doris aspera* is found here, and have hitherto searched for it in vain. It appears to be replaced by this allied species.

Doris bilamellata.—This is perhaps the most common Nudibranch in our estuary, and may be found in the utmost profusion, especially in early spring, its chief spawning season being in February and March. At that period the stony ground beside Egremont, and that in the neighbourhood of the railway pier at Monk's Ferry, literally swarm with this species, and are spotted in all directions with the white ribands of spawn. These two localities are separated by a distance of about 2½ miles, the latter being most distant from the sea; and a considerable difference exists between the specimens of *Doris bilamellata* inhabiting the two spots. At Egremont they are all of a large size, being from an inch to an inch and a half long, and more or less mottled with a rich dark brown; but at Monk's Ferry an entirely different variety occurs: here none of them exceed three-fourths of an inch in length, and many are much smaller, while the dark brown mottling gives place to a much lighter colour; and even this is in some specimens almost entirely absent, and they become of a dull white. So great a persistent difference in the individuals of one species separated by so short a distance is very remarkable, and would almost seem to give some colour to the idea that they are distinct species. Messrs. Alder and Hancock, however, were unable to fix upon any distinguishing character on which they could rely. At Monk's Ferry they swarm over the lower part of the slip, so that passengers landing from the steamers at low water unconsciously trample them and their ribands of spawn under foot.

Doris pilosa.—A common and widely distributed species, but by no means one of the most abundant of the Mersey Nudibranchs. It is a pretty little *Doris*, and one which varies very considerably in appearance, within the limits of species, not only in colour, but in general aspect. Mr. Price informs me that at Monk's Ferry he has found it of a pale lilac, and even white, spawning upon *Fucus serratus*. A deep purplish-black variety also occurs in the Mersey; but I have met with only one or two specimens during the last twelve months. When not in motion, it bears a great resemblance to a miniature hedgehog. This species, as well as *D. proxima* and some Eolids, have a habit of crawling out of the water in which they are placed; so that some hours afterwards it is not unusual to find them literally "high and *dry*" upon the edge of the vessel, and, of course, dead.

Polycera ocellata.—Of the genus *Polycera* we may reckon two species, though by no means commonly met with. The above, which, however, very closely resembles the next, is the least rare, and has been not unfrequently taken on the Egremont shore and elsewhere. I have not met with it during the last twelve months.

Polycera Lessonii.—All that can be said of this, is that our excellent naturalist, my friend Mr. I. Byerley, has taken one in the dredge, off the North Cheshire coast, outside the Mersey mouth; so that no doubt it exists near us. But although the Mersey shores offer a rich feast for the naturalist, the dredging is anything but satisfactory, and experience has only resulted in laying aside the dredge to a great extent, and trusting to the sea-boots.

Ancula cristata.—A lovely species, which I am glad to say is one of our common Nudibranchs, especially on the Egremont shore. It is here found under stones, in company with other species to be mentioned presently; and the little light speck ensconced in a crevice bears but a faint resemblance to the graceful creature into which it expands when placed in the water. No figure can do justice to the beautiful frosted silvery appearance of the branchial plumes, or the delicate transparent whiteness of the body; and as it is an active little animal and constantly in motion, its beauties are readily viewed even without the aid of a glass. Placed in the aquarium, they have lived for some weeks, marching freely about and traversing all parts of the tank. They were numerous early in the last February at Egremont; but they appear to congregate on small circumscribed patches of stones, so that it is not always easy to hit upon the exact spot.

Tritonia Hombergii.—A magnificent animal, and the largest of our Nudibranchs; but being a deep-sea species, the wonder is not that it has only occurred once or twice, but that it has been picked up at all upon the shore. Alder and Hancock state that it is seldom obtained except by the dredge or trawl. It has, however, been taken on the western shore of the Mersey, near its mouth; and I have myself picked it up on the shore of Hilbre Island, in the Dee estuary. Its great size, its very complex tentacles, and its numerous tree-like tufts arranged all along the sides, conspire to render it a creature once seen not soon forgotten.

Tritonia plebeia, another deep-sea species, has been taken in the dredge outside the Mersey mouth.

Dendronotus arborescens.—This very remarkable and beautiful animal is one of the most common and widely distributed Nudibranchs of the Mersey. It occurs more or less in all the localities frequented by the zoologist both upon the Lancashire and Cheshire shores, but is in the greatest profusion in the hottest part of the summer. The spot where I have found it in the greatest numbers is a remarkable one, and worth recording. The old landing-stage from which the ferry steamers run, is a ponderous barge-like structure supported upon iron pontoons, which are capable of being withdrawn individually. On the land side of these pontoons, and in the crevices between them, vast quantities of *Tubularia indivisa* and mussels accumulate and flourish, so that from time to time it is necessary to withdraw the pontoons one by one and scrape them with iron scoops, in order to rid them of the masses which choke them up. This *Tubularia* affords food and harbour to a vast number of animals, including several species of Nudibranchs; and among them *Dendronotus arborescens* is conspicuous. In company with my indefatigable friend Dr. Edwards, on a fine day in the month of August last, we gathered specimens of *Dendronotus* from this spot as fast as we might pick blackberries from a hedge; so that in a quarter of an hour we found ourselves possessed of upwards of forty fine full-sized specimens. It is not, however, at all times of the year that they are to be found in this profusion. On the 9th of February last I visited the same spot, and found *Tubularia* indeed in the most magnificent condition, with pendent clusters of oviform gemmules an inch long; but though I searched long and diligently, no trace of *Dendronotus* could I find. Indeed, the first specimen of the season made its appearance, on the verge of low-water at Egremont, on the 5th of the present month. This species is very sluggish in its movements, and will not live more than a day or two after its capture. Whether it requires a constant supply of the heads of *Tubularia* for its sustenance, or a constant renewal of sea-water for its respiration, I am not aware; perhaps both. We have pale-yellow as well as rich-brown varieties.

Doto coronata.—This is the only species of *Doto* hitherto met with in the Mersey, but is very common and widely distributed. Along the Cheshire shore of the estuary it is in great abundance, especially at Egremont and New Brighton, where it may be found upon the under side of stones (the larger the better) all the year round, as well as upon fronds of *Laomedea gelatinosa*, which is our commonest zoophyte. I have counted a score upon a single large stone. On the Liverpool side it may be found upon the *Tubularia* of the landing-stage. I have never found one, however, half an inch long,—the average size being a quarter of an inch, and the largest three-eighths. They are very variously coloured, seldom pale, and sometimes very richly marked, the largest specimen I have seen being also the darkest. In the aquarium this species exists longer than any other mentioned in the present paper, and remains attached to corallines for weeks and even months, moving about but little, and freely depositing its minute ribands of spawn.

Eolis papillosa.—We have at least eight species of *Eolis* proper, of which this is the largest and one of the least beautiful. It is found pretty generally distributed upon the shores of the Mersey; but being usually of a sooty colour, it is not readily distinguishable without special search. At the present time the spawn of this species is pretty abundant on the Cheshire shore, in the form of long convoluted cords upon the sides of stones; but the animal itself is comparatively seldom seen. I have never tried to keep this species in the aquarium, for its anti-actinial propensities are too well known; but in a small separate vessel of water it remains almost motionless, and dies in two or three days, perhaps for want of food. *Eolis papillosa* is a very protean species, and has been known under many synonyms. In the 'Annals of Nat. Hist.' (vol. ix. p. 34), an *Eolis* is described by Messrs. Alder and Hancock, under the specific name of *obtusalis*, which sometimes occurs upon the Egremont shore. This differs from the ordinary form of *E. papillosa* in being less than one-third the size and of a much lighter colour. But more extended observation led the ingenious authors to discard it as a species, and to consider it as a variety of *Eolis papillosa*.

Eolis coronata.—Of all the species of the genus *Eolis*, I know of none which combines elegance of form with delicacy of colouring in a more eminent degree than this; and it is the most common *Eolis* found in the Mersey. It may be taken in nearly all the localities, and all the year round, adhering to the under side of stones. It is a very active species, constantly moving about or swimming, with its foot uppermost, on the surface of the water, by a graceful but mysterious method of propulsion. It most resembles *Eolis Drummondi* in external appearance, but may be at once discriminated from it by the delicate dash of ultramarine which exists in the papillæ. In the aquarium it lives for some weeks, freely depositing its little convoluted circlets of spawn. Mr. Byerley informs me that, a few years since, some specimens found on the Egremont shore were sent to Mr. Alder, who pronounced them to be the darkest-coloured examples which had come under his notice. In the Mersey it seldom exceeds an inch in length.

Eolis Drummondi.—Next to the last, if not as common, is this species, which vies with it in elegance of form, though hardly perhaps in richness of colouring. It is met with in nearly all the localities, and at all seasons. The specimens found in the Mersey are usually of a fine brick-red colour and about an inch long; but at Leasowe, about two miles from its mouth, Dr. Edwards and myself have found them fully an inch and a half long, but of a paler colour. These large specimens much resemble *E. papillosa* in aspect, and are scarcely so handsome as the smaller ones. Indeed, in the Nudibranchiate family, we might almost say that size and beauty are in inverse proportion to one another; under a low magnifying power the minuter species exhibit delicacy of tint and texture far outrivalling those which do not require a glass for their examination. The *Eolis Drummondi* is one of the most active of the genus, constantly walking about, waving its long and most graceful tentacles, or swimming on the surface, and when disturbed, erecting by a sudden movement all the papillæ upon its back, "like quills upon the fretful porcupine." The papillæ of this and some other species, especially of *E. picta,* often fall off when the animal is about to die; and I have observed, in the case of *E. Drummondi,* a persistent vitality in the separated parts. For some time after they have fallen, the papillæ exhibit a vermicular motion, which, when examined under the microscope, is seen to be a general contraction, independent of any artificial stimulus.

Eolis Landsburgii.—It is gratifying to me to be able to record the estuary of the Mersey as a new locality for this exquisite little Nudibranch. As Dr. Edwards and myself were examining the Egremont shore at the beginning of the present month, the former picked up a specimen of the above *Eolis.* The very rich amethystine colour of the body at once referred it to the species *Landsburgii*; but on comparing it with the figure given by Alder and Hancock, we were a little puzzled by certain discrepancies. In the first place, the colour both of the body and papillæ was very much deeper and richer in our specimen than in the plate; that, however, was of minor importance. Secondly, the papillæ were much more numerous, as well as longer and more elegantly formed, than were those of the specimen figured; but on referring to their Appendix, the authors tell us that their figure was taken from an immature individual, the only one then known. The most striking difference, however, was in the tentacles. The specimen figured has the dorsal tentacles rather long, slender, and linear, and the oral tentacles a little longer than the dorsal; but in our specimen the oral tentacles were very short and thick, with transverse wavy markings, while the dorsal were nearly three times as long, arched forward, and presenting an outline not unlike an ibex-horn. This gave the animal so different an appearance that, having watched it for some hours and finding no change, I began to think it might be a new species; and as it seemed to be getting less lively, I made a careful coloured drawing of it, which kept me up till a late hour in the morning—intending, in case it died in the night, at all events to have Mr. Alder's opinion on the matter. Altogether it was six hours under observation, during which time the tentacles were as I have described them. The first glance bestowed upon it in the morning, however, dispelled the illusion; for it was crawling actively about in the vessel in which I had placed it—its tentacles no longer short and corrugated, but long and smooth, agreeing exactly with the description given by Messrs. Alder and Hancock, and the oral now exceeding the dorsal tentacles in length. It is probable that the strong light thrown upon it for examination with a low power of the microscope had produced the retraction of the tentacles which had so altered its appearance; and although I several times removed it for awhile from the light, it seemed to require some hours of darkness to restore it to its natural form. Another peculiarity of form of this specimen, and which I have not observed in any other *Eolis*, was that the posterior end of the body suddenly narrowed behind the last papillæ, and bore superiorly two or three small but very distinct and transparent papular elevations.

It was placed in the aquarium, where it lived a few days, after which it appeared to melt away; the papillæ fell off, and their rich-red colouring matter, imbibed by a multitude of eel-like creatures swarming about the mollusk, gave them all a similar tint. Its length was four-tenths of an inch.

Eolis concinna.—The only locality recorded for this small species by Messrs. Alder and Hancock is Whitley, Northumberland. To this I can add the Egremont shore, where, in February last, I found two specimens upon fronds of *Laomedea gelatinosa*, in company with other small species of Nudibranchs. I did not see their spawn, which by Mr. Alder's specimens was deposited out of the usual spiral form. They were about one-fifth of an inch long.

Eolis aurantiaca.—We have here a variety of this species, found upon the *Tubularia* growing upon the pontoons of the landing-stage in company with *Dendronotus*, *Doto coronata*, *Eolis coronata*, and *papillosa*, &c. The individuals taken in that locality were short and thick, the papillæ few and club-shaped, and very easily broken off. Altogether they were the least graceful Eolids which I have met with; and although they appeared to agree rather with Alder and Hancock's *Eolis aurantiaca* than with any other, still there was a difficulty—viz. that they were pale specimens, entirely free from any orange colour. I therefore forwarded some to Mr. Alder, who kindly wrote me word that he believed them to be specimens of *Eolis aurantiaca*, which they had found to vary considerably in colour since it received the name. The orange tip, however, though not invariable, is one of the most constant characters. The same species is found upon the Cheshire shore.

Eolis picta.—This very handsome species has been found by Dr. Edwards and myself in two localities, viz. Egremont, and under stones between New Brighton and Leasowe. At the former place I found large and richly coloured specimens fully three-quarters of an inch long. The papillæ of *Eolis picta*, though thick, are by no means without grace, and very buoyant; the animal itself is very active.

Eolis despecta.—I found this pretty little *Eolis* in February last, upon fronds of *Laomedea gelatinosa* growing in the rocky pools at Egremont, midway between high- and low-water mark. They were here in considerable numbers, in company with *Doto coronata* and one or two specimens of *Eolis concinna*. I have since found them not unfrequent in the same locality—well-marked individuals, in which the olive-green wavy line down the back and the pink ring round the tips of the eight papillæ were conspicuous. Its usual companion and allied species, *Eolis exigua*, I have hitherto searched for in vain. The length of my specimens was about one-sixth of an inch.

Embletonia pallida.—The last species of Nudibranch which I have to mention as occurring in the Mersey is a minute one, of which no figure appears in Alder and Hancock's work. It was described by them in the 'Annals' for August 1854, from specimens discovered by Mr. Price among sea-weeds upon the Birkenhead shore. "It differs," they say, "from the other British species in having a double series of papillæ on each side; the tentacles, too, are placed much nearer together; and the oral lobes are small and indistinct, being united over the head in front into a semicircular veil." Its length was only $\frac{1}{10}$ inch.

It certainly appears that the less common Nudibranchs are more or less gregarious in their habits. Among those who search for them, very different impressions are received regarding their numbers. One person may find several, and may record them as common, while another equally good searcher may be unsuccessful in finding any, and pronounces them very rare; the fact is that, for some reason or other, a certain section of these little creatures affect particular spots on the shore, and there resort in some numbers. If a person happen to pitch upon that spot, he may find several; another may pass a yard or two on one side or the other, and find none. The truth will probably lie between the two, and such species are most likely neither very rare nor very common; such are *Eolis picta*, and *Ancula cristata*. Some species, again, are widely dispersed over the whole coast, and even these congregate in particular spots in preference to others, though it is sometimes difficult to assign a cause for such assemblages; such are *Doris bilamellata, Doto coronata*, &c. Another group appear seldom or never to centralize themselves, being found at intervals over all the shore, such as *Eolis coronata* and *Drum-*

mondi and *Doris proxima*; while a fourth section may be regarded as purely accidental visitors to the beach, being inhabitants of deeper water, such as *Tritonia Hombergii.*

There is therefore a great advantage in searching in company; for what is one upon a vast sea-shore! and how small a proportion of the stores upon a rocky beach can one person examine in the short duration of an unusual ebb! Not only is there a double chance of finding when two are at work, but the probability of a successful hunt is vastly increased by systematic and friendly combination.

46 Nelson Street, Liverpool,
April 18, 1859.

[*From the* ANNALS AND MAGAZINE OF NATURAL HISTORY *for September* 1860.]

ON THE

NUDIBRANCHIATE MOLLUSCA

INHABITING

THE ESTUARY OF THE DEE.

BY

CUTHBERT COLLINGWOOD, M.B., F.L.S. &c.

In a former paper I described the species of Nudibranchiata which up to that time had become known to me as inhabiting the estuary of the Mersey; I propose in the present communication to make some remarks upon those which are found in the neighbouring estuary of the Dee. I will not here dwell upon the species which are common to both rivers, having already made special reference to them as existing in the Mersey, while the table at the end of this article will sufficiently indicate their comparative rarity or profusion in both situations. The Mersey species which have not hitherto been detected in the Dee are *Embletonia pallida*, peculiar to the Mersey, and *Eolis concinna* and *E. despecta*. Of these, *Embletonia* has not been taken for some years; and it is to be feared that the locality in which Mr. Price first discovered it has been destroyed by the formation of the Birkenhead Docks. During the past spring, I have found a third small species of *Eolis* in the Mersey at Egremont, in company with *E. concinna* and *E. despecta*: this is *E. exigua*, which inhabits the same fronds of *Laomedea gelatinosa* as the other two, being found in rock-pools considerably above low-water mark; but it appears to be much less numerous than *E. despecta*. There are thus four species existing in the Mersey which have not hitherto been met with in the Dee; and it will presently appear that the Dee possesses five species which have not yet made their appearance in the Mersey. The *Polycera*

Lessonii, recorded as dredged off the Mersey, was taken about midway between the two estuaries, and can hardly be claimed, therefore, as the especial property of either.

Among those species common to both estuaries, one, however, deserves especial mention, viz. *Doris proxima*, from the fact that although found both in the Mersey and Dee, I am not aware of its having been taken anywhere else. In external characters it closely resembles *D. aspera*; but it is not a little remarkable that *D. aspera* has not yet been detected on these shores. I have searched in vain for it myself, nor can I hear that any one else has taken it *. It appears to be *replaced* by its ally *D. proxima*. This fact would lead one to suppose it to be a mere local variety, were it not that the tongue differs so widely in the two species that Mr. Alder remarks, "some naturalists might be disposed to consider them generically distinct."

I had the satisfaction of adding to the local list, in the autumn of 1859, *Eolis rufibranchialis*, characterized as one of the most slender and delicate forms of the genus. This beautiful species I first met with in July, at Hilbre Island, in the Dee, where it was of large size, and in some numbers. Visiting the Egremont shore of the Mersey in March of the present year, I was surprised to find as many as two dozen specimens of this brilliant creature where I had never seen it before. They were very brightly coloured, but not so large as the examples taken in the Dee.

The hunting-ground for these little animals in the estuary of the Dee is of very limited extent. On the Cheshire side, long before the time of low water, the tide runs out, leaving a vast and bare expanse of sand, most unproductive of animal life. The river is six miles wide at its mouth; and with the Welsh side I am unacquainted, owing to its distance and inaccessibility. But about a mile and a half from Hoylake, at the north-west angle of the Cheshire shore, commences a ridge of New Red Sandstone, nearly parallel with the coast, extending up the river for about a mile and a half, and rising at intervals into three small islands, called respectively Hilbre, Middle Island, and Little Eye. Hilbre is the largest and most seaward of these; nevertheless at low water three sides of it are left uncovered by the tide, and it is only a portion of the north-western side which is sufficiently steep and rocky to harbour marine animals. The other two islands are left high and dry at low water. Two miles higher up the river are some rocky prominences named Caldy

* In a note now before me, from Mr. Price, he says, "Every *Doris* (*aspera*) I ever suspected and sent to Mr. Alder, he pronounced to be *D. proxima*. They were sometimes pure white; their spawn dull yellow and inconspicuous, forming a squarish spiral."

Blacks, which are seldom visited, partly from their distance, and partly because the tide rushes up the Dawpool Deeps so rapidly and so insidiously, that, without great caution and some experience, the visit is not unattended with danger. Still it is necessary that these rocks should be mentioned, because at least one Nudibranch of rarity and interest has been obtained there. It is the north-west corner of Hilbre Island, however, which is the el Dorado of Liverpool marine zoologists; and it is really, for its extent, a spot of singular richness, but at the same time sufficiently difficult of access to render a visit to it an event of interest and importance. The low-water mark is fringed with a conspicuous belt of *Alcyonium digitatum,* interspersed with numerous specimens of *Sagartia sphyrodeta* (Gosse) and *Actinoloba dianthus,* with here and there an individual of *Sagartia viduata*; while immense and beautifully coloured *S. crassicornes* are clustered in masses higher up the rock, together with the ever-varying tints of the little *S. troglodytes.* Elsewhere the rocks are encrusted with sponges, such as *Halichondria panicea* and *H. oculata*; and in the little rock-pools are abundance of Polyzoa and Zoophytes, such as the delicate *Crisia eburnea* and the screw-like *Bugula avicularia* among the former, and *Laomedea gelatinosa, Sertulariæ, Campanulariæ,* and *Plumulariæ* &c. among the latter, mingled with the flower-like clusters of *Tubularia indivisa.* Beneath nearly every stone may be found numbers of brittle-stars (*Ophiocoma rosula* and *O. texturata*), which harbour there with the two species of Porcelain Crabs, *Porcellana platycheles* and *P. longicornis,* particularly the latter, and various species of *Terebella, Nereis,* and *Phyllodoce.* In other spots are thickly-planted colonies of the beautiful Fan-Amphitrite (*A. ventilabrum*), whose variegated and spiral gills often measure as much as 2½ inches across. Besides the Crustacea just referred to, there are always to be met with *Stenorhynchus phalangium, Hyas araneus, Cancer pagurus, Portunus depurator,* abundance of Hermits (*Pagurus Bernhardus* and other species) inhabiting shells which vary in size from the largest *Buccinum* and *Fusus* to the smallest *Mangelia,* the Æsop Prawn (*Pandalus annulicornis*), and a number of minute Crustaceans, such as *Nymphon gracile, Pycnogonum littorale, Lygia,* &c., while every weed is alive with the grotesque bowing forms of *Caprella Phasma* and *C. linearis.* In addition to this host of animals, the rocks are occupied with an abundance of boring Mollusks, particularly *Pholas crispata,* with here and there specimens of *Saxicava arctica*; and their slippery surfaces afford to the special searcher several Tunicates, such as *Ascidia, Clavellina,* and *Botryllus*; while *Tapes pullastra, Chiton cinereus, Trochus cinerarius, Purpura,* and *Buccinum* are among the shelled Mollusks, as well as occasionally some less common. Even fish are sometimes entangled in the pools, and may be taken by the hand, such, for instance, as the Spotted Gunnell (*Murænoides guttata*), and the Three-bearded Rockling (*Motella vulgaris*) frequently, and occasionally the Father Lasher (*Cottus bubalis*), the Black Goby (*Gobius niger*), the Fifteen-spined Stickleback (*Gasterosteus spinachia*), and the Power Cod (*Morrhua minuta*).

Such is the hunting-ground at Hilbre Island; and when it is borne in mind that all these and many more, and often rarer, animals are found in a space which might be traversed from end to end, but for the impeding rocks, in five minutes, it will be conceded that it is a singularly rich locality. Moreover, I have not yet alluded in this sketch to that tribe which is the especial subject of this paper (the Nudibranchiata), of which no less than twenty-two species have been found in this contracted spot, some of them being of the highest rarity and interest.

The second known specimen of the exquisite *Eolis Landsburgii* was taken by my friend Mr. Byerley at Hilbre Island in 1849. In August 1859 I met with a specimen at the same spot, having, as previously stated, found it in the Mersey in April of the same year.

Tritonia Hombergii is more frequently met with at Hilbre Island than in any part of the Mersey; indeed, although considered a deep-sea species, the island is seldom visited without a specimen being taken. I refer to it particularly here, because in August 1859, Mr. Moore the curator of the Liverpool Museum, visiting the spot, brought home a pure white specimen, a very beautiful and extremely rare variety. Mentioning the circumstance to Mr. Alder, he writes, "We have got *Tritonia Hombergii* nearly colourless, but not pure white; generally a little inclined to flesh-colour." That this was not a mere sickly individual, is proved by the remarkable fact that it, together with some specimens of *Eolis papillosa*, which were taken at the same time, lived under Mr. Moore's care for four months. It is generally difficult to keep the Nudibranchiata alive in confinement for more than a week or two, or at most a month; and indeed, if placed in an aquarium, the larger species at least usually perish in a few days. The secret of the present success lies, I think, in the fact that these specimens were placed in a shallow glass dish, and in a situation constantly exposed to draughts of fresh air, which kept the water well aërated.

The five species of Nudibranchiata which have been met with in the Dee only, and not in the Mersey, are the following:—

1. *Doris depressa*. This scarce little Doris, remarkable for the great relative size of the spicula, was once taken by Mr. Byerley at Hilbre Island.

2. *Doris subquadrata.* Only two specimens of this rare Doris appear to have been yet seen. The first was discovered by Mr. Alder, in deepish water at Torbay, in 1845; and the second was found by Mr. Byerley at Caldy Blacks, in the Dee. This specimen was forwarded to Mr. Alder, who confirmed the fact of its being *D. subquadrata.* I believe it has never been taken since. It was in company with *Doris pilosa,* to which species it is closely allied, but yet differs from it in several points, and particularly in the degree of development of the pallium, which in *D. subquadrata* is so scant as to leave the head and posterior part of the foot uncovered, when the animal is extended.

3. The third peculiar Dee species is the *Eolis olivacea.* The last excursion of the Liverpool Naturalists' Field Club was to Hilbre Island, on which occasion, notwithstanding that the day was hopelessly wet, it was not sufficiently so to damp the ardour of ninety-five members and friends of this flourishing Club. A few only landed; but among the captures I was glad to number *Clavellina lepadiformis,* new to our local list of Tunicata, while, among some Zoophytes brought from the island by Dr. Edwards, there appeared a specimen of the above *Eolis* not hitherto known in this locality. It was a small specimen, very brilliantly coloured, and altogether a very elegant addition to our fauna.

4 & 5. But the most interesting genus of all is perhaps that to which the remaining two species belong. I refer to *Antiopa,* the history of which is not a little remarkable. In 1844, M. Verany of Genoa described a species of Nudibranch inhabiting the shores of Southern Europe, under the name of *Janus Spinolæ.* The name *Janus,* however, having been already occupied by a genus of Hymenopterous insects, Messrs. Alder and Hancock proposed to call it *Antiopa,* in order to avoid confusion of generic terms. The animal in question appeared to approach very near in its characters to *Proctonotus mucroniferus*; but a remarkable crest between the dorsal tentacles, added to the lamellated form of the tentacles, and the terminal branching of the biliary cells of the papillæ, appeared to warrant its separation from the genus *Proctonotus*; and for seven years it constituted the sole species of the genus, under the name of *Antiopa splendida*; and perhaps it is one of the most beautiful of this beautiful tribe. It inhabits the Mediterranean Sea, the south coasts of Europe and England,—the Menai Straits being the only northern locality known when the Ray Monograph was published. In July 1851, however, my friends Messrs. Byerley and Price, when on a visit to Hilbre Island, each picked up a specimen of a new species of *Antiopa* possessing the crest of that genus, but in the tuberculated papillæ approaching still more closely to

Proctonotus than did the first *Antiopa*. One of these was sent to Mr. Alder, but died before it reached him; still, being a unique specimen, it was figured, and appeared in the Monograph under these adverse circumstances. Much as it resembled *Proctonotus*, the crest was with reason considered sufficient to distinguish it, and it was described under the name of *Antiopa hyalina*, the original species having in the mean time been renamed *A. cristata*—as I think, unfortunately, since the crest constituted a generic, and not a specific distinction. In August 1854 Mr. Byerley again met with a specimen of *Antiopa hyalina* within a few yards of the original spot. This was the first Mr. Alder saw alive, and it was a much superior specimen, more mature, and in altogether better condition than that figured, from which it differed in the greater length and more pointed character of the dorsal tentacles, the superior attenuation of the papillæ, and greater length of the tail. A careful drawing of it was made by Mr. Hancock, but too late to replace the one engraved for the Monograph.

This remarkably local species has hitherto eluded search in every other spot, and is peculiar to Hilbre Island in the Dee; and there, until the summer of 1859, it was the sole representative of the genus. In July of that year, however, I was so fortunate as to discover some fine specimens of *Antiopa splendida* (or *cristata*). These were such beautiful objects that I sent the largest to Mr. Alder, who informed me that even finer specimens occur in the Mediterranean. I look upon it, however, as the most lovely of the tribe, but one which has met with scant justice in that, for the most part, exquisitely-illustrated work. But it would perhaps be scarcely possible to delineate it satisfactorily: it deserves the name of *hyalina* even more than its congener. Mr. Moore, who visited Hilbre about a month after I had discovered *Antiopa cristata*, and who was with me on that occasion, upon looking into the rock-pool in which I had found them, saw an individual of that species, and, with it, one with which he was not familiar. He brought it to Liverpool; and on examination, it turned out to be another specimen of *Antiopa hyalina*. Thus this rare Nudibranch has been taken in the same spot at intervals of three and five years, and at last in company with its congener, exhibiting the curious and interesting spectacle of a small rock-pool containing an entire genus, the species of which are—one a widely-distributed animal, whose geographical range extends from there to the Mediterranean Sea, the other apparently one of the most localized animals upon the face of the earth.

The value of local lists is now fully recognized; and although they can never be deemed perfect, inasmuch as enlarged research and process of time may always be expected to bring to light additional species, nevertheless the collection of such carefully prepared lists is undoubtedly the best means of illustrating the Fauna of a country, as well as of elucidating the geographical range and distribution of animals. The following Catalogue of the Nudibranchiate Mollusca of the Mersey and Dee may be regarded as accurate and complete up to the present time.

Catalogue of the Nudibranchiata of the Mersey and Dee.

1. *Doris tuberculata.* Mersey and Dee; common.
2. —— *Johnstoni.* Mersey and Dee; once or twice.
3. —— *proxima.* Mersey and Dee; common (found nowhere else).
4. —— *bilamellata.* Mersey and Dee; abundant.
5. —— *pilosa.* Mersey and Dee; not uncommon.
6. —— *subquadrata.* Dee; once (the second known specimen).
7. —— *depressa.* Dee; once.
8. *Polycera Lessonii.* Between Mersey and Dee; once.
9. —— *ocellata.* Mersey and Dee; occasional.
10. *Ancula cristata.* Mersey and Dee; common.
11. *Tritonia Hombergii.* Mersey and Dee; occasional.
12. —— *plebeia.* Mersey and Dee; occasional.
13. *Dendronotus arborescens.* Mersey and Dee; common.
14. *Doto coronata.* Mersey and Dee; very common.
15. *Eolis papillosa.* Mersey and Dee; common.
16. —— *coronata.* Mersey and Dee; common.
17. —— *Drummondi.* Mersey and Dee; very common.
18. —— *rufibranchialis.* Mersey and Dee; not uncommon.
19. —— *Landsburgii.* Mersey and Dee; rare.
20. —— *concinna.* Mersey; common (the second known locality).
21. —— *olivacea.* Dee; once taken.
22. —— *aurantiaca.* Mersey and Dee; common.
23. —— *picta.* Mersey and Dee; not uncommon.
24. —— *exigua.* Mersey; apparently rare.
25. —— *despecta.* Mersey; common.
26. *Embletonia pallida.* Mersey (the only known locality); very rare.
27. *Antiopa cristata.* Dee; occasional.
28. *Antiopa hyalina.* Dee (the only known locality); very rare.

15 Oxford St., Liverpool,
August 1860.

[*From the* ANNALS AND MAGAZINE OF NATURAL HISTORY *for January* 1861.]

REMARKS

UPON SOME POINTS IN THE

ECONOMY OF THE NUDIBRANCHIATE MOLLUSCA.

BY

CUTHBERT COLLINGWOOD, M.B., F.L.S. &c.

[Plate IV.]

THE following observations were suggested by a small Nudibranch which was kindly sent me by a correspondent residing in Glasgow, Mr. Robertson, on the 25th of October last. This minute but beautiful little animal was dredged on a frond of *Laminaria saccharina* in 8 or 10 fathoms water, from a sheltered bay in the island of Cumbrae, Firth of Clyde. I received it alive, and had it under observation, in a tolerably active state, for two days. Supposing the animal to be a normal form, I could not refer it to any British genus: nor did a comparison with the characters of all the known genera of Nudibranchiate Mollusca appear to throw much light upon the subject; it seemed to agree with no known species. I contented myself, however, for the present, with preparing a full description and careful drawings of it while it was yet living, and taking every opportunity of watching its movements. It was tolerably lively—changing its place but little, however, though its body was in constant motion, rendering it a difficult task to delineate it with accuracy. The dorsal tentacles were singularly large, and were covered with active cilia; the papillæ, or what appeared to answer to them, and which in the Eolididæ are usually very active, were in this specimen motionless; and before death they became detached and fell off, giving the little creature the appearance of being in shreds. It floated freely, foot uppermost, on the surface of the water, as is the habit of Nudibranchs, and did not produce any spawn.

After death, I pursued the examination with the microscope, and now discovered that the skin was loaded with spicula—a fact which proved that it did not belong to the Eolididæ at all, that family possessing no spicula, and also that it was a member of the family Dorididæ, all of which, however, have more or less conspicuous branchial plumes. These spicula were symmetrically arranged, and very dense along the margin of the cloak; in shape they were generally cruciform, although a few were triradiate, and some simple. The tongue was broad, and formed of numerous small denticulated spines (eight or nine in a row), with two longer spines at either side (Pl. IV.).

The fact of the presence of spicula, which could only be determined after death, was an unexpected one, but came too late to be of service in a further comparison of the animal with the members of the family Dorididæ, to which it evidently belonged; and the absence of branchial plumes became now only more remarkable, without assisting in the identification. I therefore forwarded the drawings and description to my friend Mr. Alder, knowing that his close acquaintance with the family, and great experience in the critical examination of them, would be most likely to elucidate the affinities of this little animal. Nor was I disappointed: his answer, written with his usual kindness and promptitude, was, "Upon carefully examining your drawings, I cannot resist the conclusion that the animal is a young and undeveloped specimen of *Triopa claviger*." Upon turning to the figure of this species in the Ray Society's beautiful Monograph, I could not help feeling convinced that my specimen differed from it in very important particulars. In *Triopa*, for instance, there are distinct sheaths to the tentacles, which, after the most careful observation, I failed to detect in my specimen. The absence of branchial plumes, also, which it will be observed are visible enough in the drawing of *Triopa*, had to be explained; while the colour of the processes, which in my drawing is bright vermilion, in *Triopa* is orange-yellow. Still there were points of resemblance yet remaining which only one so well acquainted with the family as Mr. Alder would have recognized. The number of the *processes* in *Triopa* agreed with that of the *papillæ* of my specimen; there were papular elevations on the back, occupying the same position in both; and the peculiar dash of colour in the extremity of the foot was also common to both.

"The tentacular sheath in the young state," writes Mr. Alder, "is very small and difficult to detect." I examined the tentacles long and carefully without discovering this sheath; and I also felt convinced that if branchial plumes had been present, I could not have missed seeing them. But, in order to make this matter certain, I wrote to my correspondent who had kindly sent me the specimen, requesting to know if he had observed these plumes. In reply, he said that, although he had carefully looked for them immediately after having dredged it, he had failed to perceive them.

Mr. Alder's recognition of the species as *Triopa claviger*, therefore, does not divest the specimen of all further interest, inasmuch as it opens up questions of considerable importance with regard to the history of the Nudibranchiata, such as the following:—

1st. How far the so-called branchiæ of the Nudibranchiata may be considered as breathing organs.

2nd. To what extent colour is valuable as a specific distinction.

3rd. The great importance of a knowledge of immature forms.

If the term *Nudibranchiate* mean anything, it means that the gills or breathing organs of this order are naked, or uncovered, and external. This was the character assigned to them by Cuvier, in which he has been followed by the majority of zoologists; and although they were called Opisthobranchiata by Milne-Edwards, the meaning of the term is virtually the same. This eminent naturalist, in 1842, was the first to remark that the family Eolididæ, in which the so-called branchiæ are papillose, were possessed of a remarkable arrangement of the digestive organs. He found that (as he interpreted it) the stomach communicated with certain vessels, while these vessels sent off branches into each of the papillæ; and this gastro-vascular apparatus being recognized by Quatrefages, he applied to those Mollusks collectively which appeared to possess it, the term "Phlebenterata." M. Milne-Edwards, however, subsequently abandoned this theory, owing to the discoveries and arguments of M. Souleyet in France, and Messrs. Hancock and Embleton in England, all of whom maintained that the so-called gastro-vascular apparatus was no other than a highly developed system of biliary ducts in connexion with a divided liver. And the result of the controversy between these eminent anatomists was, that instead of it being proved that the Nudibranchiata exhibited in their structure a degradation of type, as had been maintained by Quatrefages, it was demonstrated by Messrs. Hancock and Embleton that in *Doris*, at least, a portal heart existed, and that all the Nudibranchiata possessed a sympathetic system of nerves, being the first instance in which they had been fully proved to exist in the Invertebrata, and a remarkable example of the value of controversy, such as is often aroused by erroneous statements.

The learned authors of the Ray Society's Monograph, however, distinctly affirm that, "from the state of the circulatory apparatus, the respiration is performed *only in part* by the branchiæ," and further that "in all the families, the skin, which is covered with vibratile cilia, acts as an imperfect accessory breathing organ." And considering these statements, we can scarcely regard the term Nudibranchiata as anything but a misnomer, or, at all events, only to a limited extent correct. In the instance before us, the branchiæ were absent, and yet the animal was lively. Mr. Alder suggested that the branchiæ might have been decomposed; but special inquiry of my correspondent who dredged it, elicited the fact that he looked for branchiæ, but saw none. How long this little animal may have existed without these appendages we cannot say, but it cannot have been less than three days; and yet it belonged to a family in which the branchiæ are considered to attain a high degree of development, and may therefore be supposed to have more of the work of aëration to perform.

So also in the genus *Eolis*, the papillæ or branchiæ (so called) generally begin to fall off before the animal dies; and I have seen specimens of *E. Drummondi* crawling about with their backs entirely bare. Whether this may prove anything against their value as breathing organs may be considered doubtful; for even supposing them to be gastro-hepatic organs, the loss of any, or at all events of most of them, should, *à priori*, be fatal.

Mr. Lewes says he has seen *food* oscillating in the papillæ of *Eolis*, simultaneously with the ordinary locomotive movements of the body; and when we consider the universal morphologies of true branchiæ, we cannot help perceiving that these papillæ do not come under the same category with them; for a branchia or gill is an organ of an arborescent form, offering by its duplications and reduplications, and laminated structure, as much *surface* as possible to the surrounding medium, and supplied with an afferent and efferent system of vessels. But the papillæ of the Eolididæ do not follow this morphological law; for although they are very *numerous* in certain species, great multiplication of them is not an essential element of the arrangement. Thus in *Eolis exigua* the normal number is about ten, and in *E. despecta* only six or eight; and from this they increase to an indefinite number in *E. papillosa*, which stands at the other end of the scale. Neither have these papillæ any afferent branchial veins in connexion with them; so that neither morphologically nor anatomically can they be regarded as *branchiæ*.

Taking as illustrations the three British families of Nudibranchiata, viz. the Dorididæ, Tritoniadæ, and Eolididæ, the following appears to me to be a fair statement of the value and degree of specialization of their breathing apparatus:—The first family (Dorididæ) consists of two subfamilies, of which the Doridinæ possess true and perfect branchiæ, external and naked, situated upon the median line of the body, large and elaborate in their construction, and easily performing the aëration of the blood, although they may receive slight and unimportant assistance from the general surface of the body, which is destitute of appendages. The other subfamily (Polycerinæ) possesses branchiæ of a smaller relative size, consisting usually of three or four laminæ only, which are inadequate of themselves to carry on the respiratory process. But in these the body is not simple as in the Doridinæ, but diverges more or less into *appendages*, which supplement the branchiæ by increasing the aërating surface of the body, and generally perhaps bear an inverse ratio in size and number to the development of the branchiæ.

In the second family (Tritoniadæ) the breathing organs, although not equalling the branchiæ of the Doridinæ in the perfection of their anatomical connexion, surpass them, and more particularly those of the Polycerinæ, in extent of laminated surface; they are numerous and effective, but placed along the sides of the back, instead of being collected to one point of the median line. Hence we find this family devoid of any secondary processes which may serve as auxiliary aërating organs, such as are found in the Polycerinæ. Still the communication which exists between the efferent branchial veins and the sinuses of the skin which contain venous blood, affords a character which places the Tritoniadæ considerably below the Dorididæ in the scale of organization.

But the papillæ of the Eolididæ are not branchiæ either by morphological structure or anatomical relation. In this family the respiratory function is distributed with nearly perfect equality over the whole body, no one part being specialized for that purpose. Here there is no duplication or lamination—no provision for multiplying the extent of surface—no distinct afferent branchial vessel—no means to secure the imperfectly aërated blood from contact with the venous stream contained in the dermal sinuses—in fact, no one character which is essential to a true gill. True, the blood is aërated sufficiently for the requirements of the animal; but it is not effected by means of branchiæ, but by the general surface of the body; and if the papillæ assist more than other parts, it is not because they are *gills*, but simply because the skin is there more delicate, and allows of a more perfect interchange between the blood there exposed and the oxygenating influences of the surrounding medium.

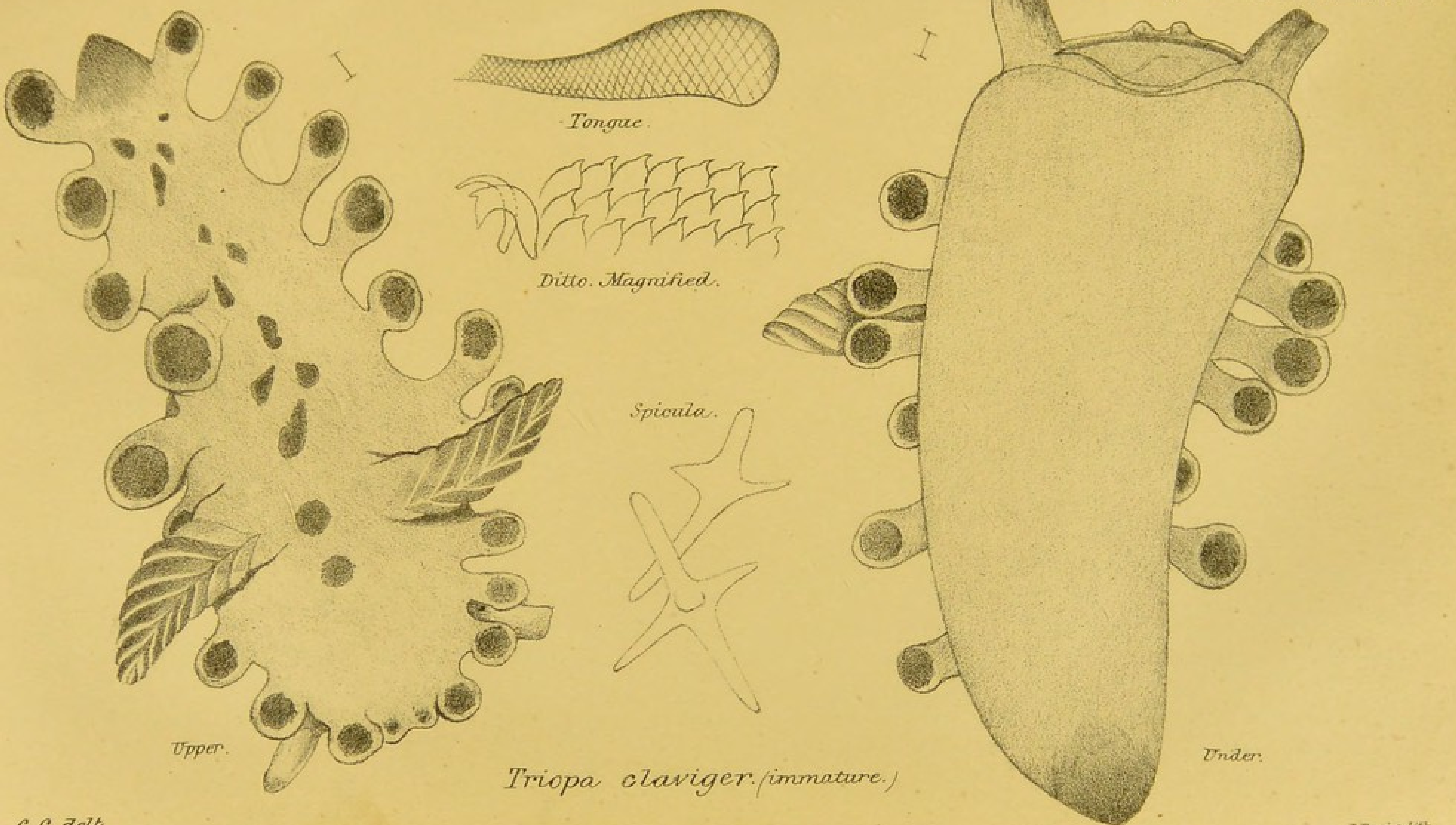
If to these important differences in the respiratory apparatus it be added that the Eolididæ in general have a much-divided liver, possess no buccal glands, no cloak with its attendant spicula, an uncomplicated systemic circulation, and an urticating apparatus similar to that of the Actiniæ (in all which respects they contrast with the Dorididæ and Tritoniadæ), there appears strong reason for believing not merely in the distinctness of the family, but that they are more widely separated from the true Nudibranchiata than has been generally admitted. At all events they have no title to the term Nudibranchiata, with which order they have apparently been associated chiefly on account of an accidental similarity of form.

With regard to the specific value of colour in the Nudibranchiata, I may remark that, in the individual specimen which has been the cause of these observations, the processes were of a bright vermilion, while in the mature *Triopa claviger* they are described as tipped with yellow or orange. Mr. Alder, however, does not lay much stress upon this fact, but only remarks that "the *Triopæ* we find in the north are more brightly coloured in the processes than those from the south." Now the most brilliantly coloured parts of the Nudibranchiata are usually the processes and papillæ, particularly the latter, in which there is a central ramification of the hepatic cells; and these it is which give the character to the animal. This brilliant colour is associated with fat, "always bearing a certain relation to the oily constituents both of plants and animals" (Bennett). Various influences of nutrition, seasonal conditions, and light, &c., may modify the production of pigment, although this last agent is no doubt less certain in its effects upon animals and plants living beneath the water, and perhaps in comparative darkness, than upon those inhabiting the surface of the earth. Indeed, the fact that many richly-coloured animals habitually lurk under stones and in obscurity would lead us to the conclusion that light has no influence in evolving these gorgeous tints. Be that as it may, however, colour, in the creatures which we are considering, is extremely capricious; and experience has shown that it is impossible to be sure, *à priori*, whether a certain colour is a permanent specific mark or otherwise. *Eolis Landsburgii* always possesses its characteristic amethystine tint, *E. rufibranchialis* its brilliant scarlet, and I have never met with an *E. coronata* which did not possess a delicate dash of ultramarine in the papillæ. But other species are far more variable, such as *Doris tuberculata*, which boasts of all the colours of the rainbow, *D. pilosa*, *Polycera* *quadrilineata*, &c., which vary considerably in the intensity of their markings; while of a great many other species some individuals are dark, or highly coloured, and others of the palest: such are *Polycera ocellata, Eolis papillosa, Embletonia pulchra, Hermæa dendritica*, &c. The danger, however, of naming these animals from the colour, especially when they are imperfectly known, is best illustrated by such examples as *Doris pilosa*, which has burdened science with not a few synonyms, having been called by Lovén, *Doris fusca*—by Leach, *Doris ochracea*—by Fleming, *D. nigricans*; whereas the species was in each case identical, and simply varied in colour. *Doris bilamellata* also received the name of *D. fusca* from Müller, but I have repeatedly met with it of the palest tint. *Tritonia Hombergii* is found sometimes purple, sometimes yellow, and Macgillivray described a specimen as a new species, under the name of *T. atrofusca*: it was, however, only a dark variety of *T. Hombergii*; and I have lately met with it of a pure white. Even the careful authors of the beautiful Ray Monograph have not steered quite clear of this error, for I have found specimens of *Eolis aurantiaca* in which no trace of orange colour was evident; and in the 'Ann. Nat. Hist.' for 1842 a species was described under the name of *E. pallida*, from its want of colour, which it behoved its discoverers to re-name, at a subsequent period, as *E. picta*, owing to the rich and variegated tints with which most examples were adorned. Both pale and dark varieties occur on the shores of the Mersey. It would appear, therefore, that no degree of certainty attaches to the fixity of colour as a specific character, and it is only when the species has been well observed that any reliance can be placed upon the uniformity of its tints, and this at too late a period for it to be of any real service in nomenclature. Not, however, that this danger is peculiar to the naming of the Nudibranchiata; it is a generally besetting one; and numberless examples might be adduced, both from the animal and vegetable kingdoms, of the fallacious and variable character of colour, and its untenability as a specific distinction.

The development of the Nudibranchiate Mollusca has not been clearly traced through all its stages; but the hatching of the ova may be readily observed; and from these ova there are produced little shelled Mollusks, or Nautilines, which are freely moveable by the aid of large ciliated lobes; but whether they undergo further metamorphosis has not been satisfactorily ascertained. There can be no doubt, however, that in order to comprehend with correctness the affinities of new species, some knowledge of the immature forms of ascertained species is necessary. The relative degree of development of certain organs can hardly be arrived at by *à-priori* reasoning; and an examination of the animals themselves in various stages of growth is requisite for the formation of correct conclusions. Thus, in the individual which has been the cause of these remarks, although the general conformation of the body presented evident signs of its not having arrived at maturity, the dorsal tentacles were well developed, and of a much larger relative size than in the mature *Triopa*. The tongue also, which is an organ of the utmost importance in determining species, appears to have been in this specimen well developed; and a careful examination of it with high powers of the microscope revealed the curved lateral denticles which are described as belonging to *Triopa claviger*. Whenever a doubt arises as to whether an animal is a new species or the young of a known species, the tongue is a useful criterion which may be safely depended on, and the more valuable because it is one of the hardest and most imperishable structures of the Nudibranch, and may serve to determine after death, a species which we have failed to recognize during life. The spicula also are important hard structures, though more variable than the tongue. It is remarkable that in my specimen—immature, be it remarked—the spicula were more highly developed than usual, being for the most part *cruciform*, while those of *Triopa* are usually *triradiate*. Mr. Alder remarks upon this, "I have drawings of the spicula of *Triopa claviger* very similar to yours, cruciform or dagger-shaped; but the triradiate are the more common kinds."

The distribution of these spicula in the Nudibranchiate order is worthy of attention. They are usually calcareous and situated in the cutis. The Dorididæ invariably possess them in large quantities, especially the Doridinæ or true Dorids, in which they are more abundant and are arranged more symmetrically than in the Polycerinæ. The Tritoniadæ do not possess them, and the Eolididæ also are entirely devoid of them, the skin in these last being soft and pliable, and the cloak absent. I once believed I could perceive a reason for this difference, in the fact that the Dorids and Polycerinæ having special and effective branchiæ, the presence of spicula thickly distributed through the dermal covering would not so much interfere with their respiration as they would with that of the Eolididæ were their skin largely occupied by them; for these latter, having no special branchiæ, require an unimpeded surface for the vascular system to be brought as much as possible in contact with the surrounding element. But the fact that spicula are found even in the branchial plumes of the Dorids and Polycerinæ militates against this theory. On the other hand, if what I have previously said is true, as to the incorrect position hitherto assigned to the Eolididæ, we should not be bound to expect that their external similarity of form to the true Nudibranchiata should necessarily be accompanied by an identity of internal economy.

But, to return to the necessity which exists for an acquaintance with immature forms, particularly among those who give names to apparently new species, the history of the Nudibranchiata is not without instances of the unnecessary multiplication of synonyms arising from this fertile source. Messrs. Alder and Hancock tell us that *Goniodoris nodosa* has received several distinct names from those who have observed it in different stages of growth. When young, and before the tubercles have begun to appear, they are the *Goniodoris emarginata* of Forbes; after a time they assume the appearance of the *Doris nodosa* of Montagu; and even when full-grown, the distention of the body with spawn, by rendering the tubercles obsolete, has given rise to the spurious *Doris Barvicensis* of Johnston. Other instances of this kind might be cited; but it must not be forgotten that there is also a danger of falling into the opposite error—that, namely, of mistaking a really distinct animal for the immature form of another species. Thus, *Tritonia alba* was long regarded as the young of *T. Hombergii*, until distinguished by Alder and Hancock; and *Tritonia plebeia* was also for some time imagined to be the young of the same animal, until recognized as a distinct species by Dr. Johnston. In all similar cases, the persistence of characters in the smaller animals, added to a careful examination of the *tongue*, will seldom fail to lead to a correct conclusion in the end.



Triopa claviger. (immature.)

C. C. delt

J. Basire, lith.

Read before the Liverpool Literary and Philosophical Society, on the 19th March, 1860, and Extracted from their Proceedings.

ON HOMOMORPHISM;

OR, ORGANIC REPRESENTATIVE FORM.

By C. COLLINGWOOD, M.B., F.L.S., &c.

By Homomorphism is meant the recurrence of certain external forms in various departments of Nature, more or less widely separated by internal structure; so that at the outset, it is necessary to divest the mind of the idea that it partakes in any way of the character of homology.

By Homology, indeed, is distinctly understood a structural affinity, uniting, as it were in a common bond, the same organ, under whatever form it may appear, or whatever function it may assume. The limbs, for example, of quadrupeds, the wings of birds, and the fins of fishes, are thus structurally united, and although taking very different *forms*, are strictly homologous one of the other. But the wing of a butterfly, though bearing a general analogical resemblance to that of a bird, has yet no community of structure with it; nor has the wing of a bat any stronger claim to be considered homologous with the wing of a true bird. The wings of a bat, or a butterfly, are *homomorphous* with the wings of a bird, and indeed perform the same function;—so far, therefore, they may be regarded as *analogues* of those organs. But it must also be understood that homomorphism does not necessarily imply analogy, in the proper sense of that term; for by analogy is understood, as distinguished from homology, an agreement of fuuction, where there is no community of structure, as just instanced; whereas homomorphism, while it expresses, primâ facie, an *absence* of agreement in structure, or homology, may, or may not, be accompanied by similarity of function, though the want of such functional agreement is the rule, and its presence an accidental exception.

From this it will readily appear that the study of homomorphism cannot be expected to be so prolific of important results as the study of homologies, inasmuch as these latter are believed to be the bonds of connection which unite forms apparently widely separated, and which throw light upon the true affinities of obscurely constituted organisms. And herein probably lies the reason why homomorphism has attracted so little attention from naturalists. I am not aware of any essay (though such there may be) upon this curious subject, which either collects and compares the various examples with which Nature abounds,—or, still less, which attempts to treat it upon such a basis as that on which all natural science should be treated. It appears indeed to be barely referred to here and there in the writings of zoologists, as something striking and remarkable, usually called up by some peculiarly curious fact in connection with the special subject upon which they happen to be engaged, and then quickly dismissed as a barren topic, unworthy of further investigation. A singular resemblance thrusts itself upon the attention, claims a passing allusion, and is no more thought of. My object, therefore, in the present paper, is to dwell more at length upon the vast number of recurrent forms met with in the *animal* kingdom, referring to the considerations which seem to be derivable from them, and the generalizations which appear to be legitimately deducible from the enquiry.

It will probably occur to some, at the first blush, that organic homomorphism has a correlative in the inorganic world; but the restricted definition already given will exclude the class of representative forms known to the chemist under the name of *isomorphous*. This term refers to a similarity of crystalline form, assumed by substances (even compounds) of different constitution, a strong corroborative argument in favour of Wollaston's theory of the simple form of atoms.* But Mitscherlich has shown that isomorphism implies, primâ facie, in bodies subject to it, a certain agreement of chemical properties, which may be regarded as the analogues of organic functions. Thus, " the acids of arsenic and phosphorus form salts which crystallize alike, and their respective bases not only correspond in a more general way in acquiring acid properties with oxygen,—forming gaseous compounds with hydrogen, &c., but also in the unusual proportions in which oxygen and hydrogen enter into union with them,—while the corresponding arseniates and phosphates also agree in taste, and in the degree of force with which they retain their water of crystallization."† This similarity of properties therefore raises isomorphous bodies from being homomorphs to the dignity of analogues.

The animal kingdom has been so severely scrutinized during the last half century by men of keen perception, such

* Bakerian Lecture, 1813.

† Daubeny, Atomic Theory, p. 170.

as Cuvier, Owen, Huxley, and others, that science is no longer at a loss for the key to the general plan upon which it has been constructed. The study of morphology, or the science of form in connection with structure, has demonstrated that there is a certain unity of plan running throughout it; and that although it is impossible to construct an archetype which shall stand for all animals, it can be shown that four such archetypes, or at most, five, will represent the primary forms around which, as centres, the whole animal kingdom may be grouped. This being the case, we might expect that there would be a certain degree of similarity of form among animals; indeed, on learning these facts, we might be disposed to look for and expect a far greater degree of similarity than we shall find; and we cannot help feeling surprised at the vast and interminable variety of form which is made as it were the vehicle for the modification of four or five types. But Nature is inexhaustible in resources, and variety is one of the charms of Nature which the Creator has afforded in an eminent degree for the adornment of the earth, and for the intellectual exercise of his highest creatures.

It is often said that no two things are alike in nature,—and with truth,—for the resemblance, whether in outward form, or in internal organization, always partakes of the character of a *near approach*, and never of direct repetition. It must not be supposed that homomorphism means repetition—Nature never repeats herself; the resemblance may be striking, and such as at first sight may cause the uninstructed to confuse together animals of very different groups; but a close study of either by degrees reveals differences no less striking than are the points of resemblance. Of this many instances will be adduced as we proceed. And this rule is constant throughout nature; for even in the inorganic world, where the resemblances are even more close than in the organic, (inasmuch as the forms assumed by inorganic matter, such as crystals, are far more simple than those exhibited by organized beings,) this fact has long been recognised. Some writers, indeed, who aim at greater precision of language in chemical technology, have proposed the term *plesiomorphism*, as a substitute for *isomorphism*; and Daubeny, while he objects to the necessity of the change, yet admits "that it would be perhaps difficult to point out two bodies which are exactly isomorphous."*

It cannot be a matter of surprise, considering the number of such resemblances existing throughout the animal kingdom, that while the study of homologies was making but slow progress, and the true affinities of animals were but little understood, the real nature of many aberrant forms should have been lost sight of in the contemplation of their homomorphic resemblances. Who can wonder if Pliny spoke of the bat, as "the onely bird that suckleth her little ones," in quaint old Holland's phraseology? What malacologist even can feel surprise that up to recent times the Polyzoan molluscoids were mistaken for zoophytes, or that Lhuyd, and at one time the illustrious Ellis, should have regarded them both in the light of "remarkable sea-plants;" while his predecessor, Baker, had even looked upon them as the production of "salts incorporated with stony matter."† Who can wonder that before the time of Savigny, the tunicated Botrylli should have been regarded as polyps—that Linnæus should have placed Teredo among the annelids—that before the Memoire of Dujardin in 1835, the Foraminifera should have been classed with the cephalopodous mollusca? In all these cases, (and others might be brought to swell the list,) the animals have been raised, or have sunk from one *sub-kingdom* to another, and have even *overleaped* a whole sub-kingdom, to take that place in the scheme of nature which their affinities

* Atomic Theory, p. 175.

† Employment for the Microscope, p. 210.

claimed for them. So late as 1812, the whales and dolphins were classed in a systematic work as "cetaceous fishes." Even now, indeed, many an animal is provisionally placed in a position which it occupies, perhaps solely, by its morphic analogies, because, from the rarity of its occurrence, or from the difficulty of bringing specimens under the scalpel of competent anatomists, its true homologies cannot be tested, and its correct position verified.

These homomorphic resemblances, however, have proved useful in their way, by affording an easy clue to a nomenclature which shall be at once apt and serviceable. Amidst the vast number of species requiring to be distinguished by a generic and specific name, systematists are often hard pressed to frame a new designation; since the same name given to two species, or even to two genera, however widely separated, is liable to lead to confusion. The inevitable result is that the most barbarous words are constantly being coined in the natural history mint, and bad Greek and Latin are mixed up with native names in nearly all the dialects of the world; and these, with a dash of the Smithii, and Jonesii, and Brownii, form altogether a Babel which is the opprobrium of natural history. But a homomorphic resemblance at once suggests a *natural* nomenclature, that is to say, a word which, by indicating the nature of the resemblance, is at once an appropriate name, and a good guide to others in the recognition of the animal *Auricula Midæ* (Lam.) is an excellent name, not only affording a clue to the shell referred to, but also delighting the scholar with the imaginative associations raised up by the beautiful classic fable on which it is founded. Few names indeed are so happy, but still such as *Cestum Veneris*, *Phyllium siccifolium*, *Crioceratites*, *Ophiura*, and the like, contrast favorably with such cacophonisms as *Hyperöodon Butzkopf*, *Pterodictycus potto*, *Balæna Agamachshik*, (Pallas), *Notopocorystes Broderipii*, or *Ardea brag!*

But although they were not always recognised as such, the existence of recurrent forms in nature could not be overlooked by the framers of systems, inasmuch as they were stumbling-blocks which almost seemed placed in their path to prevent the natural arrangement of animals from being too easy a task. A too cursory examination has not unfrequently resulted in the false position of an animal, only to be detected and triumphantly exposed by a succeeding zoologist; for not only are classes and sub-kingdoms homomorphically represented by widely separated ones, but the naturalist has often been led into exclamations of surprise at the remarkable homomorphisms existing between orders of the same class. These curious resemblances cannot better be illustrated than by comparing, first the classes of the vertebrata one with another, secondly the vertebrata with the invertebrata generally, and thirdly the sub-kingdoms of the invertebrata one with another.

Beginning then with the classes of the Vertebrata,—every one knows, whether he have thought about it or otherwise, that the four vertebrate classes are homomorphically connected. Thus, there are flying mammals, such as the bats and flying squirrels (Pteromys) uniting them with the class Aves; as well as that anomalous monotreme, the ornithorhynchus, or web-footed duck-bill. The Edentata among quadrupeds connect them with reptiles, by means of the armadillos; the great armadillo (Dasypus gigas), and preëminently, the mataco (D. apar), being homomorphic with the Testudinata; while to the saurian reptiles they are united by the scaly pangolins (Manis), and to the extinct pterosaurians (Pterodactyls) they are again united by the bats. With fishes, the mammalia are most singularly connected by the cetacea; while a special resemblance appears between the narwhal (Monodon) and the sword-fish (Xiphias.) The homomorphic resemblances between birds and reptiles are not so striking, but the Draconine saurians or flying lizards (Draconis sp.) supply examples, and the extinct pterodactyl once afforded another; while with fishes, the various species of flying fish (Exocœtus) among the soft-finned, and flying gurnards (Dactylopterus and Pterois) among the hard-finned, are good illustrations. It only remains to connect reptilian forms with fishes, and here the snakes (Ophidia) with the eels may well be compared, and less striking instances of resemblance occur between the saurian reptiles, such as the alligator, and the bony-cased sturgeon; and between the testudinata and the trunk-fishes (Ostracion.) Perhaps also that great enaliosaur, the Ichthyosaurus, might be here mentioned.

I remarked just now, that even between orders of the same class very curious homomorphisms may be observed; and I will select the class mammalia as the best one with which to illustrate this remark. The organic structure and affinities of one *order* are dissimilar from those of another, just as the structure and affinities of one *class* differ from those of another; the difference between class and order being one of *degree* and not of *kind;* so that it is as remarkable to find resemblances of form in widely separated orders, as in still more widely separated classes, although, of course, homomorphic resemblances are more striking between orders than between classes. Let us take, for example, the order quadrumana, (for I will not speak of the homomorphism existing between the bimana and the quadrumana,) and we shall find among them representative forms of various other orders. Thus, the genera Midas and Jacchus, known as marmozets, true platyrrhine quadrumana, represent the rodentia through the genus Sciurus (squirrels); and the Douricouli (Nyctipithecus felinus), in the same division, represents the cat (Felis) in the digitigrade carnivora; while among the strepsirrhine quadrumana, the loris (Stenops tardigradus) represents the true sloths in the order bruta, and the very aberrant animal, falsely called the flying squirrel (Galeopithecus), is the representative of the order cheiroptera or bats.

Among the pachydermata are some no less striking examples of species, homomorphic with those of other orders. Thus, the hyrax, an animal in structure intermediate between the rhinoceros and the tapir, a miniature rhinoceros as it has been called, yet so closely resembles the rodentia in its outward form, that it was long classed with them, and Cuvier makes the following remark concerning it: "There is no quadruped," he says, "which proves more forcibly than the daman (Hyrax capensis) the necessity of having recourse to anatomy as a test by which to determine the true relationship of animals."

The general resemblance between the cetacea and the pinnigrade carnivora (seals) need only be referred to; it is made very distinct through the herbivorous family Manatidæ, especially the dugong (Halichore dugong.)

We have seen how the loris resembles the sloth; and on the other hand, the edentate genus Bradypus (Ai) bears a singular resemblance to monkeys in general, even in that particular which is so characteristic of them, viz., their physiognomy,—while it has a carnivorous homomorph in the sloth bear (Ursus labiatus), called by Pennant the ursiform sloth, and by Shaw, Bradypus ursinus.

The insectivora are connected through the hedgehog (Erinaceus Europæus) with one of the most anomalous of animals, the singular monotreme genus Echidna, which has besides other homomorphs to be afterwards mentioned; and further through the shrews (Sorecidæ), with the rodent genus, Mus; and with the carnivora, by the bulau (Gymnura Rafflesii) of the East Indies, formerly described as a Viverra.

The rodentia are united homomorphically with the pachydermata by means of the capybara (Hydrochœris capybara, Buff.), formerly called, from its pig-like appearance, Porcus fluviatilis (Fermins), thick-nosed tapir (Pennant), cochon d'eau (Desmarchais), and Sus maximus palustris (Barrère.) By the flying squirrel (Pteromys) they claim some homomorphic affinity with the cheiroptera; but their chief homomorphism is with the marsupialia, and most striking are the resemblances. Not only do the rodentia and marsupialia bear a general mutual resemblance throughout,—both orders possessing that extraordinary development of the hinder extremities and tail, which enables the jerboas in common with kangaroos to take such wonderful leaps,—but there are particular animals in both orders which bear a most remarkable resemblance to one another. Thus, the rodent jerboas (Dipus) are closely imitated by the tufted-tailed rat-kangaroo (Hypsiprimnus penicillatus, Gould); and the true kangaroos (Macropus) are equally nearly approached in form by the Cape leaping hare (Pedetes capensis, Ill.) There is also a considerable resemblance between the wombat or badger of the Australian colonists (Phascolombys Wombat, Per. and Les.) and the rodent cavies and lagomys; while a further homomorphism occurs between individuals belonging to aberrant groups in either order, viz., the Brazilian porcupine (Synetheres) among the rodents, and the echidna among the monotremes, whose relation to the insectivora has already been pointed out.

These external resemblances between rodents and marsupials are none the less remarkable when we learn that there is less true affinity between them than between the marsupials and most other orders; for Mr. Waterhouse, in his excellent "History of the Marsupialia," remarks that in them "we find representatives of most of the other orders of mammalia: the Quadrumana are represented by the Phalangers; the Carnivora by the Dasyuri; the Insectivora by the small Phascogales; the Ruminantia by the Kangaroos; and the Edentata by the Monotremes." He adds "The Cheiroptera are not represented by any known marsupial animals, and the rodents are represented by *a single species only;*" the species here referred to being the wombat.

Lastly the marsupialia, besides their homomorphism with the rodents, have through the ursine opossum, or native devil of Van Diemen's Land (Dasyurus,) a singular relationship to the carnivorous genus, Ursus; as well as through the squirrel petaurus, to the bats.

I shall not here attempt to follow out the homomorphisms existing in the orders of the class Aves, because it would make the present paper too long for the occasion; but they will be found to be not less striking than those of the mammalian orders; and I will content myself with an illustration by means of the first, or rapacious order. Here the elegant Nauclerus furcatus, or swallow-tailed kite, stands for the passerine genus Hirundo; and the Egyptian vulture (Cathartes aura) is singularly matched by the rare Corvus gymnocephalus, or bald-headed crow, of Guinea. The scansores are connected by the similarity between the sparrow-hawk (Accipiter nisus,) and the cuckoo (Cuculus canorus,) as well as more generally between the owls and parrots. The burrowing owl (Noctua cunicularia,) of America, unites the rapacious with the rasorial birds—the anomalous secretary bird (Gypogeranus,) of Africa and the Philippines, connects them in a most remarkable manner with the grallatores, and the çariama (Sariama cristata,) in particular, for which it might readily be mistaken. The long legged harriers (Circus,) also maintain the resemblance, while the sea eagle (Haliäetos) completes the homomorphism, by connecting the raptorial birds with the natatores through the albatross (Diomedea.) Having thus illustrated one order I will quit this class of birds, only calling attention to the remarkable general resemblance between the rare Conirostral genus opisthocomus and the rasorial guans (Penelope,) the fissirostral hirundines and the natatorial terns (Sterna,) and the grotesque parrots, and equally grotesque puffins, (Fratercula.)

We shall not find it so easy to discover homomorphic resemblances among the reptiles, for there is no class which exhibits less variety within the limits of its orders, and the observation of Professor Bell, in his "Monograph of the Testudinata," with respect to the tortoises, may be applied with nearly equal force to the whole class Reptilia. "At present," says that eminent erpetologist, "they certainly remain the most isolated order, not only amongst the reptiles, but perhaps in the whole animal kingdom." Small indeed, in number, as a class, the four orders into which they may be divided are singularly characteristic and circumscribed, as well as constant in their characters. The chelonian reptiles shut up in their unyielding box—the saurians, all more or less lacertine in form—the elongated and simple ophidians, nor the short and long-tailed amphibians are capable of the same degree of diversity as are the other vertebrate classes; and although I have pointed out their homomorphic connection with the latter, with the aid of extinct forms, it is not easy to find homomorphic individuals in distinct orders, except among the lacertine sauria, and the long-tailed amphibia. When, however, they do apparently occur, it becomes probable that they are of the nature of *links* connecting different orders, and therefore partake of homological rather than homomorphic resemblance, and are inadmissable for our purpose.

A different remark, however, is applicable to the class of *fishes*. There is perhaps no tribe of animals, not even excepting the vast class of insects, which present such extraordinarily singular and eccentric forms, as do fishes. There is no degree of anomalous shape, nothing so marvellously *outré* which the imagination can conceive, which is not paralleled in this most wonderful class. I venture to say that if a person of the wildest fancy, but unacquainted with piscine forms, were to depict in his most exuberant moments an imaginary creature, as unlike any living being as he could conceive, some finny reality might be advanced to cap the monster. Take for example, and as a familiar instance, the hammer-headed shark (Zygana laticeps,) or the painted angler (Lophius pictus,) or the viper-mouthed pike (Esox viridis,) or Syngnathus foliatus, Stylophorus chordatus, Raia fasciata, and a host of others, which might easily be mentioned. But with all this wonderful variety, the forms of fishes are *sui generis*, and in no class is it less easy to find homomorphic shapes. Their morphic affinity to the other vertebrate classes has been already indicated, but order with order has little in common. The inexhaustibility of Nature's plastic resources is shown in no class to more advantage; and yet, strange to say, there is no class in which I have succeeded less in tracing homomorphic resemblances.

There is a remark which has occurred to me, and which, though it will be proper to introduce it here, must be carefully borne in mind, as it will be particularly referred to hereafter; namely, that among such animals as bear homomorphic resemblance to those of another and differently organized group, an agreement in form is generally accompanied by a singular agreement in habits. It matters not how different are the habits of the group to which it homologically belongs, from those of the group which it homomorphically resembles; it diverges from its own tribe as much in its *actions* as it does in *form*, as though a certain external configuration necessitated certain habitual movements. A few examples will illustrate my meaning, taken from within a class, where such habits are more easily compared than in animals of different classes. Thus the ursine opossum (Dasyurus ursinus,) widely separated as it is from the plantigrade carnivora, not only agrees far more closely with a bear in form than with its own congeners, having a short, clumsy figure, and plantigrade step, but it is said of them by their discoverer that "they frequently sat on their hind parts, and used their fore paws to convey food to their mouths; and many of their actions, as well as their gait strikingly resembled those of a bear."* The quadrumanous douricouli, (Nyctipithecus felinus,) not only resembles a cat in form, but is, like it, nocturnal in its habits, glides about with the stealthy movements of a cat, and "when irritated, in the posture it assumes, and the puffed state of the fur, it resembles a cat attacked by a dog." The pachydermatous hyrax lives gregariously in burrows, like the rabbits which it so much resembles in form. The echidna rolls itself up into a ball when disturbed, like its homomorph, the hedgehog. The lemurine Galeopithecus makes its flight with its young attached to the nipple, as do the true bats. The habits and food of the sea-eagle closely agree with those of the albatross; and the burrowing-owl is diurnal in its habits, and uses its feet more or less for purposes of scratching, in both which respects it differs from its congeners, and agrees with the Rasores, which it resembles in form.

Besides, however, the general homomorphism connecting whole animals in different classes or orders, it is at least curious that there are certain appendages in each class, which are characteristic of certain individuals, and distinguish them perhaps from every other, not only in their order, but in their class, but which reappear homomorphically in certain individuals in the other classes. Such an appendage is the nasal horn of the rhinoceros, which is so peculiarly distinctive of that animal. Among birds there are several instances of a central horn, but it usually springs too high up on the forehead to bear out the resemblance; as for instance the horned screamer (Palamedea cornuta). In the carunculated chatterer of Brazil, (Procneas nivea,) the appendage, which is not really

* G. P. Harris, in Linn. Trans. ix., 174.

a horn, is situated far in front of the eyes, and better represents the rhinoceros' horn; in the rough-billed pelican, however, (Pelicanus trachyrhynchus,) a stout horn-like excrescence really grows from the middle of the upper mandible; and in some species of hornbill, (Buceros,) the analogy is well carried out. Among reptiles, the extinct Iguanodon distincly reproduces the nasal horn, though it was small in comparison with the size of that colossal brute. There are many fishes which possess a single central horn, but in some of them, as in the birds, it is situated too high up on the head to bear out the resemblance. This is the case with the genus Monacanthus; but in Naseus fronticornis of Cuvier a horizontal horn projects in front of the eyes; in Chimæra monstrosa of Bloch, an inconsiderable appendage occurs in the middle of the nose; while the true homomorph perhaps may be considered to be a very rare fish, Lophotes siculus, of Swainson, of which a specimen exists in the British Museum. Here the first dorsal ray assumes the form of a horn-like process, a palm and-a-half long, Sicilian measure, somewhat three sided and pointed.

The proboscis also, so characteristic of certain pachydermatous mammalia—but which is not peculiar to them—being found in the elephant-seal (Macrorrhinus proboscideus,) as well as in some Insectivora, as Solenodon paradoxus, may be seen repeated in such birds as have the upper mandible longer than the lower, but particularly in the Heterorhynchus olivaceus of Lesson,* supposing that bird to be a normal form. Among reptiles, proboscidian forms are numerous in serpents of the genera Rhinophis, Langata nasuta, &c., and the remarkable Matamata of Cayenne, (Chelys fimbriata, Spix,) an aquatic chelonian, possesses a nasal development, precisely similar to the tapir among quadrupeds. The proboscidian species o

* Magasin de Zoologie, 1839.

fish are best represented by the curious frog-fish (Malthe nasuta,) and the extraordinary sword-fish (Xiphias gladius).*

The horns characteristic of ruminant mammalia, are paralleled, as simple elevations, by the tufts on the heads of owls of the genera Scops, Bubo, and Otus. The Egyptian Cerastes, or horned viper (Vipera cerastes,) among reptiles, and the eared trunk-fish (Ostracion auritus, of Shaw,) a formidable-looking native of the Indian seas, complete the analogy. So also with the frill round the neck from which the frilled lizard (Chlamydosaurus Kingii,) takes its name, whatever its use, it is nearly approached in form by the union of the pectoral fins of either side at their base in certain fishes, as the lump-sucker (Cyclopterus,) of our own shores; while among birds, the ruff (Machetes pugnax,) takes its name from a similar development of feathers round the head, seen also in certain humming birds, as Trochilus ornatus, and tricolor. In quadrupeds, hair supplies the resemblance in such animals as the full-maned colobus, or full-bottomed monkey of Pennant, (Colobus polycomus.) And lastly, the pouch of the pelican finds its representative in the Iguanas among reptiles.

Having thus examined the homomorphisms which exist within the sub-kingdom vertebrata, we have next to enquire what morphic connection is found between it and the other great division of *in*vertebrata. We can hardly expect to find in animals constructed on so different a plan as are the invertebrates generally from the vertebrates, that there should be so much recurrence of form between them, as we have found within the vertebrate sub-kingdom, all the members of which may be reduced to one archetypal form; nevertheless we shall meet with some striking instances of it.

Let us commence with the Mammalia; and here we find a

* It is perhaps worthy of remark that a proboscidian form occurs among the invertebrata. Thus, in the curious annelid, (Derris sanguinea,) a native of our shores, "the mouth consists of two lips, the lower one straight and fixed, the upper one hooked and moveable."—*John Adams, in Linn. Trans.*, iii., 68.

general resemblance of form between the mailed armadillos and the molluscous chitons; the isopodous crustaceans, Oniscus, and Lygia, and the fossil Nileus armadillo. The extraordinary development of the posterior extremities in the marsupials and rodents is paralleled in a remarkable manner among the Insecta by the kangaroo-beetle (Scarabæus macropus); and some of the Tardigrade arachnida, or water-bears, have a most ludicrous resemblance to certain mammalia, as may be seen particularly between Echiniscus suillus,* and a pig, or perhaps rather the insectivorous genus Centetes.

Passing on to birds, the homomorphism which is borne to them by winged insects generally, and more particularly by the stout-bodied moths and sphyngidæ, will be at once recognised. Between special birds and special insects even, homomorphism may be established. Thus the Nemoptera angulata of Latreille, a neuropterous insect, from the peculiar direction and form of its posterior pair of wings, bears a near resemblance to more than one species of Cynanthus, among the trochilid family of humming birds, as well as to the scissor-tailed blackcap (Gubernetes Yetapa, Viell,) of South America. And what closer resemblance can be looked for than that between the head of the vulture, and the avicularia, or bird's head appendages so common in the polyzoa, especially Bugula, and which are considered by Huxley to be truly a part of these molluscoids, and not of a parasitic nature.

Among the Invertebrata, we find no less striking recurrent forms of reptiles. Thus the snakes are represented by the terricolous annelids; as well as by the Ascaris lumbricoides and Strongylus among the nematoid entozoa. A very curious special homorphism also happens between the Siphonops (Cecilia annulata,) and the common earth-worm (Lumbricus terrestris.) The shelled Testudinata have a singular homomorph in a shelless mollusk, viz: the tunicated Chelysoma, so

* Ehrenberg Microgeologie, pl. 36.

called from this resemblance; as well as in the chitons, and the remarkable coccus described by Shaw as Coccus cataphractus, or the mailed coccus, connects them with insects.

Nor are the fishes altogether without their invertebrate imitators. The Diodon hystrix, or porcupine diodon may be compared with an echinus; the head of the anomalous hammer-headed shark has a parallel in the dipterous genus of insects, Diopsis, as well as the Achias oculata of Latreille, remarkable for the enormous prolongations of the sides of the head; and the curious little Pegasus draco, is the counterpart of a pteropodous mollusc.

Let us now dismiss the Vertebrata, and launching into the midst of the vast host of invertebrate animals, let us see what homomorphisms exist among their various classes and orders, dividing them simply and conveniently into mollusca, annulosa, cœlenterata and protozoa. Let us then begin with the mollusca. The tubicolous annelids are well represented through the Serpulæ and Vermiliæ, by the tubulibranchiate molluscan genera, Vermetus and Siliquaria. The pteropod genus, Spiratella (S. limacina,) bears a close resemblance to the tubicolous Spirorbis; as does also the freshwater Planorbis among the gasteropods. The limacine slug, Vaginulus, resembles the leech (Hirudo,) among the suctorial annelids; while the cyclobranchiate genus Chiton is homomorphic with certain species of dorsibranchiate annelids, the agreement perhaps being most complete between Chiton spinosus and Aphrodite hispida. The conchiferous Teredo was placed by Linnæus (who was misled by its morphic analogies,) among his Vermes, between serpula and sabella. The cœlenterata also possess their share of homomorphism with the mollusca,—principally, however, through the molluscoids of Milne Edwards. Among these, the tunicated genus Botryllus revives in appearance that radiism which seemed to have disappeared with the echinoderm Sipunculidæ, and bears a close resemblance to the first section of the Lamarckian division of corals, called Astræadæ, and of which Astræa rotulosa is a good example.

The lowest division of the mollusca, however, afford as a class, the most singular example of homomorphism which exists in the animal kingdom. The polyzoa, as Huxley remarks, "are as truly and as wholly molluscan as any other mollusca;" but even up to the year 1827, they were universally confounded with the sertularian, and other zoophytes. It was Dr. Grant, who, in that year, in his "Observations upon the Structure and Nature of Flustræ," announced the peculiar ciliated character of the tentacles, and the molluscan type of the intestinal canal, and thus raised these animals, as Busk observes "from one sub-kingdom to another." None but those who have studied these two groups in their relation to one another, can properly appreciate their remarkable resemblance;—the oral tentacles in both arranged in circlets—their compound character, the form and very nature of the polyparies, sometimes horny, sometimes calcareous, agree so curiously, that no examples of homomorphism could be more apt to set the mind meditating upon the philosophy of these resemblances, and searching for their final causes. It is however the cheilostomatous, or marine division of the polyzoa which chiefly represents the polyps; for in the fresh-water, or hippocrepian group, with the exception of the genera Fredericella, and Paludicella, the tentacles are set upon a peculiar horseshoe-shaped prolongation, or lophophore, which to a certain extent modifies *their* homomorphism with the sertularian polyps. But here another sub-kingdom steps in, and an annelid was discovered in 1856, by Dr. Strethill Wright, on shells from Torquay, and described by him in the "Edinburgh New Philosophical Journal," for that year, which appears to be the homomorph of the hippocrepian polyzoa, and has hence received from Dr. Wright the name of Phoronis hippocrepia.

We have next to point out the homomorphisms between the second invertebrate sub-kingdom, annulosa, with the cœlenterata. Considering, however, that *annulism* is the type of the one, and *radiism* of the other, it is obvious that they are incompatible with much resemblance, and can have but little in common. The very names of annulose and radiate animals indicate that they are natural divisions presenting a marked constancy to the particular forms which have given rise to those terms; and it is only in some doubtful or aberrant groups, at either extremity of the cœlenterate class, that any resemblance to the Annulosa can be traced. Thus, among the nematoid entozoa, as Strongylus, Ascaris, &c., which, however, form the last group of Huxley's *Annuloids*, there are animals bearing a close resemblance to the typical annelids, as on the other hand do the vermiform Echinodermata, as Holothuria, and particularly Sipunculus. With regard, however, to the affinities of these latter, naturalists are not agreed, and Professor Huxley, whose opinion is worthy of great respect, places the echinodermata in the annuloid division of the Annulosa.*

Between the various subdivisions of the large sub-kingdom Annulosa, however, singular resemblances may be traced. Thus, the insecta reproduce the form of the arachnida in the orthopterous Acheta arachnoides, or spider-like cricket of Jamaica, as well as in the apterous genus Phalangium, of which P. reniforme has the aspect of a spider, and P. cancroides was considered both by Swammerdam and Roesel to be a scorpion. This arachnoid appearance is also shared in the crustacea by the macrourous decapod Thalassina scorpioides, of the Chilian coast, which, as its name indicates, also bears a close resemblance to a scorpion. The dipterous Tipula is homomorphic with the araneiform edentate crustacean, Nymphon gracile; as well as with the macropodian genus

* Med. Gazette, vol. xxxiv., p. 638.

Leptopodia, or sea spider; and the form of the orthopterous genus of insects Mantis, is reproduced in the macrourous decapod, Squilla mantis. The myriapodous genus Scolopendra (Centipede,) represents the annelidans through such forms as Phyllodoce; and the Julus through the nereid, Ioida macrophthalma. Insects, too, of different orders, will bear a close comparison, as the lepidopterous Sesia apiformis with the hymenopterous bees; the sphynx, Macroglossa bombyliformis, with the dipterous Bombylius; and this again with the hymenopterous Bombus; the homopterous Aphis (as A. sorbi,) and the neuropterous Phryganea; the dipterous Syrphus and the hymenopterous wasp; the orthopterous Phasma, or walking-stick insect, and the smaller hemipterous family of hydrometridæ as Hydrometra and Velia.

The tubicolous annelid, Pectinaria belgica, is the homomorph of the Limnias ceratophylli, among the rotifers, whereever that curious order may be located.

Between the cœlenterata and protozoa, there are no less striking resemblances, not only through the foraminifera which will be alluded to presently in connection with another subkingdom, but also through some curious compound forms of polypine infusories, of which Carchesium polypinum is a good example, as representing the campanularian zoophytes, as would also the well-known Vorticella; while Dinobrion sertularia, another form, is so called from its resemblance to a sertularian zoophyte; and this also completes the morphic relations of the polyzoan molluscoids. The curious rhizopod, Actinophrys sol, also is naturally referred to the echinite forms, particularly to the long-spined species, such as Cidaris papillata, &c.

With the exception of those between the polyzoan molluscoids and the hydroid polyps, there are none more worthy of attention than the very remarkable homomorphisms existing between the very humble rhizopodous foraminifera, and certain members of the highest class of invertebrata. The foraminifera form the lowest group of the sub-kingdom protozoa, being only raised above the gelatinous Amœba by the possession of a calcareous investment, perforated with numerous foramina, (whence their name,) through which the gelatinous body of the creature, or sarcode, is thrust in the form of long threads, or pseudopodia, whence their name of rhizopods. The calcareous investment is divided into segments or thalami, variously arranged, which communicate with one another by minute pores. But this calcareous investment assumes such beautiful forms, and so closely imitates those of the highest shelled mollusks, that, misled by the external resemblance, these lowly organised creatures were, until 1834, classed by D'Orbigny, with cephalopods. In that year, Ehrenberg reduced them to the level of Flustræ, then regarded as polyps, under the name of Bryozoa; and thus there was the curious spectacle of two groups of animals arranged together, both in their wrong position, one of which was destined to take a place in the highest invertebrate sub-kingdom, and the other in the lowest. It was Professor Williamson, who in 1848, first published the fact of their affinities with the sponges; since which time, they have been studied in a better light, and their correct position assigned to them among the rhizopods.

The majority of these remarkable little organisms go to form the section Helicoidea of Schultze, and they bear so great a resemblance in form to the tetrabranchiate division of cephalopodous mollusca, of which the nautilus is the type, that the only difficulty is to select from the examples. Few, however, will bear a closer comparison with them than Nummulina planulata, Nonionina barleeana, Peneroplis planatus, and Geoponus stella-borealis. But although a vast number assume this form, many other of the higher molluscs have their homomorphs among them. Thus the Spirulina perforata, and S. foliacea closely resemble the freshwater Planorbis: the genus Marginula most strikingly imitates the terrestrial Megaspira; the elegant Bulimina pupoides is the counterpart of the spiny Melania setosa; Polymorphina lactea, (var. fistulosa,) bears a great resemblance to the well-known stromb, Pteroceras aurantiacum; Cristellaria is capped by the British Pileopsis ungarica; and Patellina corrugata by the genus Patella. Nor are the mollusca alone represented by the foraminifera, for the remarkable acalephs, Stephanomia imbricata (Q. & G.) and Protomedea lutea, have their homomorphs in the species of Textilaria.

There is, however, another class of homomorphisms which are exceedingly curious, and which I cannot pass over in silence. I refer to the recurrent forms which make their appearance in larval stages of the development of various animals. The invertebrate sub-kingdoms, in the case of very numerous species undergo certain metamorphoses before acquiring the perfect form which they are ultimately destined to assume; and these larval stages differ so much in appearance from the perfect animal, that from a misapprehension of their nature, they have not unfrequently been located in other divisions of the animal kingdom. Among vertebrated animals the only order which undergoes a true metamorphosis is the amphibia, such as the frog and salamander. The larvæ of the tailless and tailed amphibia are at first alike in form, provided with external gills and tail, and unprovided with legs. In the anourous amphibia, the tail disappears, and a frog is the result, in the salamander the tail remains. But not only is this tadpole form characteristic of the amphibia, but it was first observed by Sir J. G. Dalyell,* that the tunicated ascidians, both solitary and compound, pass through a tadpole form, and are then locomotive by means of a

* Edin. New Philosophical Journal, 1839.

vibratile tail, which they ultimately cast off when they assume their permanent fixed condition.

The only group of gasteropodous mollusca which undergoes metamorphosis is the Nudibranchiata, and these are first hatched as nautilines, bearing a great resemblance through their shell to the cephalopods; while like the pteropods they swim actively about by means of large lateral ciliated lobes, which afterwards become the epipodium. The larval forms of those decapodous crustacea in which a metamorphosis is observed to take place are so remarkably characteristic, that although they were once supposed to constitute distinct genera, they were never confounded with other species; but in the cirrhiped genus Balanus, the larval form has, as Mr. Gosse observes, "exactly the figure, appearance, and character of the young of the common Cyclops (an entomostracon,) so that you would, without hesitation, if you knew nothing of their parentage, assign them to that well-known genus."* Among insects, the larva and pupa forms of several orders are universally familiar, and the general resemblance of the former to annelids has been remarked by every one. With regard to the pupæ, indeed, especially of the lepidoptera, so great is the homomorphism existing between them and certain shells of molluscs, that a genus of pulmobranch helices has been established under the name of pupa, of which, Pupa chrysalis is perhaps the best example.

The habit of inhabiting cases, adopted by the larvæ of some insects, causes them to bear a considerable analogical resemblance to tubicolous annelids; as for instance, between such caddis worms (or larvæ of phryganeæ,) as form cases of sand, and the Sabella alveolaria; while those which collect together freshwater shells to form their habitations, may be compared to the Terebella medusa, among annelids.† But I must not

* Evenings with the Microscope, p. 238.

† A curious instance of an analogous habit is afforded by Trochus agglutinans.

pursue this subject, and will dismiss it with one or two more examples; thus, the earliest form assumed by the young of the Tubularia indivisa and Medusæ, is called a Planula, from its close resemblance to the turbellarian annelids known as Planariæ; and the polypiform stage of the so-called alternate generation of the acalephæ, (of which *Hydra tuba* is an example,) is the counterpart of the perfect condition of those polyps of which Hydra is a genus.

But one more category of recurrent forms will I allude to, those, namely, which reproduce special parts of more than one animal, and result in certain figures which we should be inclined to call *composite*. In his inimitable Epistle to the Pisos, Horace says,—

"Humano capiti cervicem pictor equinam," &c.

"If a painter were to join a human head to a horse's neck, or a fish's tail to the body of a beautiful woman, would you not laugh at him?" Yet spite of Horace, and under the name of Art, monsters are produced no better amalgamated, and which it must be confessed are more artificial than artful.*

Other such curious analogies may be found both among the vertebrate and invertebrate animals; for example, between the gnat (Culex pipiens,) and the oceanic snail, (Janthina fragilis,) both of which form a raft for their eggs, by means of which these delicate structures are preserved. In the case of the former the eggs are glued together at the moment of extrusion; in the latter they are fastened to the under side of a peculiar apparatus of air cells. An example taken from the vertebrata is afforded by the habit of certain opossums with incomplete marsupial pouches, such as Merian's opossum (Didelphis dorsigera,) which is fain to carry all its young upon its back with their tails all twisted round the common maternal tail; and an analogous dorsigerous habit exists in the Surinam toad (Pipa monstrosa,) of Bufo dorsiger of Latreille, which carries its young for 82 days in pits upon its back, until at the end of that time they are fully developed.

* I cannot help referring here to an admirable illustration of the principles which I shall presently endeavour to lay down with regard to the adaptation of forms, which occurs in Ruskin's "Modern Painters" (vol. iii. p. 106,) where the author compares a piece of true grotesque from the Lombardo-Gothic with one of false grotesque from classical (Roman) architecture. In these sculptures the workmen have combined a lion and an eagle; in the false griffin they have been fitted together by line and rule in the most *ornamental* manner; in the true griffin the most essential parts of the two animals are thoughtfully and skilfully combined, and the result is "not merely a bit of lion and a bit of eagle, but whole lion incorporated with whole eagle." p. 108.

But that which the Horatian precept condemns in Art as only worthy of derision, Nature effects in such a masterly manner as not only to excite our curiosity but to command our admiration. Nature joins together in a wondrous manner the bill of a duck with the body of a mole (Ornithorhynchus); the horns of a stag with the head of a beetle (Lucanus); places a fish's head upon a reptile (Chamæleon), a horse's head upon a fish (Hippocampus), a bird's head upon a mollusk (Bugula); and provides a fish with hands (Malthe.) She even combines the body of a lizard, the head of a fish, the prehensile tail of a new-world monkey, the tongue of a wryneck, eyes which are only found elsewhere in the telescope carp (Cyprinus buphthalmus), and the feet of a woodpecker; and from this curious compound springs the chamæleon, a creature as perfectly adapted to its requirements and mode of life as the most normal organism or the most graceful animal.

Seeing then that we meet with so many forms recurring in widely separated groups, the question now arises, in what light are we to regard them? Must we look upon the lower as dawning anticipations of higher and more perfect forms? or must we, on the contrary, regard the higher as fashioned upon an inferior and degraded type? This is a question which in a general way it is not difficult to answer; although the questions which arise out of it are not so easily disposed of. First, let us enquire what we are to understand as a degraded type. There are grades in organization, from man downwards, as everyone admits. Vertebrated animals are more complex and more highly organized than invertebrate. Mammalia are constructed upon a higher type than birds, birds than reptiles, and these again than fishes. Their whole circulatory apparatus, materially affecting every part of the organization, proves this. Again, the monkey is more highly organized than the mole, the mole than the opossum, and the opossum than the echidna; the cerebral system, no less than the generative apparatus, is proof of this. Granting, then, a scale of *organization*, may we not also claim in a general way similar gradations for organic *form*? The animal form is as superior to the vegetable form as are the complex functions of which it is the medium in the one to the simply vegetative functions which are required for the other. The vertebrate form consisting of an axis and diverging appendages is as superior to the invertebrate as are the functions of locomotion, &c., in the former superior as a class to those in the latter. Again, the mammalian type of form, adapted to walk or leap, to traverse the earth's surface with the greatest ease and advantage, is superior, as a type, to that of birds whose home is the aerial medium, or of fishes whose movements are strictly confined to the water. And no one will question that the highest type of all is the *human*, whether we regard form *or* organization; while it is only approached in form by that order, which though far below, stands next in point of organization, viz., the quadrumana. If this is granted, then it follows that there is to a great extent a graduated type of *form* as well as of *organization*.

Now, although we have found that in nearly every class and order certain wide departures from the typical form are met with, nevertheless it will be observed that a certain form is characteristic of a certain group. If therefore the aberrant form is homomorphic with some type of form placed far above it in the scale of organization, (which on the whole may be regarded as agreeing with that of form), then we may consider it as *anticipating higher forms*. Thus the very dawn of animal life, as it were, represented by the rhizopod forms, known as foraminifera, anticipate the greatly superior class of mollusca; and even the symmetrical shapes of members of the highest order of invertebrate animals, viz., the testaceous cephalopods. So also the insecta anticipate, in their winged forms, the highly organized class of birds.

But instances of degradation of typical form are far more common; thus, the bats descend to the form of a lower vertebrate class—the pangolins to the reptilia—and the cetaceous mammals assume a still inferior piscine form. The ophidian order of reptiles quit the reptilian, and even the vertebrate type, for still lower resemblances, assuming the general vermiform shape which is the typical form of the invertebrate annelidans. The polyzoan molluscoids are degraded to the morphism of the hydroid zoophytes, and these again to the still lower type of vegetable forms.

The same differences may be observed within the limits of a class;—thus, the gyrencephalous Hyrax descends to the typical form of the lissencephalous rodents, (to use the admirable classification of Professor Owen;) while on the other hand, the lissencephalous Opossum (Dasyurus ursinus) ascends to the high morphic position of the gyrencephalous Bear.

Thus it is evident that no general law of anticipation of higher, or of degradation to lower forms, can be laid down; and even the assumed law of the general agreement of form with organization, it must be confessed, cannot be shown to be unexceptionable.

Since, then, no regular system can be detected in the recurrence of forms, which agrees with an ascending or descending type of organization,—and by means of which we may satisfactorily account for homomorphism,—it becomes necessary to make an appeal to final causes. In a former passage I have alluded to the connection which exists between form and habits, and in those remarks I produced instances of striking deviations from typical *form*, which were accompanied by no less striking modifications of typical *habits*. Taking, then, this principle as a starting-point, let us see if we cannot discover a clue to the morphic deviations referred to: and in order that we may advance with safety, let us commence with instances of the greatest simplicity, and pass on from them to the more complex.

Now, among all the vertebrate classes there are certain general homologies which structurally unite every animal contained within them, however it may differ in external form. In all, the diverging appendages are present under some form or other, except indeed in certain ophidians, in which they are entirely absent. In birds, the modification of the fore extremity is obvious, and in fishes only somewhat less so; but although the relative position of the pectoral and ventral fins is sometimes reversed (as in the perch, for example), still the pectorals are *always* homologous with the fore, and the ventral with the hind limbs of other vertebrata. There is, therefore, a great community of *plan* in vertebrates, with respect to those parts which constitute the elements of external form.

Let us now glance at the media in which they move. Mammalia are, as a class, destined to tread the surface of the earth, birds to fly in the air, and fishes to swim in the sea; but neither is the air nor the sea devoid of mammalian inhabitants; and both land and water, as well as air, afford a home for birds. Reptiles also occupy all three stations; and fishes alone, being essentially water-breathing animals, as well as of a decidedly inferior grade of organization, never quit that element. But in order that a mammal should be adapted to an aquatic existence, it must be fashioned more or less in the form of a fish; an elaborate hand or foot would be useless, and projecting appendages injurious. It is therefore piscine in form, covered with a smooth skin, and differs from a fish only in the position of the tail, which being horizontal instead of vertical, is an index of its air-breathing habits. So also, an aquatic bird has a smooth covering of close-set feathers, an attenuated head, fin-like wings, and feet situated so far back as to answer the purpose of a propelling tail when in the water; and could we see a Penguin in the act of swimming beneath the waves, it would undoubtedly have the aspect of a fish. Take again the Seals, in which these aquatic habits are not so complete as in the cetaceans, and we find them modified in form to be something intermediate between a fish and a mammal; while an Otter, which is rather terrestrial than aquatic, has its quadrupedal character still less modified—in it, there is the close-set fur, the depressed form, and the webbed feet; but the feet are not fins, nor is the tail.

With regard to flying quadrupeds, it is of course more or less necessary that the upper extremity should form a wing of some kind, which, however different in the homologies of its parts from the wing of a bird, must necessarily bear some general resemblance to it in form. A bat is as purely an aërial animal as is a bird, but its wing not being formed upon the type of that which exists in a true bird, must be inferior; nevertheless it is as truly and completely a *wing* as is the far more perfect, but less bulky, wing of a bird.

Further, if we select a single class, such as the mammalia, and bear in mind the same principle, we shall find it lead to the same results. Some quadrupeds of each order are arboreal, some terrestrial, and others subterranean; some are carnivorous, some insectivorous, and some frugivorous; some are nocturnal, some diurnal, and some crepuscular. If, now, an animal belonging to one order, is, like an animal of a different order, insectivorous, the former probably bears some remote analogy to the latter by virtue of that fact;—if the animals of two different orders are not only *both* insectivorous, but also crepuscular, for example, the probability of their resemblance is increased; but if the two are insectivorous, crepuscular, *and* subterranean, then the great agreement of their habits must be accompanied by a considerable approximation of form.

Perhaps there are no facts in the natural history of animals which are simpler, or with which we are more familiarly acquainted in a general way, than the broad characteristics which differentiate the habits and modes of life of quadrupeds, birds, and fishes; and on the other hand, the aberrant forms which are assumed by aquatic mammals and birds, and by aërial quadrupeds, and the homomorphism of these aberrant forms with those of the classes of vertebrata which they most nearly approach in their habits and modes of life, are highly important questions, which thus admit of elucidation with a degree of probability commensurate with this exactness of our knowledge of those habits. The kind of homomorphism which obtains between members of a class (such as among the various orders of the mammalia) requires a different kind of knowledge, viz., not a general acquaintance with broad facts, but a special familiarity with individual habits. Now, such a special knowledge is by no means always possessed, or even easily attainable; but when it is so, it is found that the greater the agreement of habit and modes of life between any two animals of distinct orders, the more striking is the homomorphism which exists between them. Of this proposition, several illustrations have already been given.

Taking now our stand upon these facts, and carrying the principle which I have laid down into the invertebrate division of animals, the first thing which strikes us is the comparative artificiality of some of the resemblances which have been mentioned as existing between them and the vertebrate sub-kingdom. The habits of a mollusc and a fish can scarcely be compared, still less can those of a tunicate and a reptile, or of an infusory and a quadruped; and yet we perceive between them close resemblances of form; but between a worm and a siphonops, or between an insect and a bird, we can readily argue a community, because we at once estimate the narrow limits in the one case, and the wide extent in the other, of their analogical functions. It would be highly unphilosophical to suppose that these close resemblances were the effect of accident, and still more so to say that they result from accident in one case, and from profound design in another.

The homomorphisms existing between the vertebrata and invertebrata are not numerous; indeed, as might be expected in animals so widely separated, they are rare, and usually imperfect. I confess they present the greatest difficulty. And yet where knowledge of habit assists us, the difficulty to a great extent vanishes. There is no class of invertebrata more familiarly known than the insects, and there are no clearer homomorphisms between these great sub-kingdoms than those between insects and birds; and who is there that does not perceive that the forms assumed by insects are as much the necessity of their habits—and that in habit, as in form, they assimilate to birds, just as a bat does, or as a whale does to a fish.

Again, how little do we know of the habits of the invertebrate classes generally. The majority of them are marine; and it is only quite recently that they have even been *seen*, except through the medium of pictures, by the majority of persons. We are not on terms of familiarity with *them*, as we are with quadrupeds and birds; and seeing that our comprehension of their homomorphism is in direct ratio to our knowledge of their habits and modes of life, it is not a matter of surprise that we should be unable to penetrate the mystery of the similarity between the Foraminifera and the Mollusca, or between the Polyps and the Polypine Infusories. For here, again, the explanation of their homomorphisms is measured by the amount of our knowledge. We know why a Bombylius resembles a Bombus, or a Teredo a Sabella, having some acquaintance with the similar habits of each, and seeing a degree of similarity between them. We know why a caddis-worm resembles a tubiculous annelid, and this again a tube-inhabiting rotifer; it is the common habit of forming a tube for their otherwise unprotected body which assimilates them. But we know not why a Chiton resembles an Aphrodite, because we are equally ignorant of the habits of either.

Let me now, in application of the foregoing principles, throw out some suggestions in relation to the most striking instance of homomorphism which occurs, perhaps, in the animal kingdom,—viz., that existing between the polyzoan molluscoids and the hydroid polyps. In both these widely separated groups we have certain compound forms, made up of numerous membranous or calcareous cells, upon a common axis or stem, which branches in a plant-like manner, each cell being the habitation of a distinct animal. These are their homomorphic characters ; now let me state what are the special characters of each group. First, hydroid polyps :—mouth with filiform, simple tentacula; stomach excavated in the cellular substance of the body; no distinct muscular apparatus; body contractile in all its parts—gemmiparous externally. Second, polyzoa :—body not contractile, symmetrical ; mouth and anus separate ; gemmiparous and oviparous. It therefore appears that the polyzoa are minute molluscs, differing in all their homologies from polyps. Let us next inquire of which group the polyzoary form is typical. Clearly not of the mollusca, which are for the most part of very different form ; and equally clearly it *is* typical of the polyps, in which class it assists their analogy with vegetable forms. The polyzoarian form, then, is aberrant from the molluscan, and typical of the hydroid polyps. *Why* this form is the best adapted for the life of polyps I am not required to prove, but only why (that being granted) it is also the best form for the polyzoa. Next let us enquire what differences exist in the form of the animals themselves. In the polyp there is a gelatinous substance hollowed out into a stomach, a single aperture serving the purposes of taking in food, and passing out rejectamenta and ova—this common outlet being surrounded with a circlet of gelatinous contractile tentacles, armed with nettling capsules. But the molluscoid has an œsophagus, stomach, gizzard, intestine, distinct anus, besides a liver and nervous system.

In none of these particulars has it any relationship with polyzoa; but the mouth is surrounded with a circlet of tentacles, not indeed like those of the polyps, simple and contractile, but uncontractile and covered with vibratile cilia. They are probably the homologues of the labial palpi of other molluscs. This circlet of tentacles, then, is the *great point of resemblance* between molluscoids and polyps; in the latter the common arrangement—in the former, arising as it were from an accident or variety of organization. But yet, is it not easy to perceive that the common possession of tentacles exhibited by polyps and polyzoa implies a very great similarity, nay, almost *identity*, in one of the most important *habits*, namely the mode of procuring food?

Having so far established a community of habit between them, let us next refer to the grand organic distinction which is implied in the widely different form of the digestive apparatus. In the polyps, the rejectamenta being passed out by the mouth, such animals are well fitted, doubtless, for living in cells with a single aperture; the mollusca, however, have an intestinal canal, and anal aperture besides. But it must be borne in mind that the anus in the polyzoa does not open at the extremity of the body opposite the mouth, as in the archetypal mollusc; but by a sudden bend of the intestine, the anal aperture is brought into the closest possible proximity to the mouth; so that, although separate, they both open at the same spot; and let it not be supposed that this diminishes aught from their position as molluscs, for in the highest molluscs, viz., the cephalopods, the same thing takes place in a somewhat less degree. Here again is a structure which implies great *community of general habit*. Lastly, there is another most important community of habit between the polyps and polyzoa, viz., that although the mollusca, as a class, are oviparous, the polyzoan molluscs are, in addition, *gemmiparous*, like the polyps; and this power is evidently the secret of the production of those compound forms which the polyzoa present in common with polyps. Hence we see that with scarce anything in common, except superficial characters, the habits of polyzoa and polyps are nearly identical; and to this fact I would look for an explanation of their identity of form.

In conclusion: Lord Bacon has somewhere remarked that experiments and observations are of two kinds, viz., first *of fruit*, and second, *of light*—by which he meant that some led directly to some plain and definite ends, which amply repaid the labour bestowed upon them; while others, by no means to be despised, yet were not so obviously accompanied by actual fruit. Far be it from me to raise homomorphism to the rank of homology; I have endeavoured throughout to place them in strong contrast; and although I do not wish to forego all claim to fruit from these observations, I am willing to allow them rather to belong to the second category. But I cannot sympathize with those who would taboo such curious questions, simply because some others lead to more important results.* Everything in Nature is worthy of investigation, and although I may not have succeeded in fully tracing out the law of order which probably exists in these homomorphisms, still I have by the enquiry improved my own knowledge of Nature, and have given, I trust, an insight into the creative workings of the Almighty, which cannot fail to increase the desire to be more closely acquainted with them. Surely, human works fall infinitely short of the surpassing interest which appertains to those of the Great Artificer; and human history is but a line in the great scroll of the universe, which has been inscribed from the beginning with the works of the Creator. Let no one presume ignorantly to contemn, or

* For an example of such reasoning, see Bain "on the Senses and Intellect," p. 499, where the writer of that generally excellent work argues rather as the disciple of a severe school of logic, than as a loving and humble follower of Nature.

conceitedly to overlook the stupendous work of creation, of which man is the keystone and the crown : but if ever he be tempted to assert his superiority by underrating the matchless perfection of Nature, let him humble himself in the dust, when he remembers that the God who formed *him* looked upon all the things which he had made, " and behold they were very good."

On Recurrent Animal Form.

A Paper read before the British Association, at its Meeting at Oxford, 1860.

[*From the* ANNALS AND MAGAZINE OF NATURAL HISTORY *for August* 1860.]

ON RECURRENT ANIMAL FORM, AND ITS SIGNIFICANCE IN SYSTEMATIC ZOOLOGY.

BY

CUTHBERT COLLINGWOOD, M.B., F.L.S. &c.

NO ONE conversant with Zoology can have failed to remark the fact of the recurrence of similar forms in different groups of the animal series. Not only do species of one family resemble species of an allied family, but group with group, order with order, and even class with class, and subkingdom with subkingdom, can produce instances of the most striking homomorphism. The resemblances to which I allude are those of external form, unaccompanied by homologies of internal structure; nevertheless I imagine that this peculiarity, instead of entirely destroying its interest, and rendering it valueless, as some have appeared to consider, only places the subject in a different category of scientific facts, and invests it with a value peculiar to itself. In the history of classification it has always naturally happened that external form, rather than internal structure, has been the mainspring of systems; the knowledge of structural homologies has been painfully accumulated, and the systems built upon the characters presented by external form have from time to time been corrected by increasing knowledge of structure, till in these days zoologists have agreed that *structure*, and not *form*, should be the basis upon which systems should be framed with the greatest claim to accordance with Nature. Nevertheless systems founded upon *homologies* are liable to be interfered with, and their symmetry affected by encroachments of form; so that eminent zoologists differ as to the position of animals, even in the present advanced state of zoology, owing to the fact that, while one regards *homologies of structure* as paramount, another allows great weight to external and striking *resemblances in form.* Under these circumstances, therefore, it can be no waste of time to inquire what connexion exists between the two, and to attempt to point out a cause for *agreements of form,* in cases where corresponding *agreement in structure* is wanting.

Nature is inexhaustible in resources; and variety is one of her greatest charms. It is often said that no two things in Nature are alike, and with truth; for the resemblance, whether in outward form, or in internal organization, always partakes of the character of a *near approach,* and not of *distinct repetition.* This is particularly the case with *form,* which varies more, and is more simple in its variations than structure; and it is this which confirms my belief that *structure,* and not *form,* is at once the truest basis of Systems of Nature, and the safest criterion in cases of doubt and difficulty. Thus, an Archetypal animal may agree to a certain extent in *structure* with a vast group of animals, and yet may resemble none of them in outward *form.*

It cannot be a matter of surprise, considering the number of such resemblances existing throughout the animal kingdom, that while the study of homologies was making but slow progress, and the true affinities of animals were but little understood, the real nature of many aberrant forms should have been lost sight of in the contemplation of their homomorphic resemblances. Who can wonder if Pliny spoke of the Bat as "the onely bird that suckleth her little ones," in quaint old Holland's phraseology? What malacologist even can feel surprise that, up to recent times, the Polyzoan Molluscoids were mistaken for Zoophytes? or that Lhuyd, and at one time the illustrious Ellis, should have regarded them both in the light of "remarkable sea-plants," while his predecessor, Baker, had even looked upon them as the production of "salts incorporated with stony matter"? Who can wonder that, before the time of Savigny, the Tunicated *Botrylli* should have been regarded as Polypes? that Linnæus should have placed *Teredo* among the Annelides? that, before the Mémoire of Dujardin in 1835, the Foraminifera should have been classed with the Cephalopodous Mollusca? In all these cases (and others might be brought to swell the list), the animals have been raised, or have sunk, from one *subkingdom* to another.

But, although they were not always recognized as such, the existence of recurrent forms in Nature could not be overlooked by the framers of systems, inasmuch as they were stumbling-blocks, which almost seemed placed in their path to prevent the natural arrangement of animals from being too easy a task. A too cursory examination has not unfrequently resulted in the false location of an animal, only to be detected, and triumphantly exposed, by a succeeding zoologist.

Every one knows, whether he have thought about it or otherwise, that the four Vertebrate classes are homomorphically connected. Thus there are Flying Mammals, such as the Bats and Flying Squirrels (*Pteromys*), uniting them with the Class Aves; as well as that anomalous Monotreme, the *Ornithorhynchus*, or Web-footed Duck-bill. The Edentata among Quadrupeds connect them with Reptiles, by means of the Armadillos,—the Great Armadillo (*Dasypus gigas*), and preeminently the Mataco (*D. Apar*), being homomorphic of the Testudinata, while to the Saurian Reptiles they are united by the Scaly Pangolins (*Manis*), and to the extinct Pterosaurians (Pterodactyles), again, they are united by the Bats. With Fishes, the Mammalia are most singularly connected by the Cetacea; while a special resemblance appears between the Narwhal (*Monodon*) and the Swordfish (*Xiphias*).

The homomorphic resemblances between Birds and Reptiles are not striking; but the Draconine Saurians or Flying Lizards (*Draconis*, sp.) supply examples, and the extinct Pterodactyl once afforded another; while with Fishes the various species of Flying-fish (*Exocœtus*) among the soft-finned, and Flying Gurnards (*Dactylopterus* and *Pterois*) among the hard-finned, are good illustrations. It only remains to connect Reptilian forms with Fishes; and here the Snakes (*Ophidia*) may well be compared with the Eels; and less striking instances of resemblance occur between the Saurian reptiles, such as the Alligator, and the bony-cased Sturgeon, and between the Testudinata and the Trunk Fishes (*Ostracion*). Perhaps also that great Enaliosaur the Ichthyosaurus might be here mentioned.

Without extending my illustrations too far, I will select the Mammalia as an example of the recurrence of form within the limits of a single Class. The organic structure and affinities of one *Order* are dissimilar from those of another, just as the structure and affinities of one *Class* differ from those of another; the difference between Class and Order being one of *degree*, and not of *kind*; so that it is as remarkable to find resemblances of form in widely separated *Orders* as in still more widely separated *Classes*, although, of course, homomorphic resemblances are more striking between Orders than between Classes. In the Order Quadrumana, for instance, we shall find representative forms of various other Orders. Thus the genera *Midas* and *Iacchus*, known as Marmozets, true Platyrrhine Quadrumana, represent the Rodentia through the genus *Sciurus* (Squirrel); and the Douroucouli (*Nyctipithecus felinus*), in the same division, represents the Cat (*Felis*) in the Digitigrade Carnivora; while, among the Strepsirrhine Quadrumana, the Loris (*Stenops tardigradus*) represents the true Sloths in the Order Bruta, and the very aberrant animal, falsely called the Flying Squirrel (*Galeopithecus*), is the representative of the Order Cheiroptera, or Bats.

Among the Pachydermata are some no less striking examples of species homomorphic with those of other Orders. Thus the Hyrax, an animal in structure intermediate between the Rhinoceros and Tapir, a miniature Rhinoceros, as it has been called, yet so closely resembles the Rodentia in its outward form, that it was long classed with them; and Cuvier makes the following remark concerning it:—"There is no quadruped," he says, "which proves more forcibly than the Daman (*Hyrax capensis*) the necessity of having recourse to anatomy as a test by which to determine the true relationship of animals."

The general resemblance between the Cetacea and the Pinnigrade Carnivora (Seals) need only be referred to; it is made very distinct through the herbivorous family Manatidæ, especially the Dugong (*Halicore Dugong*).

We have seen how the Loris resembles the Sloth; and on the other hand, the Edentate genus *Bradypus* (Ai) bears a singular resemblance to Monkeys in general, even in that particular which is so characteristic of them, viz. their physiognomy, while it has a carnivorous homomorph in the Sloth Bear (*Ursus labiatus*), called by Pennant the Ursiform Sloth, and by Shaw, *Bradypus ursinus*.

The Insectivora are connected through the Hedgehog (*Erinaceus europæus*) with one of the most anomalous of animals, the singular Monotreme genus *Echidna*, which has, besides, other homomorphs, to be afterwards mentioned; and further through the Shrews (*Soricidæ*), with the Rodent genus *Mus*; and with the Carnivora by the Bulau (*Gymnura Rafflesii*), formerly described as a Viverra.

The Rodentia are united homomorphically with the Pachydermata by means of the Capybara (*Hydrochœrus Capybara*), formerly called, from its pig-like appearance, *Porcus fluviatilis* (Fermin), Thick-nosed Tapir (Pennant), Cochon d'eau (Desmarchais), and *Sus maximus palustris* (Barrère). By the Flying Squirrel (*Pteromys*) they claim some homomorphic affinity with the Cheiroptera; but their chief homomorphism is with the Marsupialia, and most striking are the resemblances. Not only do the Rodentia and Marsupialia bear a general mutual resemblance throughout, both Orders possessing that extraordinary development of the hinder extremities and tail which enables the Jerboas, in common with Kangaroos, to take such wonderful leaps, but there are particular animals in both Orders which bear a most remarkable resemblance to one another. Thus, the Rodent Jerboas (*Dipus*) are closely imitated by the Tufted-tailed Rat-Kangaroo (*Hypsiprymnus penicillatus*, Gould); and the true Kangaroos (*Macropus*) are equally nearly approached in form by the Cape Leaping Hare (*Pedetes capensis*, Ill.). There is also a considerable resemblance between the Wombat or Badger of the Australian colonists (*Phascolomys Wombat*, Pér. and Les.) and the Rodent Cavies and Lagomys; while a further homomorphism occurs between individuals belonging to aberrant groups in either Order, viz. the Brazilian Porcupine (*Synetheres*) among the Rodents, and the Echidna among the Monotremes, whose relation to the Insectivora has already been pointed out.

These external resemblances between Rodents and Marsupials are none the less remarkable when we learn that there is less true affinity between them than between the Marsupials and most other Orders; for Mr. Waterhouse, in his excellent 'History of the Marsupialia,' remarks that in them "we find representatives of most of the other Orders of Mammalia. The Quadrumana are represented by the Phalangers; the Carnivora by the Dasyuri; the Insectivora by the small Phascogales; the Ruminantia by the Kangaroos, and the Edentata by the Monotremes." He adds: "The Cheiroptera are not represented by any known Marsupial animals, and the Rodents are represented by *a single species only*"—the species referred to being the Wombat.

Lastly, the Marsupialia, besides their homomorphism with the Rodents, have, through the Ursine Opossum, or Native Devil of Van Diemen's Land (*Dasyurus*), a singular relationship to the Carnivorous genus *Ursus*, as well as, through the Squirrel Petaurus, to the Bats.

Space will not permit me to compare the forms of Invertebrata one with another. Among them many remarkable analogies of form may be observed; and even between the Vertebrata and Invertebrata they will be found to occur. Further illustrations of this subject may be found in a paper by the author in the 'Proceedings' of the Liverpool Literary and Philosophical Society for the past session.

On no principle of gradation of *form* can these resemblances, unaccompanied as they are by homologous relations, be accounted for. Some are *advances*, others *degradations* of form; and we must look for some deeper and more subtle cause which shall connect animals so widely separated as are the members of distinct subkingdoms. There is one circumstance, however, which cannot fail to strike the thoughtful inquirer, and which, I think, holds out a clue to the remarkable facts to which I have just now briefly alluded. The circumstance to which I refer is, that, in not a few cases, striking deviations from typical *form* are accompanied by no less striking modifications of typical *habits*; and further, that these *modified* habits have a strong tendency to assimilate with the habits naturally exhibited by those animals whose form they assume. It is not easy to compare the habits of animals essentially different in structure, and occupying widely separated positions in the animal kingdom; but a few examples taken from within a Class will illustrate my meaning, and give us an opportunity of carrying the arrangement forward to cases of greater complexity. Thus, the Ursine Opossum (*Dasyurus ursinus*), widely separated as it is from the Plantigrade Carnivora, not only agrees far more closely with *a Bear* in form than with its own congeners, having a short clumsy figure and Plantigrade step, but it is said of them, by their discoverers, that "they frequently sat on their hind parts, and used their fore paws to convey food to their mouths, and many of their actions, as well as their gait, strikingly resembled those of a Bear *."

The Quadrumanous Douroucouli (*Nyctipithecus felinus*) not only resembles a Cat in form, but is, like it, nocturnal in its habits, glides about with the stealthy movements of a cat, and "when irritated, in the posture it assumes, and the puffed state of the fur, it resembles a cat attacked by a dog." The pachydermatous Hyrax lives gregariously in burrows, like the Rabbits, which it so closely resembles in form. The Echidna rolls itself up into a ball when disturbed, like its homomorph the Hedgehog; the Lemurine *Galeopithecus* makes its flight with its young attached to the nipple, as do the true Bats. The habits and food of the Sea Eagle closely agree with those of the Albatros; and the Burrowing Owl is diurnal in its habits, and uses its feet more or less for purposes of scratching, in both which respects it differs from its congeners, and agrees with the Rasores, which it resembles in form.

In all these cases—and the list might be greatly swelled—the agreement between form and habit, independent of homological relations, is so striking that one is almost led to the conclusion that a certain external configuration necessitated certain habitual movements. I do not mean to say that this is the case; but I am inclined to think that a more careful review will lead us to the conviction that the converse of this proposition is the secret, not only of these, but of the other striking cases of *homomorphism*, as it has been called, to which reference has already been made.

The principle may be thus stated:—*That agreement of habit in widely-separated groups is accompanied by similarity of form.* Let us now see if we are not justified in deriving such a principle from instances such as those just adduced, added to what knowledge we possess with regard to the habits of animals in

* G. P. Harris, in Linn. Trans. ix. p. 174.

general; and commencing with cases of the greatest simplicity, let us pass on to those which are more complex.

Now, among all the Vertebrate Classes there are certain general homologies which structurally unite every animal contained within them, however it may differ in external form. In all, the diverging appendages are present in some form or other, except, indeed, in certain Ophidians, in which they are entirely absent. In Birds, the modification of the fore extremity is obvious, and in Fishes only somewhat less so; but, although the relative position of the pectoral and ventral fins is sometimes reversed (as in the Perch, for example), still the pectorals are *always* homologous with the fore, and the ventral with the hind limbs of other Vertebrata. There is therefore a great community of *plan* in Vertebrates, with respect to those parts which constitute the elements of external form.

Let us now glance at the media in which they move. Mammalia are, as a class, destined to tread the surface of the earth, birds to fly in the air, and fishes to swim in the sea: but neither is the air nor the sea devoid of Mammalian inhabitants; and both land and water, as well as air, afford a home for birds. Reptiles also occupy all three stations; and fishes alône, being essentially water-breathing animals, as well as of a decidedly inferior grade of organization, never quit that element. But in order that a mammal may be adapted to an aquatic existence, it must be fashioned more or less in the form of a fish; an elaborate hand or foot would be useless, and projecting appendages injurious. It is therefore piscine in form, covered with a smooth skin, and differs from a fish only in the position of the tail, which, being horizontal instead of vertical, is an index of its air-breathing habits. So also an aquatic bird has a smooth covering of close-set feathers, an attenuated head, fin-like wings, and feet situated so far back as to answer the purpose of a propelling tail when in the water; and could we see a Penguin in the act of swimming beneath the waves, it would undoubtedly have the aspect of a fish. Take, again, the Seals, in which these aquatic habits are not so complete as in the Cetaceans, and we find them modified in form to be something intermediate between a fish and a mammal; while an Otter, which is rather terrestrial than aquatic, has its quadrupedal character still less modified: in it we find the close-set fur, the depressed form, and the webbed feet; but the feet are not fins, nor is the tail.

With regard to flying quadrupeds, it is of course more or less necessary that the upper extremity should form a wing of some kind, which, however different in the homologies of its parts from the wing of a bird, must necessarily bear some general resemblance to it in form. A Bat is as purely an aërial animal as is a bird; but its wing, not being formed upon the type of that which exists in a true bird, must be inferior; nevertheless it is as truly and completely a wing as is the far more perfect, but less bulky, wing of a bird.

Further, if we select a single Class, such as the Mammalia, and bear in mind the same principle, we shall find it lead to the same results. Some quadrupeds of each Order are arboreal, some terrestrial, and others subterranean; some are carnivorous, some insectivorous, and some frugivorous; some are nocturnal, some diurnal, and some crepuscular. If, now, an animal belonging to one Order is, like an animal of a different Order, insectivorous, the former probably bears some remote analogy to the latter, by virtue of that fact. If the animals of two different Orders are not only *both* insectivorous, but also crepuscular, for example, the probability of their resemblance is increased; but if the two are insectivorous, crepuscular, *and* subterranean, then the great agreement of their habits must be accompanied by a considerable approximation of form.

Perhaps there are no facts in the natural history of animals which are simpler, or with which we are more familiarly acquainted in a general way, than the broad characteristics which differentiate the habits and modes of life of quadrupeds, birds, and fishes; and, on the other hand, the aberrant forms which are assumed by aquatic mammals and birds, and by aërial quadrupeds, and the homomorphism of these aberrant forms with those of the classes of Vertebrata which they most nearly approach in their habits and modes of life, are highly important questions, which thus admit of elucidation with a degree of probability commensurate with this exactness of our knowledge of those habits. The kind of homomorphism which obtains between members of a Class, such as among the various Orders of the Mammalia, requires a different kind of knowledge, viz. not a general aquaintance with broad facts, but a special familiarity with individual habits. Now, such a special knowledge is by no means always possessed, or even easily attainable; but when it is so, it is found that the greater the agreement of habit and modes of life between any two animals of distinct Orders, the more striking is the homomorphism which exists between them. Of this proposition several illustrations have already been given.

Taking now our stand upon these facts, and carrying the principle which I have laid down into the Invertebrate division of animals, the first thing which strikes us is the comparative artificiality of some of the resemblances which might be instanced as existing between them and the Vertebrate subkingdom. The habits of a Mollusc and a Fish can scarcely be compared; still less can those of a Tunicate and a Reptile, or of an Infusory and a Quadruped, and yet we perceive between them close resemblances of form; but between a Worm and a *Siphonops*, or between an Insect and a Bird, we can readily argue a community, because we at once estimate the narrow limits in the one case, and the wide extent in the other, of their analogical functions. It would be highly unphilosophical to suppose that these close resemblances were the effect of accident, and still more so to say that they result from accident in one case, and from profound design in another.

The homomorphisms existing between the Vertebrata and Invertebrata are not numerous; indeed, as might be expected in animals so widely separated, they are rare, and usually imperfect. I confess they present the greatest difficulty; and yet, where knowledge of habit assists us, the difficulty to a great extent vanishes. There is no Class of Invertebrata more familiarly known than the insects, and there are no clearer homomorphisms between these great subkingdoms than those between insects and birds; and who is there that does not perceive that the forms assumed by insects are as much the necessity of their habits, and that in habits, as in form, they assimilate to birds, just as a Bat does, or as a Whale agrees with a fish.

Again, how little do we know of the habits of the Invertebrate classes generally? The majority of them are marine; and it is only quite recently that they have even been *seen*, except through the medium of pictures, by the majority of persons. We are not on terms of familiarity with *them*, as we are with quadrupeds and birds; and seeing that our comprehension of their homomorphism is in direct ratio to our knowledge of their habits and modes of life, it is not a matter of surprise that we should be unable to penetrate the mystery of the similarity between the Foraminifera and the Mollusca, or between the Polypes and the Polypine Infusories. For here again the explanation of their homomorphism is measured by the amount of our knowledge. We see why a *Bombylius* resembles a *Bombus*, or a *Teredo* a *Sabella*, having some acquaintance with the similar habits of each, and seeing a degree of similarity between them. We know why a Caddis-worm resembles a Tubicolous Annelide, and this, again, a tube-inhabiting Rotifer; it is the common habit of forming a tube for their otherwise unprotected body which assimilates them; but we know not why a *Chiton* resembles an *Aphrodite*, because we are equally ignorant of the habits of either.

Let me now, in application of the foregoing principles, throw out some suggestions in relation to the most striking instance of homomorphism which occurs, perhaps, in the animal kingdom —viz. that existing between the Polyzoan Molluscoids and the Hydroid Polypes. In both these widely-separated groups, we have certain compound forms made up of numerous membranous or calcareous cells, upon a common axis or stem, which branches in a plant-like manner, each cell being the habitation of a distinct animal. These are their homomorphic characters; now let me state what are the special characters of each group. First, Hydroid Polypes: mouth with filiform, simple tentacula; stomach excavated in the cellular substance of the body; no distinct muscular apparatus; body contractile in all its parts, gemmiparous externally. Secondly, Polyzoa: body not contractile, symmetrical; mouth and anus separate; gemmiparous and oviparous. It therefore appears that the Polyzoa are minute Molluscs, differing in all their homologies from Polypes. Let us next inquire of which group the Polyzoary form is typical. Clearly not of the Mollusca, which are for the most part of very different form; and equally clearly it is typical of the Polypes, in which Class it assists their analogy with vegetable forms. The Polyzoary form, then, is aberrant from the Molluscan, and typical of the Hydroid Polypes. Why this form is best adapted for the life of Polypes I am not required to prove, but only why (that being granted) it is also the best form for the Polyzoa. Next, let us inquire what differences exist in the form of the animals themselves. In the Polype there is a gelatinous substance hollowed out into a stomach, a single aperture serving the purposes of taking in food, and passing out rejectamenta and ova, this common outlet being surrounded with a circlet of gelatinous contractile tentacles, armed with nettling capsules. But the Molluscoid has an œsophagus, stomach, gizzard, intestine, distinct anus, besides a liver and nervous system. In none of these particulars has it any relationship with Polypes; *but* the mouth is surrounded with a circlet of tentacles, not indeed like those of Polypes, simple and contractile, but uncontractile, and covered with vibratile cilia. They are probably the homologues of the labial palpi of other Molluscs. This circlet of tentacles then is the *great point of resemblance* between Molluscoids and Polypes —in the latter the common arrangement, in the former arising, as it were, from an accident or variety of organization; and yet is it not easy to perceive that the common possession of tentacles exhibited by Polypes and Polyzoa implies a very great similarity, nay, almost *identity*, in one of the most important of habits, namely the mode of procuring food?

Having so far established a community of habit between them, let us next refer to the grand organic distinction which is implied in the widely different form of the digestive apparatus. In the Polypes, the rejectamenta being passed out by the mouth, such animals are well fitted doubtless for living in cells with a single aperture; the Mollusca, however, have an intestinal canal, and anal aperture besides. But it must be borne in mind that the anus in the Polyzoon does not open at the extremity of the body opposite the mouth, as in the archetypal Mollusc, but, by a sudden bend of the intestine, the anal aperture is brought into the closest possible proximity to the mouth, so that, although separate, they both open at the same spot. And let it not be supposed that this detracts aught from their position as Molluscs; for in the highest Molluscs, viz. the Cephalopods, the same thing takes place in a somewhat less degree. Here, again, is a structure which implies great *community of general habit.* Lastly, there is another most important community of habit between the Polypes and Polyzoa, viz. that, although the Mollusca as a class are oviparous, the Polyzoan Molluscs are, in addition, *gemmiparous,* like the Polypes; and this power is evidently the secret of the production of those compound forms which the Polyzoa present in common with Polypes. Hence we see that, with scarcely anything in common except superficial characters, the habits of Polyzoa and Polypes are nearly identical; and to this fact I would look for an explanation of their identity of form.

(From the Proceedings of the Liverpool Literary and Philosophical Society. Read December 10th, 1860.)

ON AGASSIZ' VIEWS OF DARWIN'S THEORY OF SPECIES.*

By CUTHBERT COLLINGWOOD, M.B.,Oxon, F.L.S., &c.

When the subject of Darwin's Theory of the "Origin of Species" was brought before this Society, a short time back, the paper of M. Agassiz, in the "Annals" of September, 1860, in which he severely criticises the views of Mr. Darwin, was prominently set forth, and characterized as "quite unworthy of so distingushed a naturalist." I then ventured to differ from the writer in this general estimate, and also to demur from the representation given of his fundamental statements; and I agreed to the invitation to defend the remarks of M. Agassiz at some future time. Since then, I have been waiting for an opportunity of laying before you a few observations upon this subject, premising that a more careful perusal of M. Agassiz' criticism has only confirmed me in the opinion I then expressed, viz., that I considered it to be one of the most conclusive and formidable (against Darwin's theory) which had yet appeared.

I know not how I can satisfactorily show the value of M. Agassiz' paper, except by taking up his principal positions *seriatim*, and endeavouring to prove their truth and logical accuracy; and this I shall hope to do, dwelling more particularly upon those points which were specially singled out for objection. Moreover, I shall not enter farther upon a discussion of Mr. Darwin's views than we are necessarily led by the subject-matter of Agassiz' criticism.

* This paper is an answer to certain statements made at the Second Ordinary Meeting of the Society, some of which will be found printed in an Appendix.

And here let me premise that the criticism in question is one among a very few, which, proceeding from the pen of a profoundly scientific physiologist, and accurate observer, fairly addresses itself to the scientific and physiological aspects of the question—not repeating and corroborating Darwin's own somewhat easily appeased doubts, but attacking it at points which were not hitherto observed to be weak, and arising, as it might be almost said, accidentally, from some considerations relative to the degrees of individuality, and specific differences observed among Acalephs. There does not appear to me to be a word in this paper unworthy of, or inconsistent with, the character and attainments of the author of "An Essay on Classification," a work which, in my humble opinion, is a noble contribution to zoological enquiry, and is characterized by a solidity and accuracy of statement—a conformity with observed phenomena—a chain of logical sequence,—which favourably contrasts with the necessarily imperfect hypothesis of Mr. Darwin—with its gaps—its assumptions—and its demands upon our faith.* And this fact alone renders it, *à priori*, unlikely that the man who wrote the former should be guilty of anything approaching to petulancy or absurdity when reviewing the latter.

It would be presumptuous in the highest degree in me to consider it necessary, under ordinary circumstances, to stand forth as the apologist for one so eminent in every way as Louis Agassiz—one who is an ornament to science, and the pride of the country of his adoption. I only feel called upon to do so on your invitation, and because in the review

* It is, perhaps, necessary to state here, lest I should be misunderstood, that although by no means able to subscribe to the Darwinian hypothesis, I would not wish (as some appear to do) to condemn the whole theory as visionary and mischievous. Neither theory is capable of direct *proof*, and both are so dependent upon knowledge (not only the knowledge of an individual, but also the accumulated knowledge of an age), that I think it would betray an unworthy assumption of wisdom on my part wholly to reject the new one, virtually unheard and untested.

in question he has been charged with dogmatism and intentional obscurity. Did I think that these charges could be substantiated, I would at once lay down my pen; but I firmly believe that a candid enquiry will result differently.

M. Agassiz begins by advocating the idea—"That while species have no material existence, they yet exist as *categories of thought*, in the same way as genera, families, orders, classes, and branches of the animal kingdom;" and again, "that all the natural divisions of the animal kingdom are primarily distinct, founded upon different categories of characters, and that they all exist in the same way,—that is, as *categories of thought embodied in individual living forms*." Now, in all these expressions, I can see nothing obscure nor petulant—but, on the other hand, I *do* see the accurate reasoning of a philosophic mind, and a consistency in the support of a fundamental principle; which principle is in complete antagonism to Darwin's theory; so that there is no possibility of amalgamating the two ideas. Agassiz has, in all his works, maintained the same principle, and no one can reasonably object to his re-stating it on this occasion. But since it is complained that it is obscurely stated, let us examine whether it be not in truth logically and tersely expressed. What is a category of thought? I reply that it means a mental abstraction, in which all the predicates and all the attributes of the idea of species are arranged in an orderly series. Species exist in individuals—all the *similar* individuals existing at one time, embody the idea of a species; the individuals live—they are *objective*—they thrust themselves upon our notice as material beings—but something more than this *mere existence* is arrived at by our reasoning faculties, which *subjectively* infer that these forms represent an *idea*, which we may reasonably conceive was present with the Creator, when it pleased Him to make them, and that idea is *species*. Thus we arrive synthetically through all the characteristics of species, so comprehensively described by Agassiz in his "Essay on Classification," at the generalization with which we imagine the Creator to have set out. Species, then, is an idea, not an entity; but an idea which sprang from the Eternal Mind.

"As the community of characters," says Agassiz, "among the beings belonging to these different *categories* arises from the intellectual connexion which shows them to be categories of *thought*, they cannot be the result of a *gradual material* differentiation of the objects themselves." I quote this passage because it was imagined, not only that it conveys no sense, but it was even suggested that the author wittingly wrote nonsense. Such a notion is to me incomprehensible; but, farther, I see in it a condensed chain of logical reasoning, which demands close study, and no superficial glance, to appreciate its whole import. The author has just been speaking of the several great plans upon which it has been demonstrated that the animal kingdom has been constructed. It has been shown by the labours chiefly of Owen, Huxley, and others, that no one plan can be constructed to which all animals are reducible. No *invertebrate* animal can be shown to be formed agreeable to the *vertebrate* plan; the molluscan and articulate plan have scarcely anything in common; and the cœlenterata and protozoa, moreover, differ in plan from either, and are probably not even mutually reducible. Here, then, community of *origin*, and community of *characters*, are not synonymous terms. There is *community of characters* in a *class*, but he distinctly asserts that "classes are founded upon different modes of execution of these plans, and, therefore, they embrace representatives which could have no *community of origin*." Moreover, in the sentence I am examining, it must be borne carefully in mind that there is an antithesis between the abstract idea, or category of thought, on the one hand, and the living embodiment, or individual forms, on the other. Bearing this in mind, let us now read the sentence—"As the community of characters among the beings belonging to these different categories (*i.e.*, great branches of the animal kingdom, each formed upon a different plan) arises from the intellectual connexion which shows them to be categories of thought (in the sense explained above) they (that is, these different categories or abstract plans, embodied in vertebrata, mollusca, articulata, &c.) cannot be the result of a gradual *material* differentiation of the *objects* themselves." Here, the antithesis is between *intellectual*, in the first part of the sentence, and *material*, in the second—between *categories of thought* (or the idea of species) in the first part, and the *objects* (or the embodiment in living forms) in the second.* For Mr. Darwin tells us that the gradual material differentiation of individuals has given rise to all the *great plans* of structure. The whole sentence is pregnant with meaning—not a word is employed which has not a definite and necessary connexion with what precedes or with what follows; and the simple difference between the position of the writer and that of the reader is this, that Agassiz wrote the sentence with a full and thorough appreciation of all the bearings of the subject, every word being fraught with meaning in his mind, whereas, his reader having less grasp of the subject, has, necessarily to learn it by degrees, and by a dint of study of its contextual relations.

A few remarks may here be appropriately introduced upon the subject of these great plans, which appears to me to be one of the last importance.†

* "The leading objection of Mr. Agassiz is likewise of a philosophical [metaphysical] character. It is, that species exist only as *categories of thought*—that, having no material existence, they can have had no material variation, and no material community of origin. Here, the predication is of species in the subjective sense, the inference in the objective sense."—*Prof. Asa Gray, in Atlantic Monthly Magazine, October*, 1860.

† Nothing can prove more certainly the *natural* character of these four distinct plans than the fact that Von Baer and Cuvier, each of them independently arrived at the same conclusions concerning them—Von Baer, through the study of developmental changes, and Cuvier, by means of a close attention to the anatomical structure of animals.

These great plans of animal structure are not mutually reducible. However animals of different branches may agree in their *external* characters (as I showed at length in a paper read before the Society last session) no comparison can be instituted between their internal structure. No *series of forms* can be constructed, passing insensibly from one great branch to another. The highest forms of one branch are superior to the lowest forms of the branch next above it in organisation, but there is no *community of characters* between the two—each adheres to its own special type or plan. Thus, cephalopods may, in some points, be regarded as intermediate between mollusca and fishes, but the highest cephalopod is superior to the lowest fishes; nevertheless, as Von Baer remarks, "metamorphose a cephalopod as you will, there is no making a fish out of it, except by building up all the parts afresh." Darwin himself recognises this difficulty. Hence he says, in summing up, "I believe that all animals have descended from at most only *four* or *five* progenitors." But at this stage of his argument, the demands of his theory are imperative, and he adds—"Analogy would lead me one step further, namely, to the belief that all animals *and plants* have descended from some *one* prototype;" and arguing from what we must be excused from designating somewhat vague ideas of a *community of composition*, he adds this climax—"Therefore, I should infer from analogy that, probably, all the organic beings which have ever lived on this earth have descended from some one primordial form, into which life was first breathed."*

* Much stress has been laid, in derivative hypotheses, upon the changes which the organism undergoes in embryo; and, truly, it must diminish our feeling of incredulity in, and repugnance to, the theory of derivation, when we reflect on these changes. *A priori*, it does not seem more incredible that some adult species should have arrived at their present condition by having passed through inferior forms during immense periods of time, than that embryos should (as we know they do) pass through various representative forms of lower types of animal life, previous to arriving at their permanent condition. Embryology shows us

Let me now proceed to the examination of Agassiz' further arguments. I pass over his caustic remarks upon the confusion of ideas implied in the general term, *variability of species;* and I must also necessarily pass by his categorical contradiction of many of Darwin's fundamental statements; but never was a theory more sorely beset than is that of Darwin by the repeated assaults of such a giant in palæontology as Agassiz. Statement after statement, by which the whole theory hangs together, is assailed and impugned—stone after stone of the Darwinian structure trembles before the battering-ram of the champion of species. Out of twelve such reiterated attacks, ten of which are purely palæontological, and stand unchallenged, only one has called for remark, and that one, perhaps, the least important. Nevertheless, believing, as I do, that Agassiz has written no line without an object, I am bound to bring it before the tribunal of criticism. He says—"He (Darwin) would have us believe that animals acquire their instincts gradually, when even those that never see their parents, perform at birth the same acts, in the same way, as their progenitors." Now, this appears at first sight to be such a truism, that it seems unnecessary either for Agassiz to state it, or for me to defend it. But we must not forget that Agassiz writes with especial reference to an argument before us all, viz., Darwin's work on the "Origin of Species." We must, therefore, consider this passage relatively to that work. In chapter 8, we read—"If we suppose any habitual action to become inherited, then the resemblance between what originally was a habit, and an instinct, becomes so close as not to be distinguished;" and again—"Under changed conditions of life, it is at least possible that slight modifications of instinct

that there is no *natural barrier* to development, as long as that development is confined to cognizable gradations. But we have yet to learn that the embryo of a vertebrate animal ever exhibits the articulate or molluscan type; and the primary distinction thus implied casts doubt and difficulty upon the other cases in which the transition *seems* more easy and simple.

might be profitable to a species; and if it can be shown that instincts *do* vary, ever so little, then I can see no difficulty in natural selection preserving, and continually accumulating variations of instinct to any extent that may be profitable." Here, then, Darwin compares instinct to habit, and argues concerning it as he would argue concerning habit. But *instincts* exhibit themselves at the very threshold of life, before it is possible for *habit* to be developed, which presupposes some experience. Hence, how can we "believe (to use the words of Agassiz) that animals acquire their instincts gradually, when even those who never see their parents, perform at birth the same acts, in the same way, as their progenitors?" It will be seen, that in this connexion, the argument is not carping nor superfluous, but forcible and cumulative.

I now pass to a more important part of the subject, namely, the remarks of Agassiz in regard to the assumed connexion between *affinity* and *genealogical relationship;* and, in the first place, I cannot construe his observations in any way so as to make him argue that "similarity between adult animals is but an agreement in a single stage; and if agreement in a single stage be sufficient to prove genealogical relationship—then, since the embryos of very distinct animals are much alike, there must be a close relationship between these very distinct animals." What he *does* say is this—"There is nothing *parallel* between the relations of animals belonging to the same *genus* or the same *family*, and the relations between the *progeny of common ancestors.* In the latter case, we have the result of a physiological law regulating reproduction, and in the former, affinities, which no observation has thus far shown to be in any way connected with reproduction." Here we have an argument, in which the opponent challenges Darwin for *facts* in support of his hypothesis that *affinities* among animals are evidence of *genealo-*

gical relationship. He proceeds—"The most closely allied species of the same genus, *or* the different species of closely allied genera, *or* the different genera of one and the same natural family, embrace representatives which, *at some period or other of their growth,* resemble one another more closely than the nearest blood-relations; and yet we know that they are only *stages of development* of different species, distinct from one another at every period of their life." Here is not a word about similarity between *adult* animals, but the whole argument is based upon *developmental* changes, and the *reductio ad absurdum* is not proven. Thus, proceeds Agassiz, "The *embryo* of our common freshwater turtle (*Chrysemys picta*) and the *embryo* of our snapping turtle (*Chelydra serpentina*) [distinct genera, be it observed] resemble one another far more than the different *species* of Chrysemys [a single genus] in their *adult* state; and yet not a single fact can be adduced to show that any one egg of an animal ever produced an individual of any species but its own." A great and overwhelming fact against the theory of derivation, since it proves that the character of the species impressed upon the germ from the beginning, by hereditary descent, is dominant through all the various changes, analogies, and differentiations through which the embryo passes; never swerving from its undeviating course, except by the force of unwonted disturbing causes, and even then returning by the shortest cut to its original form; so that, as Agassiz elsewhere happily expresses it, "while *individuals* are perishable, they transmit, generation after generation, all that is specific or generic (or in one word *typical*) in them, to the exclusion of every *individual peculiarity,* which passes away with them." How different this from what Darwin's theory would demand of us, which tells us that it is just these *individual peculiarities* which are preserved, and, by their accumulation, *alter* the type.

But the head and front of Agassiz' offence lies in the following illustration. He says—"A young snake resembles a young turtle, or a young bird, much more than any two species of snakes resemble one another, and yet they go on reproducing their kinds and nothing but their kinds; so that no degree of affinity, however close, can, in the present state of our science, be urged as exhibiting any evidence of community of descent." There is no man living who has more right to speak authoritatively on embryology, particularly upon that of the Reptilia, than Agassiz. For the first four years of *my* existence, *he* dwelt, as a disciple, in the house of Ignatius Döllinger, the master of the great Von Baer, and of Pander, and the father of the science of embryology. His laborious and marvellous work on the "Embryology of the Turtle" (Boston, 1857), which forms a portion of the "Contributions to the Fauna of the United States," is a monument of science and industry, of which any nation may justly be proud. No author has more completely, more thoroughly, or more exhaustingly investigated this difficult branch of physiology than Agassiz; and his assertions on this subject are entitled to the very highest respect. It is conceded that when Agassiz writes of a *young* snake and a *young* bird, in this passage, he refers to an embryo snake and an embryo bird, and, indeed, to a *young* embryo. I can only, however, bring the authority of other eminent physiologists to corroborate the assertion of Agassiz, which, *to non-physiologists*, no doubt, appears somewhat startling. I quote the following passage, therefore, from "Carpenter's Comparative Physiology," p. 628—"All the most important parts of the apparatus of organic life, and even the fundamental portions of that of animal life, are developed upon the same general plan in all vertebrata; and the *special* peculiarities of each class only *gradually* evolve themselves. The conditions under which the alimentary canal, the heart and blood-vessels, the liver, the corpora Woolfiana, the vertebral column, the nervous centres, and the eye and ear, first present themselves, exhibit no essential difference in the fish, reptile, bird, or mammal." Again, "the history of development," says Von Baer, "is the history of a gradually increasing differentiation of that which was at first homogeneous." The fundamental type, he elsewhere explains, is first developed, and afterwards more and more subordinate characters appear. In these passages is stated, then, the fact, well known to physiologists, which Agassiz has summed up and illustrated in the line in question.

But is the objector and doubter aware that Darwin himself mentions this very fact, quoting Agassiz as an authority. At p. 439 of the "Origin of Species," we read—"It has already been casually remarked that certain organs in the individual, which, when mature, become widely different, and serve for different purposes, are in the embryo exactly alike. The embryos, also, of distinct animals, *within the same class*, are often strikingly similar; a better proof of this cannot be given than *a circumstance mentioned by Agassiz, namely, that having forgotten to ticket the embryo of some vertebrate animal, he cannot now tell whether it be that of a mammal, bird, or reptile.*" Not, however, that this is anything new—for, a dozen years ago, Agassiz wrote—"To deny the reality of natural groups because of their early resemblances would be to take the resemblance for the reality. It would be the same as saying that the frog and the fish are identical, *because at one stage of embryonic life, it is impossible, with the means at our command, to distinguish them.*" And again, in another place—"Hence, the embryos of different animals resemble each other more strongly when examined in the earlier stages of their growth. We have already stated that during almost the whole period of embryonic life, the young fish and the young frog scarcely differ at all; *so it is also with the young snake compared with the embryo bird.*" The truth is, that at a certain period, the embryo of a snake and the embryo of a bird *are* as much alike as the embryos of two snakes, and affinity *is* thus at fault in indicating relationship, which is, in fact, the argument of Agassiz, and one which cannot be gainsaid. This being the major proposition, the minor is, of course, included in it, namely, the assertion of Agassiz that "an *embryo snake* resembles an *embryo bird*, more than two *adult snakes* (of different species) resemble one another." The differences between embryos should undoubtedly be compared among themselves; but, nevertheless, if such differences are inappreciable in comparison with the distinct specific differences observed in adults, there can be no reason why the argument should not be strengthened by such a comparison.

There is yet one more portion of the paper of M. Agassiz, in which he has, as I conceive, been seriously misunderstood; and, it is a point not inferior in importance to any of those upon which I have already touched. Returning to the subject of *individuality* among Acalephs, with which he commenced the paper, he proceeds to specify the very remarkable modifications which the great "mystery of organic life" exhibits. First, he describes *hereditary individuality* as exhibited in all the higher animals. This is rare in Acalephs, and only exists in the Ciliogrades and some Pulmograde Discophoræ. Second, *derivative*, or *consecutive individuality*, such as occurs in the Nudibranchiata, which, from a single egg, produce more than one individual; this also occurs in such Medusæ as have what is termed an *alternation of generations*. Thirdly, *secondary indviduality*, such as is inherent to those individuals arising as *buds* from other individuals, and remaining connected with them (as in the fixed Polyparia); and, fourthly, *complex individuality*, in which such a community acts as a single individual, while each individual member may perform distinct acts of its own. This last occurs as a character of the Siphonophoræ among Acalephs—the Physogrades of De Blainville.

There is thus among Acalephs, great diversity of individuality; and, moreover, a similar diversity is observed in the specific differences among them; or, in other words, a greater or less degree of polymorphism is remarked. With Ctenophoræ (or Ciliogrades of De Blainville) this polymorphic tendency is at a minimum; for here, not only are the individuals composing the group closely similar, but being all hermaphrodite, there is not even the polymorphism arising from difference of sex. *This*, however, *does* occur in the Pulmograde Discophoræ (to which our naked-eyed Medusæ belong), and sometimes the variations are very striking, as in Aurelia, one of the covered-eyed division, which has received from writers the names, Aurelia lineolata (Peron), A. radiolata (Lamarck) A. granulata, A. rosea, A. surirea, A. purpurata, Medusa purpurata (Penn), and Biblis Aquitaniæ (Lesson), the species indicated being in every case *Aurelia aurita* (Forbes). Deviations from the normal number of parts constitute another source of polymorphism. Next, the cycle of individual differences embraces two distinct types of individuals—the *Medusa* type and the *Hydra* type. *One* of these types may exhibit more or less diversity, there being frequently *two* kinds of Hydra united in one and the same community; or (though more rarely), two kinds of Medusæ, as among the Siphonophoræ (Physogrades). Thus, in the Diphydæ, which appear like pieces of transparent glass, and which were imagined by Cuvier and others to consist each of two distinct animals, always united, although separable with impunity, Professor Huxley shewed (Phil. Trans., 1849) that they consist of two constantly associated, though easily separated forms, slightly attached, but capable, for some time at least, of an independent existence. These two Medusa forms, one (anterior natatory body) including the other (posterior natatory body), may be very similar, as in Diphyes, or very dissimilar, as in Cuboides vitreus. In the latter, the including (anterior) individual is large and cuboid, the included (posterior) individual is small, tetragonal, and campanulate; whereas in Abyla trigona, the reverse occurs, the including individual being here small, subcuboid, and campanulate; and the included, much larger, oblong, and polygonal.*

Agassiz goes on to argue from all this, as follows—"But notwithstanding the polymorphism among the individuals of one and the same community, genetically connected together, each successive generation reproduces the same kinds of heterogeneous individuals, and *nothing but* individuals linked together in the same way. Surely we have here a much greater diversity of individuals, born one from the other, than is exhibited by the most diversified breeds of our domesticated animals; and yet all these heterogeneous individuals remain true to their species, in one case as in the other, and do not afford the slightest evidence of a transmutation of species."

It is immediately after this that the passage follows, the objection to which has given rise to these remarks—"Would," says Agassiz, "the supporters of the fanciful theories, lately propounded, only extend their studies a little beyond the range of domesticated animals—would they investigate the alternate generations of the Acalephs—the extraordinary modes of development of the Helminth—the reproduction of the Salpæ, &c.,—they would soon learn that there are in the world far more astonishing phenomena, strictly circumscribed between the natural limits of unvarying species, than the slight differences produced by the intervention of man among domesticated animals, and, perhaps, cease to be so confident

* In Prof. Huxley's elaborate Monograph of the Oceanic Hydrozoa (Ray Society, 1859) the Cirrhigrada and Physograda of De Blainville are recast and differently arranged, forming the two families, Calycophoridæ and Physophoridæ. The including and included individuals spoken of in the text are regarded by him as organs of propulsion, and distinguished as proximal and distal nectocalyx. I have retained Cuboides as an illustration, because it does not appear that this is interfered with by Huxley's supposition that it is a Diphyozoöid, derived from Abyla. In Hippopodius, a genus of the Calycophoridæ, the nectocalyces are said to be as many as twelve in number.

as they seem to be, that these differences are trustworthy indications of the variability of species."

I have here fairly stated Agassiz' views—in fact quoted them nearly verbatim, simply adding illustrations; and, I need scarcely remark, in the first place, that these "astonishing phenomena" can, in no respect, be imagined to be *novelties* to M. Agassiz, who, thirteen years ago, published, in conjunction with A. A. Gould, the admirable "Outlines of Comparative Physiology," in which a chapter is devoted to a lucid exposition of these very changes. In the second place, that in Darwin's work on the "Origin of Species," the subject of the "alternate generations of Acalephs, the extraordinary modes of development of the Helminth, and the reproduction of the Salpæ," are altogether ignored, and find no place in the argument, being nowhere, in the remotest manner, alluded to. From this I deduce *three* things:—First, that no man had more cause than Agassiz, by reason of his thorough acquaintance with the subject in all its bearings, to be impressed with the vast importance of these polymorphisms and alternations in any question of biology so comprehensive as the Origin of Species. Secondly, I think we have every right to infer that these most curious and astonishing phenomena (notwithstanding the elaborate notice which he takes of the somewhat analogous phenomena of *neuter insects*) had not been regarded by Darwin in so important a light as to make him consider them a necessary part of his argument, or a possible objection to his theory; and, thirdly, that Agassiz, whose opinion on the question must command the highest respect, by calling attention to the omission, has done nothing more nor less than might reasonably have been looked for from so distinguished a Physiologist.

But I still maintain that the object of the whole reasoning of Agassiz in the passage quoted is simply to draw the reader's attention to the fact of the great extent to which polymorphism obtains among Acalephs, and that he nowhere states that he regards the metamorphoses undergone by them in the alternations of generations, in the light of *varieties*. He simply includes, and very properly, the cycle of ovum, hydroid, and medusoid, in *one polymorphic species;* and the illustration is, therefore, perfectly just.

But if Agassiz *had* definitely stated his opinion that the transformations of the Medusæ could be regarded as varieties, his doctrine would not have been so heretical but that he would have received the support of many eminent physiologists, and among them of the late illustrious Professor E. Forbes, than whom few had more closely studied the Acalephæ, as his beautful Monograph, published by the Ray Society, amply testifies. At page 82 of that work, he says—"In what light are we to regard the relationship between the Medusa and Polyp? The one is *not the larva* of the other, as is often improperly said, because there is *no metamorphosis* of the one into the other. The first is the parent of the last, and the last of the first, but neither is a *stage* of an *individual* existence, destined to begin life as a Medusa and end it as a Polyp, and *vicé versâ.*

In the case of Aurelia—

a. The Medusa produces eggs;
b. The eggs produce Infusoria;
c. The Infusoria fix, and become hydroid Polyps;
d. The hydroid Polyps produce Medusæ by gemmation.

With such facts, unquestioned facts, before us, it seems to me that we have no choice between theories, and we must admit the idea of *alternation of generations* to be true."

In point of fact, however, the phenomena of alternate generations, or "the production of dissimilar individuals among sexual animals, by a non-sexual process" (Allen Thomson) are far more astonishing than the transformations undergone by insects. For there is only the most superficial analogy between the *alternation of generations* of Medusæ and Salpæ, and the *metamorphoses* of insects. In the latter there is a distinct change from one stage into another, readily traceable; in the former, the animals "remain different through their whole life, so that their relationship does not appear until a succeeding generation. The son does not resemble the father, but the grandfather; and in some cases the resemblance reappears only at the fourth or fifth generation (as in Distoma) or even later" (as in Aphis, at the ninth.) Thus in the case of the Acalephs—the little animal, which on leaving the egg, has the form of an infusory, passes in succession through the phases of Scyphistoma, Strobila and Ephyræ, so called, because, before these changes were understood, they were imagined to be different *genera,* and were named accordingly. "But the remarkable point in these metamorphoses is, that what was at first a single individual, is thus transformed by transverse division into a number of entirely distinct animals, which is not the case in ordinary metamorphoses. Moreover the upper segment [of the strobila] does not follow the others in their development. Its office seems to be accomplished as soon as the other segments begin to be independent; being intended merely to favour their development, by securing and preparing the substances necessary to their growth." Hence they are called Medusa polypiform *nurses*. "There is [then] this essential difference between the metamorphoses of the caterpillar, and alternate reproduction, that, in the former case, the same individual passes through all the phases of development; whereas, in the latter, the individual disappears, and makes way for another, which carries out what its predecessors had begun. It would give a correct idea of this difference to suppose that the tadpole, instead of being itself transformed into a frog, should die, having first brought forth young frogs; or that the chrysalis should, in the same way, produce young butterflies. In either case the young would still belong to the same species, but the cycle of development, instead of being accomplished in a single individual, would involve two or more acts of generation."*

I must, however, bring the subject to a close; not for want of material, for it is almost inexhaustible, but because I have already exceeded the limits I had anticipated. I trust I have fulfilled my pledge of justifying the criticism of M. Agassiz from the charges which have been brought against it; and I believe I may safely leave the matter in the hands of those who have listened to my vindication.

At the conclusion of the paper, the PRESIDENT said he would not invite discussion at that late hour (10.5). He desired to express the great interest and pleasure which he was sure had been felt by all who had listened to the many instructive matters which had been brought before them in the paper which had just been read by Dr. Collingwood, who, nevertheless, he thought, had altogether failed in showing the injustice of his strictures on the criticism of M. Agassiz. He would confine his remarks to two points, and, after all that had been said, he considered the illustration of the embryo snake and the embryo bird was an appeal to ignorance and not to science; and that M. Agassiz' petulant and offensive assumption of want of information on the part of Mr. Darwin and his supporters, on a subject unquestionably familiar to them, justified his censure of M. Agassiz' review as unworthy of so distinguished a philosopher. He (the Rev. H. H. Higgins) was not a supporter of Mr. Darwin's theory, but he deeply regretted the uncandid manner in which it had been in many quarters attacked.

Dr. COLLINGWOOD observed that calling the similarities among embryos "an appeal to ignorance" was simply begging the question. He did not consider it necessary to repeat his arguments, but he would cheerfully abide by what he had written, and was quite content that it should stand as the record of his defence of Agassiz.

* The passages in inverted commas I have quoted from Dr. Wright's edition of Agassiz and Gould's "Outlines of Comparative Physiology," London, 1851. I have considered myself justified in doing this, for these reasons; first, because although a work of Agassiz himself, two other names are associated with his in it;—secondly, because the statements are the most succinct and definite I have been able to meet with;—and thirdly, because I believe they are still accepted as the correct and philosophical view of the subject of *alternation of generations.*

Dr. Edwards hoped the President would not leave the chair without affording him the opportunity of expressing the gratification he had received from Dr. Collingwood's able exposition of M. Agassiz' views, and he moved that the cordial thanks of the society be presented to him; for he felt sure that all present must have been pleased with the philosophical tone and highly instructive character of his paper, which, he considered, relieved M. Agassiz from the charge of wilful obscurity, and, at the same time, was exceedingly impartial on the general subject.

The Rev. C. H. Burton seconded the motion, and confessed that he could not agree with the President's remarks, for he considered that Dr. Collingwood had successfully justified M. Agassiz.

APPENDIX.

LITERARY AND PHILOSOPHICAL SOCIETY.

SECOND ORDINARY MEETING.

Abstract of a Paper by the Rev. H. H. Higgins, M.A.,

ON DARWIN'S THEORY OF THE "ORIGIN OF SPECIES."

He considered the paper by M. Agassiz, inserted in the *Annals and Magazine of Natural History*, to be quite unworthy of so distinguished a naturalist. Having entered at some length into his reasons for holding this opinion, he said:—A singular argument is used by M. Agassiz to show that affinities between animals are not evidences of genealogical relationship. Similarity, he argues, between adult animals, is but an agreement in a single stage, and, if agreement in a single stage be sufficient to prove genealogical relationship, then, since the embryos of very distinct animals are much alike, there must be close relationship between those very distinct animals; a *reductio ad absurdum*. M. Agassiz thus writes:—"A young snake resembles a young turtle or a young bird more than any two species of snakes resemble one another, and yet they go on reproducing their kinds, and nothing but their kinds; so that no degree of affinity, however close, can in the present state of our science, be urged as exhibiting any evidence of community of descent." A child might reply, if a young snake is more like a young bird than one old snake is like another, a young snake is not so like a young bird as it is to another young snake; so affinity, after all, is right in its indications. But this would be to concede to M. Agassiz far too much. Does an embryo snake resemble an embryo bird more than two kinds of snakes resemble each other? Differences of embryos must surely be compared amongst themselves, and not with the distinctions subsisting between adults.

M. Agassiz suggests:—"Would the supporters of the fanciful theories, lately propounded, only extend their studies a little beyond the range of domesticated animals; would they investigate the alternate generation of the Acalephs, the extraordinary modes of development of the Helminth, the reproduction of the Salpæ, &c., they would soon learn that there are in the world far more astonishing phenomena, strictly circumscribed between the limits of unvarying species, than the slight differences produced by the intervention of man amongst domesticated animals, and perhaps cease to be so confident as they seem to be, that these differences are trustworthy indications of the variability of species." It is, no doubt, desirable that Mr. Darwin and his supporters should not remain in ignorance of the "astonishing phenomena" connected with the transformations of the Salpæ, Medusæ, &c., though it is not clear why these changes should be more astonishing, *except to those to whom they may be novelties*, than the transformations undergone by insects; but, in the matter of the argument, the illustration given by M. Agassiz is altogether wide of the mark, for the simple reason that the transformations of the Medusæ are not varieties at all, any more than the caterpillar is a variety of the butterfly.

work. How an embryo could possibly be [illegible] more than two kinds of snakes resemble each other? Differences of embryos must surely be compared amongst themselves, and not with the differences existing between adults.

II. Agassiz objects:—"Would the supporters of the fanciful theories lately propounded, only extend their studies a little beyond the range of domesticated animals; would they investigate the alternate generation of the Acalephs, the extraordinary modes of development of the Helminths, the reproduction of the Salpae, &c., they would soon learn that there are in the world far more astonishing phenomena, strictly circumscribed between the limits of generic and specific [illegible] the slight differences produced by the intervention of man amongst domesticated animals, and perhaps come to be so convinced as [illegible] seem to be, that these differences are [illegible] nary indications of the variability of species." It is no doubt [illegible] that Mr. Darwin and his supporters should not remain in ignorance of the astonishing phenomena [illegible] and [illegible] of the origin [illegible] though it is not clear why these changes should be more [illegible] to refer to [illegible] they may be [illegible] than the transformations undergone by insects, that, is the [illegible] the illustration given by M. Agassiz [illegible] of the earth, for the simple reason that the transformations of the Echinoderms are not changes in any way more than the [illegible] is a variety of the butterfly.

THE
INFLUENCE OF THE MICROSCOPE
UPON THE
PROGRESSIVE ADVANCE OF MEDICINE:

An Address

DELIVERED AT THE OPENING OF THE SESSION

1859-60.

AT THE

LIVERPOOL ROYAL INFIRMARY SCHOOL OF MEDICINE.

BY

CUTHBERT COLLINGWOOD, M.A., M.B. Oxon., F.L.S.

MEMBER OF THE ROYAL COLLEGE OF PHYSICIANS, LONDON;
LECTURER ON BOTANY AT THE MEDICAL SCHOOL;
PHYSICIAN TO THE NORTHERN HOSPITAL,
&c. &c. &c.

LIVERPOOL:

PRINTED BY HENRY GREENWOOD, 32, CASTLE STREET.

1859.

ADDRESS, &c.

GENTLEMEN,

THE first of October is a *white day* in the annals of medical education. On this day are assembled throughout the country the students of the numerous medical schools, to inaugurate a new session, and to give an earnest of the zest and diligence with which they intend to resume its duties. On this day the working practitioner throws aside for an hour the cares of his busy profession, for the pleasure of meeting his old student-friend upon the familiar benches, and delights to recal his long past student-life by an agreeable intercourse with his former *confères*. And on this day, also, the new student, fresh from the discipline of school, stands for the first time in a position which is at once a novel and an exciting one. He finds himself suddenly thrown into the society of those who, since they are no longer boys, feel that they have serious work before them; and being men, are determined to meet it in a manly spirit.

On this day, too, it falls to my lot, as the representative of the Liverpool School of Medicine, to address you. It is at once a difficult task and an agreeable privilege: for it *is* a privilege to have it in one's power officially to hold the attention of an intelligent auditory, composed, as this is, of experienced colleagues, of diligent and discriminating students, and of novices thirsting for information. I say it is an agreeable privilege, to be able to stand before such an assemblage even for one short hour—but it is at the same time a task whose difficulty I can well appreciate. An Introductory Address is no novelty — many of you have heard a dozen — some of you have had experience of the difficulty of selecting a subject, or of saying anything which has not been said a score of times upon similar occasions. The path before me is a thoroughly beaten one; worn bare by the feet of hundreds of previous travellers. No fertile patches of verdure do I perceive in the vista before me — no wayside flowers but have been culled by those who have preceded me. And yet I think I can perceive paths which, although they may slightly diverge, lead nevertheless, eventually, to the same goal.

The very fact that his audience is composed of such extremely diverse elements, is one of the chief difficulties which beset the writer of an Introductory Address. Were there none but young students, eager to commence their studies, and expecting some information which may serve them as a guide in the prosecution of them, the case would be different; but there are, in addition, tried practitioners, whose student-life dates ten or twenty years back, and who can hardly be expected to sit with patience and listen to the good advice of which the tyro stands in need. It will be necessary for me, therefore, to meet the exigencies of the case in such a manner as that, while the one shall not feel that his cause is neglected, the other shall not have reason to consider his valuable time to be wasted.

Let my earliest observations, then, be directed to those students who, on this day, enter for the first time within the walls of the medical school. Of such I would fain believe that they do so, probably without exception, in a hopeful, in a willing, and in a determined spirit. They do not come here at a day's notice, for they have probably well weighed the question of their future profession; and circumstances, or their own bias, or perhaps both combined, have led them to the choice of Medicine. Neither are they altogether unprepared, for although upon the very threshold of the Esculapian temple, it is possible that they have made themselves to a certain extent acquainted with the nature of the studies which lie before them, though they can have but indistinct and inadequate impressions of the extreme interest which surrounds each one of them. In entering upon a new undertaking of this nature, there is a degree of healthy excitement produced, which serves to stimulate the student and to encourage him to throw himself heartily into the work before him without loss of time; and there is also a degree of freshness of thought — a youth of intellect, as it were, which renders the mind susceptible of being favourably impressed by the varied studies upon which he is entering. Novelty is always pleasing, and especially so when combined with an intrinsic charm, such as is possessed by the Sciences cognate to Medicine. Such an exhilaration of the mental faculties, therefore, being highly advantageous in the outset for the prosecution of studies so diverse and so abstruse as those which constitute the medical curriculum, it is no less important that it should be sustained as much and as long as possible—that the attention should not be permitted to flag, nor the freshness to be worn off by the reactionary attacks of indolence which are but too likely to ensue.

The thoughtful student comes to his task stimulated by example and armed with hope. He sees men filling various high and responsible stations in life — men who are regarded by their contemporaries with esteem, and even with veneration — men who have enriched science with the development of their intellect — men who have advanced their art by the philosophic application of their long experience — he sees these men, on the one hand, illuminating the brilliant intellectual circle in which they move; and on the other, imparting their stores of knowledge to eager disciples; and he knows that these were once, like himself, listeners — that they, like himself, were once hopeful beginners — that their advantages were not greater than those which *he* possesses — and that by diligence and integrity he may aspire one day to occupy a position inferior to none of them. With this thought in view, he has a powferful inducement to *work*, not by fits and starts, nor yet unduly, but steadily and perseveringly, with the full assurance that no man ever won his way to an enduring and enviable reputation who did not earn it by close application and the conscientious performance of his daily duties.

These duties, Gentlemen, in the course which you have chosen, are devoid of glitter and of extrinsic attraction, but they are far from possessing monotony or sameness. You might in other professions have found more opportunity for the exercise of superficial qualities and ornamental accomplishments; but you would have met with none which offered such scope for profound investigation, or for the successful cultivation of which such a combination of mental qualities is desirable.

Yes, Gentlemen, I commend your choice — it is a noble one, and Medicine is a noble Profession, so long as its professors are united in brotherly concord — so long as its aim is single — and so long as petty jealousies and envious bickerings do not disturb the harmonious tendencies of the healing art, and the philosophic calm which should spread its influence over the earnest searcher after Truth in Nature. For what is the profession of Medicine, but first, an inquiry into the abstrusest natural phenomena; and secondly, the application of the principles thus arrived at to the alleviation of human suffering, and the smoothing of the pillow of death! For the first, it is the highest exercise of the functions with which the Creator has endowed reasoning Man, to search out the springs of the Divine Mind, and to reconstruct, as it were, the Divine will from the glimpses which are afforded us of the government of the material world. The masterpieces of Creation can only fully declare the ineffable glory of the Creator, when they are submitted to the investigation and analysis of reasoning minds — for it is then alone that an insight is gained into the causes of things — it is then alone that a reflection is obtained of the Divine wisdom and beneficence. And of all the secular studies which exalt the intellect by assimulating it to the mind of God, the study of the ultimate laws which govern organized bodies is at once the highest and the most ennobling. What can be a more elevating study than that which teaches us how fearfully and how wonderfully we are made — and how complex a mechanism it is which carries on the mysterious functions of life? What a more awful profession than that which brings us into daily contact with Death?

But the votary of Medicine must not expect to draw upon himself the notice of the world at large. The *éclat* which accompanies the destruction of an host cannot be expected to follow the silent working of the good Samaritan. Self-denial must constitute a prominent feature of the medical character. Content to inure himself to sights of suffering and sounds of grief, he must find his reward in the conscious performance of his duty, and in the knowledge that no class of men have greater power of doing good than the medical profession. It is essentially domestic — essentially benevolent — and offers scope for the exercise of many of the finest feelings which adorn our human nature. And although a few narrow minds may affect to underrate the services rendered by our profession to mankind at large, still we may rest assured, that in all ages a due estimate has been, and will be formed, of the value of our Art—"an Art so much sought after," says Cicero in the Tusculan Disputations, "that the invention of it, as being so useful, is ascribed to the immortal Gods."

Having then once given himself heartily to the preparation for his professional career, the student need not fear that his interest will be allowed to flag, or his willingness to work have just cause for diminution. Let him only keep up his attention, and each successive phase of his studies will but appetize him, as it were, for the reception of fresh mental food, and stimulate him to advance, step by step, with energy and with advantage. It does occasionally happen, that a taste for the medical sciences, combined with an industrious turn of mind, has led to a too great devotion to them, to the detriment of what is equally necessary to be attended to, namely—*health;* for such is the fascination which knowledge has for some minds, that every thing else is lost sight of in the race for its acquisition—an abuse to which the greatest and best things are unhappily liable. But it is less necessary to insist upon this point than on its converse. While one student neglects his health for his studies, a dozen are too apt to neglect their studies for the sake of any present pleasure which may allure them, not recollecting that study is the business of their life at that period, just as commerce, or practice, is the business of life of the more matured individual. The student would perhaps be foremost to blame the practitioner if the latter neglected his daily avocations; but it is a most illogical conclusion, if the student imagine that he has any more right to neglect *his* opportunities than the practitioner his duties; they are both equally incumbent upon them—they are both the appointed business of their respective periods of life.

But it will be far more difficult for one who has comparatively little interest in his pursuits—I would not say *to excel* in them, for that were next to impossible—but to follow them with advantage, and upon equal terms with those whose heart is in their work. It too often happens in our profession, and indeed in *all* professions, that the student discovers, too late, that he has mistaken his vocation. If this should happen, and he cannot retrace his steps, I would recommend to him the advice which Lord Bacon gives in his essay *Of Nature in Men*—"In studies, whatsoever a man *commandeth* upon himself, let him set hours for it." It will require no small amount of self-discipline for such an one, even when aided by principle, to keep his place in the ranks with those who pursue their studies *con amore.* But I would have no one voluntarily bind himself to a profession in which he takes no interest; for by so doing, he condemns himself to a life of vexation and disappointment, while it is not possible that the profession itself can derive any benefit from his presence in it.

It must not be imagined, however, that even moderate diligence and application will carry the student forward in his career with such an impetus, that he shall ever feel himself upon the crest of an advancing wave. It is not in the nature of things, nor, if we knew what was for our advantage, would it be desirable. The apothegm of Ennius, *nimium boni est, cui nihil est mali,* "nothing is really good which has no admixture of evil," although disputed by the ancient philosophers, will be accepted by us, as containing germs of Truth; and nothing can be better established than the fact that too great facility is apt to beget a careless ease, and all the train of disadvantages flowing therefrom. How often do we see a promising career blasted, and turned to gall and bitterness, by a neglect of talents which only required ordinary cultivation to render them pre-eminent: how frequently does it happen that too great dependence upon natural powers has made shipwreck of the prospects of one, who, but for this fatal facility, might have surpassed all his fellows? It is perhaps, then, a fortunate circumstance, and it certainly is one of those compensating circumstances which we see everywhere around us, that indolence and satiety are likely to arise but rarely from this cause. It is, I say, a circumstance by no means to be regretted, that the earnest student is not always advancing with an equal rapidity, nor always elated with success. Difficulties and temptations will beset his path, but their effect will be, not to discourage him, nor to cause him to abandon the career to which he has once applied himself — such a result would be but a poor comment upon his former earnestness and application. No! difficulties must be met by manly resistance, not by pusillanimous retreat. Nothing is worth acquiring which does not cost something in the acquisition, and the greater the difficulty, provided it is not insuperable, which few difficulties are, the greater is the value of the victory achieved over it. The difficulties and temptations, therefore, which meet the student will not arrest his career, but will only act as a healthy stimulus to his powers — will only arm him with determination to go forward, and will only serve, therefore, to ensure his final achievement, and to enhance the value of success.

Among the difficulties which the medical student discovers in an early stage of his career, is that arising from the number and variety of the studies he has to pursue. Let us suppose that he starts with a resolute determination to work hard at Anatomy — it is an excellent resolve, but he soon finds that the subject is extensive, and that the facts easily escape his memory; that this alone, indeed, is a subject which itself might lay claim to a large portion of his time. But there are others with no less pressing claims — Physiology calls for his attention, Chemistry must not be neglected, Medicine, Surgery, Materia Medica, Botany, and other subjects present themselves in rapid succession before his notice, so that in the multiplicity of his studies he begins to feel perplexity — while one is learnt another is forgotten; he may become temporarily discouraged, and perhaps feel something akin to despair, as the wide field of medical science gradually unfolds itself before him.

The remedy for this difficulty evidently is to be looked for in a methodical arrangement. The time should be duly apportioned to each subject, and the student should make it a matter of duty that the rules which he lays down for self-guidance should be conscientiously adhered to. Without this, of course, it would be folly to expect any benefit to accrue. Studies, like other things, become habits when persevered in, and studious habits, like business habits, when once acquired will be found of the utmost value. By the adoption of this method, the student will himself be surprised at the steadiness and rapidity of his progress. The University of London has recognized the difficulty arising from this multiplicity of subjects, which (although in turn it is necessary that they should all be mastered) yet without doubt, overload the brain during the brief period of the curriculum, and more particularly as the time of examination draws nigh. By the division of these subjects, however, into two parts, each of which forms the material for an examination, separated by an interval of two years, the student has the opportunity of giving especial attention to certain of his studies unclogged by others, and having been examined in these, he may, to a great extent, divest his mind of an immediate attention to their details, while he is devoting himself more particularly to the *second* class of subjects, which arise more or less out of the first. This is an advantage which cannot be overrated, and an example which I should be glad to see carried into practice by other examining boards.

But there is also another mode in which this difficulty may be at least diminished — a mode which has the double advantage of costing nothing, and being within the reach of every one. I refer to *early-rising*, a habit which nearly all those men who have achieved greatness, have found not only serviceable, but necessary. By rising an hour or two hours before the accustomed time, the day is lengthened, work is facilitated, and a satisfaction is experienced throughout the day which those alone can judge of who have made the trial. One-third of a man's life, on an average, is spent in sleep; and how much more even do some devote to the dreamy pleasures of the placid Morpheus. There can be no doubt that the majority of persons sacrifice far more time than is necessary to this part of — I cannot say their *economy*, for its excess is evident *waste;* nor can I call it their existence, for it is but the shadow of Life. Early-rising soon becomes habitual, and I doubt not that those who imagine that they require more sleep than others, are, in general, egregiously deceiving themselves. The great Boerhaave was in the habit of rising at four o'clock during the summer, and at five during the winter, devoting to study the early hours thus saved, and gaining that health and vigour which enabled him to carry on this practice until his death, at the appointed age of three score years and ten. Consider only, that rising two hours earlier, or at six instead of eight, will, at the year's end, have increased your waking life by as much as two calendar months of twelve hours to the day! Such a simple calculation makes one ashamed of opportunities lost, and of precious time wasted. Let it also produce a determination to profit by it for the future.

The medical student is doubtless exposed to peculiar temptations, which will at once occur to the thoughtful among them, and will be jealously guarded against. It is not my intention to dwell particularly upon those temptations to swerve from morality, from which all right-minded and earnest young men will recoil with loathing, but I would only remind you, that success in professional life is not alone to be won by that confidence which expertness and readiness are capable of supplying— there are yet important qualities to be taken into consideration, which are as essential even as professional capacity and medical knowledge. No one, perhaps, is admitted so freely into personal or family confidence as the medical adviser, and to no one will persons become more attached than to the medical man who has won their confidence and their esteem, for the one cannot be had without the other. The social position which the Doctor occupies is a proud one, and no right-minded man but will, by the punctilious performance of social duties, and the blamelessness of his life, strive to render himself worthy of the sacred confidence which many delight to repose in him. There is, however, one temptation peculiar to students, of a nature rarely dwelt upon, but which I think deserving of especial notice. It is a very general custom at the present time to offer *prizes* in the various departments, in order to stimulate the student, by means of honourable rewards, to outstrip his companions in the fair contest for mental supremacy. I think, on the whole, that such prizes are useful, and that they *do* offer something tangible, which the student considers worth striving for; and I further believe that a stimulus of this kind is, in general, of a healthy nature. But I am persuaded no less, that this system is liable to a great abuse, owing to the prevalence of the feeling that a single prize will confer more distinction than a general sound acquaintance with *all* the subjects studied; and to obtain this single prize, it certainly does sometimes happen that every thing else is neglected and thrust into the background. Now this is not the spirit in which prizes should be striven for, nor is it the spirit in which prizes should be awarded. A prize is not for one who, though he may be a proficient in a particular subject, is a dunce in every other, but rather should be given to that one who having a satisfactory and sufficient knowledge of all, at the same time excels the rest of his fellow students in one or more. This should be a *sine quâ non* in the adjudication of prizes — and it is the neglect of the first part of this proposition which not unfrequently develops a prize-taking boy or student into an ordinary and mediocre individual. Diffuseness, or the study of numerous subjects at one time, is a thing to be avoided in after life, or at all events should be severely regulated by the broadness of the educational basis. Scarce any man who has made for himself a name in science, or in art, but has devoted himself more particularly to a certain branch of human knowledge, towards which he naturally leaned, and which he has patiently and thoroughly investigated; for so wide is the domain of Nature, and so short is human life, that any one department affords ample material for thought and for discovery, which a life-time is not sufficient to exhaust. But with the student it is widely different. *He* is laying a foundation for the future. *His* education is not the end, but the means — and the broader, the firmer the foundation, the nobler, the more extended the superstructure which he will be enabled to raise upon it with safety. The sciences which relate to Medicine, and upon which a true estimate of disease and the means of cure are founded, are, it is true, not few nor insignificant; no student can be expected to master them all in their details, but nevertheless, there is an absolute necessity for obtaining as deep an insight into them as the opportunities of student-life will afford. They are so knit together, that neglect of one may paralyze the functions of another, and in applying his knowledge to practice, the consequences of this neglect, too late perhaps, become painfully apparent. Nothing which enters into the curriculum of study should be neglected — every thing is worth knowing, and although some things are at the very basis, and form the very groundwork of medical knowledge, still no opportunity should be lost of acquiring information — still less should any one make to himself the excuse for neglect, that the subject before him has not a practical bearing, and that the aim of it is not at once perceived.

But although none of the sciences bearing upon Medicine can with safety be neglected, it does not follow that every one of them is to claim an equal amount of time and attention. Without entering into a comparison of them all, it will be sufficient to single out one, as above all the most important, and the most deserving of extra-diligence, inasmuch as it forms the *pivot* upon which all the rest turn. I refer, of course, to Anatomy — the key-stone of the Asclepian arch — the alpha and omega of medical and surgical science — and without which all is empiricism and guess-work. Who would attempt to repair a piece of machinery unless he possessed a knowledge of mechanics? What watchmaker would think of employing, as an assistant, one ignorant of lever and escapement? And yet the human body is more complex than the most intricate machinery — more wondrous than the most delicate watchwork. It cannot be too often impressed upon the student, nor in terms too strongly marked, that Anatomy is the groundwork of safe and scientific practice, and that it is to the development of our knowledge of *it*, and of its sister science, Physiology, that we must look for the levers which must work the progressive advance of scientific medicine. Only let me give one caution — and let it not be considered as an over-refinement, or a superfluity of delicacy. The atmosphere of the dissecting-room — the constant contact with dead humanity — is liable to beget callousness of feeling, and, I think I may add, coarseness of sentiment, which, to say the least, is extremely undesirable in a class of persons whose finer sensibilities are so often called into requisition. The dignity of the human body is entirely lost sight of in its corruption and degradation; and unless a high standard of feeling and principle support the student, he is apt, from too frequent familiarity with lifeless humanity, to scoff at death and make a jest of mortality. The body which has "shuffled off this mortal coil," is not merely a mass of inanimate clay — were it only that it is a most curious and inimitable machine, ever revealing to his scalpel, as Harvey said, some new proof of God's wonder-working hand, there would be cause to admire it; but since it is, we are assured, only awaiting the summons to put on immortality — corrupt, that it may be rendered hereafter incorruptible — degraded, that it may be hereafter perfected — a foreshadowing of the appointed state of all of *us* — these considerations should check the levity of the thoughtless student, and cause him to leave the half-formed jest unsaid, and turn his coarse ribaldry into reverential respect.

I have just referred to the value of Anatomy as a branch of special medical education, and, more briefly, to the importance of its handmaid, Physiology; and in the following remarks my aim will be more fully to illustrate this subject, by endeavouring to point out that it is to these two sciences that we must look for the advance of Medicine from empiricism to rational principles — and how the more recent discoveries in Physiology promote this desirable end, by affording us palpable and established data, upon which we may safely found modes of practice with the reasonable hope of successfully combating disease. "Physiology," says Wolff, in his "Theory of Generation," "is related to Anatomy precisely as the corollary is related to the theorem from which it is deduced;" — and this being the case, it follows that a most minute and careful study of *structure* must ever precede and pave the way for any theory of *function*. And let it not be imagined by any one that this stepping-stone is safely and permanently laid down. The anatomy of the larger organs has, it is true, been long since satisfactorily ascertained; but the anatomy of *tissues*, which in the aggregate perform the most important functions of the economy, requires patient research — an eye accustomed to use the higher powers of the microscope — a hand to which the delicate scalpel is a familiar instrument — and a judgment not easily carried away by phantasies, but able to weigh cautiously the evidence of fallacious senses. This being the case, it is evident that *the study of ultimate structure* presents a no less inexhaustible field of investigation than that afforded by other natural sciences, and that therefore the knowledge of *function* must ever be limited by *its* boundaries.

In all physiological investigations we may set aside *vital force* as an ultimate fact, which may be taken for granted as acting in all organic changes. The physicist does not feel called upon to explain the *cause* of gravity, but only to elucidate the mathematical laws through which it acts — neither should the physiologist be too eager to grapple with an ultimate fact, which if it ever be fully comprehended at all, must be so as the result of a far higher generalization than he is yet in a position to make. But herein, as appears to me, lies the error of physiologists, that they, at the very outset, make an attack upon that most mysterious and impregnable position, from which they must necessarily fall back discomfited, like the moth which flutters round the bright and flaming candle. The nature of vital force is doubtless the most interesting problem in physiology — attractive from its very mystery — a problem which, like the philosopher's-stone, is destined to occupy the thoughts of, and to serve as food for speculation to many a master-mind; but its solution cannot be expected until many a yet unexplained fact be bridged over by a scientific induction, and many a missing link of the Titanian chain be painfully forged in the furnace of profound thought and patient philosophical investigation.

There is no direction in which Physiology has made such rapid and interesting advances as in the elucidation of the developmental changes which occur in organized beings. This branch of biology has risen into a distinct science, under the name of Embryology; and that evidently, because the high value of the lessons taught by the various stages of development is now fully recognized and appreciated; and observers have multiplied in a field which promises such a rich harvest of new facts and deeply interesting problems. The whole process abounds in suggestive points, which are throwing considerable light upon our knowledge of function; and inasmuch as the history of development, as Von Baer remarks, is "the history of a gradually increasing differentiation of that which was at first homogeneous," the progressive rise and comparative succession of the various organs, afford indices of the highest value as applied to the elucidation of the functions of the matured parts. In fact, the study of *development* is auxiliary to the study of *function*, just as the study of Comparative Anatomy, by pointing out the order of evolution of special organs, from which their comparative value in the economy may be safely deduced, is a valuable aid to the same important end. Any theory therefore, which runs counter to the information afforded by embryology may be regarded as spurious and unfounded—just as though it were not borne out by a comparative examination of the structure of inferior animals. Thus it was long held that the liver was the "sole source and prime mover of all vital organization"—a doctrine disproved by the subordinate value which that organ assumes in the development of the chick, in which its appearance is preceded by others which are of greater importance, as the heart, cerebral cells, &c.

It is to the Microscope that we are indebted for the basis of these generalizations; an instrument which has contributed vastly—and will contribute yet more—to the advance of physiological science. The imperfect apparatus in the hands of Leuwenhoeck and Swammerdam afforded revelations which astonished the scientific world two centuries ago; and the careful labour which has been expended in recent times upon the construction of achromatic lenses, has placed the histological knowledge of our own day upon a basis as firm as that which supports our knowledge of general Anatomy. It is only, however, within the last ten years, that that perfection of definition and illumination have been attained, which render the microscope the most powerful auxiliary in anatomical analysis; and it is scarce twenty years since the science of Embryology began its existence—a bantling of the Microscope;—a marvellous instance of the rapidity of development which characterizes the arts and sciences in our own age—surpassed by no bygone era in human history.

No *laudator temporis acti* can venture, in our day, to compare it with the past, having any hope of success—for the greatest nations of Antiquity must hide their diminished heads before the progress of the present century. Assyrian tyranny may have fostered early science — Egyptian priestcraft may have been instrumental in developing the mechanical Arts — Greek heroism may have extended regions of philosophical speculation — and the fine arts may have found their grand climacteric in the luxury of Rome — but it was ordained for our country, in the nineteenth century, to create more "wonders of the world" than the ancients spread over a hundred Olympiads, and to win in half a century more trophies of science and art — in geology — in organic chemistry — in photography — in steam locomotion — in naval architecture, and in the electric telegraph — than all the nations of antiquity produced in the four thousand years which preceded the birth of Christ. We may contemplate with reverence the ruins of Thebes — we may recur in spirit to the days when the Parthenon was a magnificent edifice, resplendent with the freshness of its pristine beauty — or we may carry our thoughts back with admiration to the Augustan age of philosophy and letters — but I maintain that this present era, in which we live, is the most wondrous age which the human race has yet beheld, wherein the arts and sciences are every year applied to some new and stupendous undertaking, the conception of which, a century ago, would have been ranked with the wildest fables of the "Arabian Nights" — when *new* arts and *new* sciences are almost annually springing up, full-grown, as it were, from the practical application and correlation of the vast stores of human knowledge, which are garnered up, not alone in books, but also in the active brains of the brightest intellectual ornaments which have adorned any age or country.

But this is a digression, into which I have been led by a consideration of the rapid strides which one important science has made through the improvements which have taken place in the construction of Microscopes — illustrating the interdependence of the physical sciences, and the close connection which exists between the labours of the physicist and the natural historian. The conclusions to which the study of embryology in the lower forms of life has led, are among the most unlooked for, and the most startling, even to the physiologist; and under the various terms alternate generations — parthenogenesis — agamogenesis, &c., are included a series of phenomena which demonstrate the proverb, that "Truth is stranger than fiction." It might perhaps at first sight appear that these phenomena can have no practical bearing upon our profession; and yet certain facts included in the term alternate generations, are of the highest interest in a pathological point of view. For example, it is now well ascertained that the intestinal worms pass through their various changes in more than one animal — that each developmental stage of these Entozoa requires a special nidus, which, in some cases at least, it finds in a different animal from that which finally perfects it. Thus the *Tænia cænurus* which infests the intestines of the dog, has been identified by Küchenmeister as only a more perfect form of the

Cœnurus cerebralis, whose nidus is in the brain of the sheep; and what interests the practitioner even more, is the fact, that it has been made the subject of proof, by direct experiment, by the same eminent helminthologist, that the *Cysticercus cellulosæ* which infests the pig or the sheep, becomes, when transferred to the duodenum of man, the troublesome *Tœnia solium* (or tape-worm)—a fact, which, while it strikes at the root of the old theories of equivocal generation, serves to show that it is not always by the most direct paths that we must search for explanations of physiological phenomena; and at once suggests preventive measures against the attack or recurrence of the disease. Other cystic Entozoa appear to be developed in the same remarkable manner—and the extreme diversity of the metamorphic forms of identical animals, hitherto regarded as distinct, points to the strong probability that the number of species of the lower or protozoic forms of life, at all events, may be very materially diminished by the continuance of such investigations.

The aspect of practical medicine has undergone considerable change of late years, as careful examinations have been instituted into the modes in which the ultimate structures of the organized body perform their functions of nutrition, secretion, and elimination. It is in these inquiries that the Microscope also has been of essential value; for without it, not a step could have been taken, except in darkness and doubt. Physiological chemistry has also afforded the most useful collateral aid—demonstrating that a proper combination of albuminous and fatty principles is absolutely necessary to healthy nutrition—and that, with these, a due admixture of mineral substances must not be neglected. The enunciation of this great principle was a step which indicated a vast advance in the groundwork for a rational method of the treatment of disease by dietetic rules; and while it could be applied to the explanation of many heretofore obscure and anomalous disorders, it threw a flood of light upon a vast series of diseases of nutrition, by pointing out how, owing to an hereditary or acquired organic vice, there might be an excessive or defective assimilation of one or more of these principles. The indications thus afforded become useful, accordingly as the organic vice is eradicable or amenable to treatment; for still the ultimate cause of this want of balance is as obscure as ever, and is probably dependent upon a modification of the vital force, that intangible phantom, which Lewes calls "one of the metaphysical entities."

But while a general vice of nutrition, such for instance, as that which results in the deposition of tubercular matter throughout the whole system, seems thus to indicate a special dietetic treatment, there are changes to which particular and important organs are liable, in which the Microscope has been useful in pointing out their nature, and to a certain extent, their cause. Thus, for example, fatty degeneration—the cause of the sudden cessation of the heart's action, or the gradual loss of function by the renal apparatus—could not possibly be elucidated until the Microscope had elicited the ultimate structure of muscles and glands, and pointed out how, particle by particle, the true muscular or cellular substance, upon which the integrity of the economy depended, gave place to oil-globules, which destroyed its cohesion, weakened its vitality, and ultimately abolished its special function. The long-known change of muscle into adipocere seems to bear upon this most important condition; and it appears probable, according to Dr. Quain, that the fatty matter is a result of the chemical transformation of tissue or exudation, subsequently to its deposition from the blood. Whether this be the *rationale* of the degeneration, or whether it arise simply from the vicious secretion of fat in such abundance, as by obstruction of the capillaries to produce atrophy of the original secreting organ, is undecided — though it *does* seem highly probable that fatty degeneration and simple atrophy may be more nearly allied than is at first sight apparent. It will be remembered, however, that it is to a physician who has but recently departed from us, that we are indebted for the first association of the phenomena of albuminuria with renal degeneration ; a discovery which arose out of the minute structural acquaintance with the complicated and important secreting organs involved ; and the recent perfection of which acquaintance could alone have given the power of appreciating the value of these pathological changes. Thus, although it has not been hitherto productive of important remedial measures, this most valuable discovery has facilitated diagnosis — rationalized medical theory — and removed an opprobrium which the large class of cases of this nature was constantly bringing upon our science.

Again, the theory of Inflammation, that most curious and most important process, which from the very earliest times since medicine has been cultivated as a science, has attracted the eager attention of the physiologist and pathologist, has only, within our own times, and by the aid of microscopic research, received such a degree of elucidation as has served to place it upon a sound scientific basis. Perhaps no change has been more carefully watched, and more variously accounted for — none has served as a more convenient peg upon which to hang an ingenious speculation, or to support a baseless and extravagant theory, than has this. The history of these hypotheses is perhaps the most instructive chapter in the annals of medical science, as serving to illustrate how prone men are to run astray from the positive and real in search of the abstract and the speculative, and how great errors may arise from arguing upon ill-founded premises and premature conclusions — from giving to effects the importance due to their causes. Such errors as these have retarded science, and established prejudices which it takes whole generations to shake off. Heat, pain, redness, and swelling — that quartette of symptoms which have been so long regarded as pathognomonic of the inflammatory process — are now each estimated at their true value ; and while some of them have been elucidated by the microscope, others can be only provisionally explained by the aid of physiological experiment and analogy. A change occurring in the minute capillaries, and revealed to the microscope in all its detail of contraction, reaction, stasis, and exudation, is the basis upon which the scientific practitioner of the present day endeavours to build a rational theory of this most interesting condition. The process is no longer open to discussion — the long current phenomenon of *determination of blood* is shown not to be a cause, but a secondary condition; and the physiologist is able to trace back these effects beyond the influence of mechanical causes, and to show the high probability that both local inflammation, and the febrile condition generally, arise from a modification of innervation. Nor is this so vague a result as at first sight may appear. The experiment of Bernard upon the sympathetic nerve, in which a section of it in the neck was followed by a rapid elevation of temperature in the corresponding half of the head, have led Virchow to suggest, that the heat which is so marked an accompaniment of the inflammation, may be dependent upon a loss of power of the nerves — the natural moderators of the development of heat; while the known functions of the vagus, which have been experimentally ascertained, seem to point to *it* as the principal source of the symptoms so long remarked as characterising the inflammatory attack. The same great authority is disposed to regard the inflammatory process as very closely related to *irritation*, and differing from it only in degree. And when we consider the *rationale* of a mechanical irritation, this theory appears philosophical, and in accordance with observed facts; for irritation acts by modifying the vital powers of a tissue, which modification may result in such a destruction of the balance of nutritive functions, that secretion becomes excessive, and materials are allowed to pass through the coats of the vessels in greater abundance than is necessary for the processes of repair.

New light, too, has been thrown upon the phenomenon of hyperinosis, or increase of fibrine, from which it appears, that instead of being, as it was always imagined to be, a sign of preternatural power, and indicative of the necessity of depletive measures, it is in reality the very reverse, its appearance being in some manner related to a deficient vitality, requiring an economy of the vital powers for the after-repair of the lesion. Thus it is evident, that the complicated process which is included under the general term inflammation, being at the very root of medical science and practice, correct views of it are absolutely essential to a rational plan of treatment; and such views are even yet struggling for acceptance.

It cannot fail to strike a person who is not acquainted with the difficulties which beset the path of physiological investigation, as not a little remarkable, that there should be so many internal organs whose existence, from their size, could not fail of being observed from an early period, but whose functions have hitherto baffled the most ingenious experimentalists. Such, for example, are the spleen, the thymus and thyroid bodies, and the supra-renal capsules. The study of developmental changes has shown that some of these are more particularly organs of fœtal and infant life, but become gradually reduced to a mere vestige at adult age; while others, however, as the spleen and supra-renal capsules, appear to perform important functions throughout life, although the precise nature of these functions has not hitherto been made evident. Collateral light has however been thrown of late years upon these subjects, by a careful observation of the effects which result from changes of structure in these bodies, which changes seem to be pretty constantly associated with important derangements of function ; so that, although the normal function is concealed, the abnormal results are palpable. Professor Bennett, of Edinburgh, and the German physiologist Virchow, have both paid considerable attention to the first-named organ, and it appears from their clinical researches, that hypertrophy of the spleen, a form of disease only too common, is very generally accompanied by a most remarkable condition of the blood, in which the white, or colourless corpuscles, are very considerably increased in number, so that instead of being as one to fifty of the coloured corpuscles, they sometimes constitute as large a proportion as one-fourth part of the whole. The questions which naturally arise out of a consideration of these curious and interesting pathological conditions, bear intimately upon the physiology of the organ. Does the spleen, from the fact of its enlargement of substance, form these colourless corpuscles in so much the greater abundance? and, are these white cells the embryo condition of the ordinary red corpuscles? These questions will not remain long unanswered ; inquiry once set on foot by such interesting facts, threatens to demolish the stronghold of mystery which has so long concealed the functions of that remarkable body.

We have here an instance, not of physiological knowledge helping us to an acquaintance with the nature of disease, but the converse ; and another example occurs in the case of the supra-renal capsules. Although these bodies at birth are proportioned to the kidneys in size as one to three, while in the adult they are but as one to twenty-two, and gradually diminish in size throughout life, they nevertheless appear to be of essential importance to healthy existence. The normal functions of these ductless organs have never been recognised, and they have long been regarded as bodies, which, like the thymus, have performed their duties during the period of intra-uterine life. It appears, however, from the careful inductions of Dr. Addison, that these bodies cannot become the seat of disease with impunity to the system ; and a train of symptoms, terminating in dissolution, have been, with apparent good reason, connected with morbid changes in them. Among the most well-marked characters which distinguish these changes, is the peculiar and general bronzing of the skin, which however, although unmistakable as a symptom, is unfortunately too tardy a symptom to be of value as an indication for relief ; for the structural changes which it appears to indicate are then too fully established to admit of remedy. Still, these things demonstrate that Medicine is not standing still — they show what we might expect to be the case, that the great body of intelligent followers of the medicine of this day leave no corner of anatomy, physiology or pathology, unransacked ; and that the *last ten years* have not been barren of tangible materials to add to our knowledge of disease ; for I was in the wards of the Edinburgh Infirmary when Dr. Bennett's prime case of Leucocythæmia occurred ; and as Dr. Addison's clinical clerk, I drew up several of the important cases which led to his generalization upon capsular disease.

But to no part of the organism has so much attention been directed of late, as to the *nervous system*, and particularly to the cerebro-spinal axis, the histological details of which are being worked out with admirable care, patience, and success. In these tissues, whose functions are more mysterious and more obscure than those of any others, it is particularly the case that an acquaintance with structure must precede and pave the way for a comprehension of function; but from the nature of the nerve-structure, it results that investigations of this kind are accompanied by more than ordinary difficulty, and demand more than ordinary ingenuity and patience. Even the membranes which envelope the brain partake of this general recondite character, and it has only been within the last few years that the true nature of the Arachnoid has been elucidated. Hitherto it had been regarded as a serous sac like the pleura or pericardium, until Henle showed that its inner surface, with the epithelium, is everywhere in contact with the dura mater, and that it does not line the ventricles of the brain. But when we turn our attention to the grey and white nervous substance itself, and examine the inextricable interlacement of fibres of various calibre, their decussations, loops, and connections, and the variety of ganglionic cells, simple, bi-polar or multipolar, which are so abundantly entangled in the fibrous tissues, our surprise at the slow progress of neuro-physiology must give place to a feeling of wonder that so much has been satisfactorily ascertained. Many important questions in the minute structure and arrangement of the nerve-substance still baffle the most ardent and enthusiastic inquirers — as, for example, the nature of the flat gelatinous fibres, the functions of the ganglia upon the posterior roots of the spinal nerves, and the mode of termination of the nerve-tubes in the grey matter of the brain. But on the other hand, there are triumphs of physiological investigation, as the result of recent inquiries, which give an earnest of future success. Such are the discoveries of the afference and efference of distinct nerve tubes from the same ganglionic cell, and of the fact that it appears to be by means of nerve fibres entering ganglionic cells in the grey matter upon one side of the cord, that an anastomosis is kept up with similar cells upon the opposite side, by means of commissural fibres stretching in loops between them — a fact which must modify our notions of reflex action.

The discoveries of Brown Sequard, Van der Kolk, and a host of other eminent investigators, have, however, not as yet added very materially to our knowledge of therapeutical indications in nervous diseases They have rather been of value as assisting the pathologist in his examination of the structures involved, after death has supervened, and affording him a more just appreciation of the nature of the processes which had taken place during life. Beyond the broad fact of the amenability of certain mechanical lesions of the nerve-substance to relief at the hand of the surgeon, our knowledge of the *treatment* of nervous diseases cannot be said to have been yet very much advanced by the recent discoveries. In a physiological point of view however, as establishing relations between various parts, and offering explanations of complicated and recondite vital phenomena, they possess the highest interest. What is requisite is only a sufficient accumulation of facts, in order that they may in time be correlated and made subservient to generalizations which may bring us to a more intimate comprehension of nervous phenomena. But it would be foolish to underrate the value of careful observations and well established inductions, because they do not instantly supply indications for superior modes of treatment. Every fact observed and placed upon a firm experimental basis, is valuable, as tending to the great end in view; and we hail with satisfaction and pleasure the great accession of observers, and the important chain of observations so quickly collected concerning *this wondrous apparatus.* For this it is which makes us cognizant of our own individuality, as well as of our mutual relation both with other organisms, and with the world at large. This it is which renders us sensible of feelings and impressions of pleasure and of pain — which initiates thought, which develops ideas. This is that medium between the material and the immaterial, the finite and the infinite, the seat of that *divinæ particula auræ* which links us indissolubly with conscience, and which sets up within our inmost souls a firm seat for principle, morality, and religion, here, and a confident hope of a bright immortality hereafter.

In these remarks I would not be understood as pretending to do more than to indicate the direction in which we may look for the advance of Medical Science; a more extended sketch would be out of place upon an occasion like the present, and would trespass more upon your time than an introductory lecture can claim to do. "Two things," says Whewell in his History of the Inductive Sciences, "two things are necessary to the formation of science, observation of things without, and an inward effort of thought — in other words, sense and reason." These are the requisites which must be brought to bear upon the subject — cultivated external means of appreciating nice and delicate points of structure, and a comprehensive mental vision, which can grasp a wide range of facts and perceive their mutual relation. These two qualities are by no means always found united in the same individual, but while the means of research are always open to the former class; accumulations of facts are arranged ready to hand for the latter. Such works as Todd and Bowman's "Physiological Anatomy," and Todd's "Cyclopædia of Anatomy and Physiology," are monuments of science of which we may feel nationally proud. In them the student will find how every ramification of the subject has been touched upon more or less, by investigators who have left no corner of organic nature into which they have not pryed. Materials for future generalizations, suggestions for further inquiry, abound in every direction, and I would advise the student to take up some special subject which requires further elucidation, and by experimental research and mental effort, to endeavour to throw light upon it. By so doing, desultoriness will be avoided, and the training which the mind receives from such discipline will be found of the highest value; while the special study of a particular subject will insensibly involve a fund of information which may at any time be brought to bear upon collateral branches.

In conclusion, Gentlemen, I would congratulate you upon the times on which you have fallen, when so many facilities for education of all kinds are at command. Education cannot be too highly valued; it is an engine which, when properly wielded, is capable of achieving all that money, that potent talisman, can do, and more: for social position is, in this age, regulated rather by education than by wealth; those who are so fortunate as to possess it, know its worth; and those who possess it not, value it no less highly in others. There is nothing to which education may not aspire—and there is no education to which a youth may not aspire in the present day. The facilities afforded by our old Universities have been wonderfully increased of late, and crowds of aspirants seek the advantages they are liberally holding out to them. No class of men, now, can claim to be the educated class *par excellence*; for all classes are fairly in the race. Let not the Medical Profession, as represented by its young and commencing members, be behindhand—let them keep up the *préstige* so long held by it; and while they are not found wanting in the technical knowledge which is necessary for professional success, let them also seek to improve that general and earlier education which every gentleman is desirous of possessing.

PRINTED BY H. GREENWOOD, 32, CASTLE STREET, LIVERPOOL.

ON THE

ASTRONOMY OF THE ANCIENT CHALDÆANS,

REGARDED AS AN EXPONENT OF THE

RECENTLY DISCOVERED MONUMENTS,

OF

NINEVEH AND BABYLON.

BY

CUTHBERT COLLINGWOOD, M.A., M.B., F.L.S., &c.

ON THE

ASTRONOMY OF THE ANCIENT CHALDÆANS, &c.

It is a task of no small difficulty to penetrate so far back into the mists of antiquity, as to arrive at that remote age when the study of astronomy first engaged the attention of mankind. The labours of many able and learned men have been directed to this subject, but considerable difference of opinion has resulted from their researches. And it could scarcely be otherwise, when the very sources of information on which we most naturally rely give such a diversity of accounts, that the modern historian usually singles out that theory which best accords with his own preconceived notions, and sets himself to prove its truth. The great work of M. Bailly is a model of speculative ingenuity. Instead of a gradual collection of facts, and the mere rudiments of science which we find scattered through the early history of all nations, this celebrated but unfortunate writer imagines that he sees the shattered remnants of a great and perfect system, which some lost nation had, ages before, built up; and that this system was the common origin of the Chaldæan, Eygptian, Hindoo, and Chinese Astronomy.* He says, referring to some happy speculations of ancient philosophy which were not established as *truths* till ages afterwards, "These bold and merely philosophical ideas were not supported by facts among the ancient nations known to us, though perhaps we may be able to show that they

* Bailly. "Traité de l'Astronomie Ancienne." Paris, 1781, pp. 16, 70, 80, &c.

were the vestiges of a higher antiquity, and of a science brought to perfection." This theory, propounded with all the elegance and learning for which he was distinguished, found many disciples; and Professor Playfair* was led, by his review of the subject, to believe that the Hindoos must have possessed astronomical tables at a remote era, which implied the existence of very extensive and accurate scientific observations. But the Utopian theory of the French academician finds but few supporters at the present time, though his learned and laborious collection of facts is appreciated by all. Bishop Berkeley, while admitting that there were traces of profound thought in the various schemes of ancient philosophy, refers the explanation of it to the fact, that "men in those early days, were not overlaid with languages and literature. Their minds seem to have been more exercised and less burdened than in later ages, and as so much nearer the beginning of the world, to have had the advantage of patriarchal lights handed down through a few hands."†

Astronomy has been called the Universal Science, and its laws are the Laws of the Universe — it is the science by which, above all, Man has vindicated the nobility of his intellect, and established, as it were, a nearer communion with the Divine Mind. When we consider our position in the system of the universe, the minuteness of the speck of vantage-ground from which the observations of the astronomer are to be made, and the constant movement of that speck amidst bodies, all of them in motion, the marvellous powers of analysis become more evident — for with the mechanical assistance of the space-penetrating telescope, and the equally important aid of infallible numbers, the astronomer is enabled to

* Playfair. "On the Astronomy of the Brahmins." Trans. R. S. Ed., vol. ii. 1790.
† Bishop Berkeley, "Siris," p. 141.

sweep the utmost bounds of the universe — to analyze the movements of the heavenly bodies — to distinguish the causes and the amount of their perturbations—and thus, by connecting the scattered links in the chain of causation, to arrive at length at glimpses, and even at well-defined views, of the architecture of the heavens. The boundless distance of the bodies under observation, their enormous magnitude, and their inconceivable velocity, are all admitted as elements of the sublime in the human mind, while the numbers which enter into astronomical calculations are of such immeasurable vastness, that they overwhelm the imagination, and only permit of a relative judgment of their immensity. But while we look with wonder and admiration at the fabric which has been raised, and at the knowledge of the expression of universal LAW which has been arrived at, we must remember on the one hand, that many phenomena still baffle us, as for example the nature of comets — the forces which act in the spiral nebulæ of Lord Rosse — the significance of variable stars, &c.; and on the other hand, we must bear in mind, that although an error in angular measurement, five hundred times as great as that which would now employ the correcting pen of our observers, would have been passed over by Ptolemy— nevertheless, it ill becomes the modern astronomer to hold in contempt the apparently absurd theories and speculations of the ancients; for, as M. Bailly justly remarks, all depends upon circumstances and means — *we* have the accumulated experience of ages, and it has taken two thousand years to arrive by the mazy paths of error at the clear and burning light which now shines in the sanctuary of truth. Nor need any despair of arriving at yet higher truths, and more perfect generalizations in this or in any other science; the limits of the human intellect are not yet reached; and let it be remembered, that although Adam Smith pronounced the knowledge of the weight and density of matter in the sun, planets, and satellites, to be a result almost beyond the reach of human reason and experience, yet how soon was this estimate falsified by the sagacious inductions of Bailly, Brindley, Airy, and other astronomers, based upon their mutual perturbations and disturbances.

Several nations have either claimed for themselves, or have had claimed for them by others, the honour of having been the originators of astronomical science. Chaldæa, Egypt, India, China, and Greece, are the chief upon the list, and arguments more or less cogent have been adduced by the supporters of each; but while endeavouring to indicate that it is to the first of these ancient nations that the honour is due, I will give some brief reasons for excluding the others from the list of candidates. Even in Greece there can be no doubt that the study of Astronomy is of high antiquity, although they borrowed the earliest beginnings of it from other nations. Only very rude observations existed in Greece up to the time of Pythagoras (B. C. 557), and it would appear that the earlier Greeks, those therefore who were the most competent judges, disclaimed any pretensions to having originated astronomy; for Herodotus states (Euterpe c. 4), that in his time (B. C. 450), the Egyptians were more skilful astronomers than the Greeks; and further, he allows (c. 43), that they borrowed the twelve gods (which were of astronomical origin) from Egypt. Solon, the great Athenian lawgiver, reported that "his own countrymen were mere novices in the sciences of antiquity," while (in the Epinomis), Plato makes the Athenian say;—"I cannot tell you the name of the third star, for it is not known. The reason of this is, that the first who made these discoveries was a Barbarian. For it was an ancient country which produced the first who cultivated this study, where they were favoured by the beauty of the summer season, such as is Egypt or Syria * * *. These observations, verified during an almost infinite series of years, have been spread abroad in all places, and particularly in Greece."* Yet notwithstanding this withdrawal of claim made by the most ancient historian, legislator, and philosopher of Greece, there have been men in modern times (including Sir Isaac Newton), who have laboured to attribute to them that to which they themselves denied their right. Thus, Costard, in his learned work,† expresses his main design to be "to restore to the Greeks the honour of inventing what the world generally supposes them only to have borrowed." But there is much internal evidence opposed to this imagined priority of the Greeks, which will appear as we advance; and the Oxford divine is sometimes led into contradictory statements in his ardour to follow out his *main design.*

With regard to India and China, there can be no doubt that their observations reach a very high antiquity. It hardly comes within the scope of my subject to do more than indicate the fact, as the evidence against their priority is rather negative than otherwise. There is recorded, in the "Tung Kien Kang Muh," a very ancient Chinese observation of the conjunction of the five planets in the beginning of spring, during the reign of Chuen Hio; and according to Lindsay,‡ "the ancient documents of China abide the test of the severest scrutiny, and we are fully warranted in receiving them as genuine." Kirch assigns the date of B.C. 2448 for this conjunction. This, according to the received chronology, would be before the flood, and therefore could hardly be an ob-

* Compare Cic. de Div. I. i.

† Costard, on the "Rise of Astronomy among the Ancients."

‡ J. B. Lindsay. "The Chrono-Astrolabe," p. 100.

servation specially Chinese. Moreover, Greswell is very distinct on this point, and asserts, that "whatsoever Egyptians, or Chinese, or Hindoos, or any other nation, ancient or modern, may pretend to produce to the contrary, B.C. 1520 (the date of Hezekiah's sickness) is much more remote from the present time than the beginning of authentic history anywhere out of the Bible. It may be asserted with confidence, that not a single event of this year, either is, or can be known at present, except from Holy Writ."* A work of Confucius, however (Chun-tsiu, B.C. 550), is extant, containing authentic accounts of thirty-six solar eclipses, all of which are said to have been verified except four, extending backwards to B.C. 719,† proving their observations to have advanced to a great degree of perfection at a very early period. The first eclipse related in the Almageste is one of the moon, B.C. 721, observed at Babylon (Book iv. p. 95).

The Hindoos doubtless had relations with China very long before the Greeks and Romans; and Dr. Vincent remarks, in his edition of the Periplus of Nearchus, that 1700 years B.C. we find an account of the Ishmaelites conducting a caravan of camels, loaded with the spices of India, and the balsam and myrrh of Hadramaut, proceeding through Arabia to Egypt, for a market (Gen. xxxvii.): showing at what an early period communica-ation was kept up between these three great seats of astronomic and other science; and to which commerce, probably Thebes and Memphis owed their splendour and prosperity. Like most other of the oriental nations, the Indians laid claim to an extravagant antiquity; and Satyavarta, the first of the Solar race of princes among the Hindoos, is fabled to have reigned the whole of a Satyazug, or 1,728,000 years.‡

* Greswell. "Fasti Temporis Catholici," vol i. p. 322.

† Lindsay. "Chrono-Astrolabe," p. 94. ‡ See page 11.

But the controversy concerning the antiquity of astronomy lies really within narrower limits, and the claims of Egypt and Chaldæa are paramount above all others; it is between these two nations that the question is undoubtedly contracted. In Egypt especially, the priests pretended to a vast antiquity, and invented many stories, some of which are detailed by Herodotus (Euterpe, c. 142), concerning the myriads of years that their country had existed. Thus they feigned that they had a king who reigned three myraids of years; although this is a comparatively short period to the reign of the Indian Satyavarta. The Egyptian chronology of Herodotus carried them back nearly 50,000 years — a duration which may be considered as purely absurd; and if taken literally, no doubt it becomes so, and yet there have been found modern scholars who have been willing to allow them a considerable portion of this antiquity. When the celebrated zodiac was discovered in the ceiling of the temple at Denderah, the planisphere and square of which are now deposited in the Imperial Library at Paris, the French scholars unhesitatingly allowed it an age of 16,000 years at least,* notwithstanding that Herodotus, who so carefully observed, and so accurately described the cities of the Nile, fails to make any mention of this, the most magnificent temple of them all, thus confirming the opinion of the sagacious Belzoni,† that it was a Greco-Egyptian temple of the period of the first Ptolemy (Lagus), *i.e.*, built about 260 B.C., and 150 years after the historian's death. One effect of this boast of antiquity was perhaps intended, viz.—to let the Greeks see how much more venerable the Egyptians were than they, and how much superior to them in the arts and

* Dupuis must be excepted, who, in his "Dissertation sur le Zodiaque de Dendra," p. 28, assigns it a date of B.C. 1468.

† "Researches and Observations in Egypt and Nubia," p. 33.

sciences; and indeed, the Greeks were much indebted to the Egyptians, for it is probable that Pythagoras drew most of his philosophy, which exercised such an extensive influence on Greek history and character from Egypt, which country he undoubtedly visited in the reign of Amasis, and if Iamblichus may be credited, remained there twenty-two years, when he was taken captive by the victorious Cambyses, and carried to Babylon. But on this subject, perhaps, Simplicius is more near the truth, who writing in the reign of Justinian, in the sixth century, says, "I have heard that the Egyptians have observations of the stars written down for no less than 2000 years, and *the Babylonians for more.*

In confirmation of the latter part of this sentence, we may quote Herodotus (Euterpe, c. 109), who tells us that the πόλος (or concave hemispherical sundial) and the gnomon, as well as the division of the day into twelve parts, were derived by the Egyptians from the Babylonians, clearly indicating that the latter were the masters of the former in astronomical science. Moreover, Greswell, in his most learned and valuable Fasti,* says — "It is a singular fact, that superior as the Egyptians were to the Chaldæans in the true science of astronomy, yet, in this particular science of astrology, they seem to have voluntarily acknowledged themselves their inferiors, and to have voluntarily submitted to be taught by them." Now we shall see as we proceed, that the earliest advances in astronomy were identified with astrology, and the two sciences were one, until mankind had gained such a mastery over the *true* science, as to be capable of pursuing it independently of the *false* one.† Although, therefore,

* Greswell's "Fasti Temporis Catholici," vol. ii. p. 74.

† In the best Latin writers, *astrologia* is employed to denote astronomy in general. (See Cic. de Divin. ii. 42). And astrology was traditionally, in Greece and Rome, of Chaldæan origin. Hence such expressions as "Ars Chaldæorum" — Χαλδαιων μεθοδοι — are of constant occurrence.

the most ancient sphere was the production of Egyptian ingenuity* ((just as the first maps on record were those affirmed by Eustathius to have been charts of the marches of Sesostris); nevertheless, we must look to the plains of Shinar for the cradle of astronomical science, and to the dispersion of mankind, twenty-two centuries B.C. for its epoch. It is very evident from Genesis x. 10, that the ancient writer of that book looked upon the land of Shinar, the site of Babylon, as the post-diluvial centre of the human race. According to Bryant's mythology, the Chasdim, or Chaldæans, were descended from Cush, the son of Ham, and father of Nimrod, who lived B.C. 2240. The chronology of the cunieform inscriptions harmonizes perfectly with the numbers given in the scheme of Berosus, which scheme, divested of its fabulous element, gives a fixed date of B.C. 2234, for the commencement of the Chaldæan empire, a date which is corroborated by Simplicius, Pliny, and other authorities,† and endorsed by the researches of Sir H. Rawlinson. The Chaldæans themselves, however, like other nations, were not behindhand in claiming a fabulous antiquity. Cicero‡ says, that the Babylonians pretended to have observations extending over 470,000 years; and Berosus states, that the first ten kings of Chaldæa reigned 120 sari, the sarus being 3600 years. Thus the ten kings reigned 432,000 years, a period which, while it bears a close resemblance to that named by Cicero, is also of just the same extent as the Indian mythic period, called a Kali-zug.

In fact it is an undoubtedly astronomic period, and depends upon the Chaldaic divisions of Sosses, Neres, and Sares, as applied to decatemories. The decatemory was an astrological division of the zodiac into tenths of signs,

* Greswell's "Fasti Temporis Catholici," vol. ii. p. 71.

† Rawlinson's Herodotus, vol. i. p. 433. "On the Early History of Babylonia." By Sir H. Rawlinson.

‡ Cicero de Divin. ac Fato, lib. i. c. 19.

each therefore consisting of 3°; and the Sosses, Neres, and Sares, were periods of 60, 600, and 3600 years respectively. Each decatemory being divided into 60 minutes, and each minute into 60 seconds, the assumed degree or decatemory, of which 120 complete the zodiac, will contain 3600 seconds, as the Sare contains 3600 years; and 3600 + 120 = 432,000 seconds, or minute fractional sub-divisions, as 120 Sari of 3600 years each compose the grand Chaldaic *period of restitution* of 432,000 years. This term, then, evidently refers to the great secular cycle of precession.* It is not a little remarkable, moreover, that while the Chaldaic *period of restitution* agrees with the Kali-zug of India, the Ṣatyazug (referred to at page 7) is the same number quadrupled (432,000 × 4 = 1,728,000), clearly demonstrating the relation existing between these ancient periods and their common origin from precessional changes in the zodiac.

It does not come within the plan of the present paper to enter more fully into the proofs that Chaldæa was the cradle of astronomical science; but besides the evidence already adduced, it may be mentioned, that Artapanus† relates a tradition, that Abraham (who came out of Ur of the Chaldees),‡ instructed the Egyptian king in science; while Lucian, Plato, Cicero, and others among the ancients, and among the moderns, Sir William Jones, Montucla, and Landseer, have accumulated arguments in favour of its Chaldæan origin.§

Let us now examine the circumstances of its earliest development; and in doing so, we shall find, in addition,

* Religions of Profane Antiquity, p. 206.

† Artapanus, in Euseb. Prep. Evang., θ′; also Alexander Polyhistor, in eodem opere.

‡ Gen. xi. 31. Josephus (Antiq. I. vii. 2), quoting Berosus, calls Abraham 'ουρανια 'εμπειρος.

§ "Les Chaldéens," says Bailly, "malgré les erreurs qu'on peut leur imputer, doivent être regardés comme le plus savant des peuples connus dans l'antiquité."—"Astronomie Ancienne," p. 152.

internal evidence to the same effect. "It seems not to be doubted," says an old writer, "that there has been some kind of observation of bodies celestial since there were men." And there were two conditions which especially merit attention and consideration in this place, viz. — the beautiful climate of the country bordering on the Persian Gulf, and the occupation of its earliest inhabitants. Among the ancients, we have the testimony of Herodotus (Clio. c. 193) to the singular fertility, and abundant cereal riches of Babylon; and even at a more early period, it, or rather perhaps the country bordering it upon the north, had been alluded to in glowing terms by Rab-shakeh (2 Kings, xviii. 32). I have already referred to the remark of Plato; and every modern traveller is agreed as to the fertility of the soil, and the singular purity of the atmosphere of those regions. Layard* speaks of the country between Nimroud and Khorsabad, as "a rich plain, capable of a very high cultivation, though wanting in water"— which was anciently supplied by a extensive artificial irrigation, for which there are great facilities. Many other authorities might be cited, but these are sufficient to show that this is precisely the spot which would attract a pastoral people, who could settle here, and rapidly advance in arts, science, and civilization; while the clear atmosphere would not only give them facilities for astronomical observations, but invite them to such studies by the brilliant appearance of their nocturnal skies — "en sorte que le spectacle des astres les devoit occuper, pour ainsi dire, *malgré eux*."†

If we next glance at the occupation of this infant period of society, we shall have further cause to perceive by what means they were led to the prosecution of such observations. In the history of the progress of civilization

* Layard's "Nineveh and Babylon" (first journey, p. 130).

† Lalande's "Astronomie." Paris, 1764. Tome i. p. 63.

of all nations, it is a general principle, that men in the rudest state of society obtained a subsistence from the chase, limiting their desires to bare existence and sufficiency of food. In such a savage state, we cannot expect to find any advance in art, beyond an improvement in the construction of weapons; such a community would not be sufficiently affected by any external circumstances, to make it worth the effort to reason how far they might succeed in making external circumstances subservient to their comfort, but subsistence once procured, the stimulus for labour, either of mind or body, is withdrawn. In the progress of social improvement, the condition of shepherds followed that of hunters. This change in the mode of living appears quite natural, inasmuch as men would be anxious to reduce into possession all the tamer animals rather than continue the precarious plan of hunting. The life of shepherds was peculiarly adapted to contemplation, and as the preservation of their flocks formed the chief object of their care, it was their interest to study the aspect of the nocturnal skies.* Under such favourable conditions, and with such a transparent atmosphere, they could not be long without observing, like the Saxon peasant Palitzch, and our own Ferguson, in a manner at first rude, that the heavenly bodies had certain proper motions, which they soon learned to associate with important terrestrial changes. The glorious sun arose, crossed the vault of the sky, then set, and was succeeded by the beautiful moon, and by all the host of heaven, which seemed to chase each other over the wide expanse, then fall into that mysterious western depth, simultaneously with the appearance of others in the east.† Moreover, the sun was not invariable in his blazing path—

* Duncan. "The Religions of Profane Antiquity," p. 5.

† Compare Hesiod "Works and Days," ii. 319;—

"When strong Orion chases to the deep
The Virgin Stars."—*Cooke.*

he arose not always from the same point of the horizon, he culminated not always equally high in the heavens — his course was now contracted, now expanded, and these contractions and expansions were associated with seasonal changes of the utmost importance to their pastoral mode of life. The host of stars too, gradually traversed the vault of heaven, and the nightly appearance of the firmaments was an index of the solar power by day. Thus the sun's path through the stars, like a fiery serpent* coiling round the universe, was one of the earliest observations made. Then again the changing moon must have attracted the highest interest from these ancient "star-gazers and monthly prognosticators,"†—her waxing and waning orb — her seasonal absence and her regular reappearance. Next, the appearance of certain wanderers, threading their mazy path through the labyrinth of the fixed, could not ~~but~~ fail to be a matter of most curious observation. Thus it would be easy to trace the steps by which the sublime science rose into importance. But when, in a natural succession, these shepherds‡ paid more attention to the occupancy of the soil, to the division of land, to the sowing and planting it for the production of food for themselves and their beasts, they would be led into a far more minute observation of those phenomena which had previously been objects principally of curiosity and awe. They would then perceive, that the times of sowing and the times of reaping were, in spite of themselves, regulated by the movements of the heavenly bodies — that they depended on them, as it were, for the welfare of their crops, and ultimately for the

* Job, xxvi. 13.

† Isaiah, lxvii. 13.

‡ It will be recollected, that according to the priest Manethos, Egypt was conquered B.C. 2082, by a race of *shepherd-kings* ('Υκσως) who came from the east, and retained possession of the country for 511 years.—(Josephus, c. Ap. i. 14, quoting Man. Ægypt. *lib* 2.)

well-being of the community, and thus they would be led to reverence the starry host as divinities, and to worship them as Gods. Hence arose Sabæism or Astro-theology, which took its rise from the shepherd-race, and superseded natural Fetichism, or the worship or material substances as such. The pursuit of agriculture was most favourable to the development of Sabæism, and we find that the most ancient profane work which has come down to us* is a manual of Agriculture whose title interpreted by the scholiast, is, the art of agriculture and the proper season for its prosecution. And long did this pursuit exist as an honourable calling; "the ancients," says Niebuhr† "with one mind, esteemed agriculture to be the proper business of the freeman as well as the school of the soldier."

It is to these first steps in the history of astronomy—to the doctrines of the very ancient Sabæans, that we must look for an explanation of the old theogonies and mythologies, overlaid as they are with symbols. It is to a study of the stellar universe as it presented itself four thousand years ago, that we must refer for a key to the religious fables of antiquity, apparently so utterly absurd and meaningless; and which are too often taught to the youth in our schools, without reference to their true import, or indeed without letting him be aware that they have, concealed under their harlequin exterior, the sublimest astronomical truths—the accumulated discoveries of the ancient observers. The enlightened antiquary of modern times, has done much to exonerate the ancients from those charges of frivolity and folly, which ignorance has sometimes shown an inclination to cast upon them.‡ By a comparison of the fragments of ancient

* Hesiod, Ἔργα καὶ Ἡμέραι.

† Niebuhr. "History of Rome," vol. i. Preface.

‡ Bacon's "Wisdom of the Ancients," passim.

art which time has permitted to come down to our own day, with the scattered allusions to the framework of the ancient religions which are to be found in the works of their historians, philosophers, but especially in their poets, it becomes a matter of moral certainty, that those tales which, in wild extravagance, rival the boldest fictions of the "Arabian Nights," were, in fact, verbal expressions of the fundamental truths of astronomy—the motions of the celestial bodies, especially of the sun and moon, the great sources of light and life—of their risings and settings, their oppositions and conjunctions with the principal stars and with the signs of the zodiac. These were known to the priesthood (who, indeed, were the astronomers, and priests in virtue of their superior acquaintance with the heavenly bodies, their divinities) in all the sublimity of truth; but as they regarded the stars as superior Intelligences, it was considered profane to disclose them indiscriminately to the vulgar. While, therefore, they themselves carefully observed and noted the results of their observations, they shrouded the glorious truths in fantastic fictions and romantic tales, and *these* they gave to the vulgar to be their faith. Only to a favoured few were these mysteries unveiled, and truth discovered in all her moral grandeur. On these, the initiated, the most solemn oaths were imposed, that they should not divulge the secrets which were thus confided to them; for well the priests knew, that should the common herd know as much of the Majesty of Nature as they did, they would no longer be required as mediators, and thus their power and authority would at once terminate. And seldom, if ever, were these binding oaths broken. The least attempt, or appearance of an attempt (as in the case of Æschylus), was followed by instant vengeance. And this fully accounts for the few direct allusions to the nature of these mysteries which are found in ancient writers. They either avoid the subject altogether with a superstitious awe, or they hint at it so obscurely, that little information can be gathered from them. Indeed it is probable, that but few of them were acquainted with the origin of the Chaldean mysteries —for in passing from one country to another, from Arabia to Egypt, from Egypt to Greece, and from Greece to Rome, they were so garbled and decorated by the art of the poet, as to render them almost unintelligible to the latter people, and there were but few, if any among them, who could enter into the spirit of the founders of their religion.* Even the Father of History himself, while he is detailing fragments of information concerning the gods which he had gathered from the Egyptian priests, seldom appears to perceive their true bearing upon his religious system. These scraps, however, are of incalculable value to the intelligent student of antiquity. Had the promised work of Herodotus on Assyria (Clio. c. 184, &c.) come down to us, doubtless the conscientious, laborious, and discriminating collection of facts which distinguished him would have tended greatly to confirm many speculations which are yet needing the corroboration which the decypherment of the cuneiform inscriptions may still be anticipated to afford — but most probably that valuable scroll added fuel to the lamentable conflagration of the Alexandrian library, a catastrophe which the latest posterity will never cease to deplore.

But while the most ancient astronomers readily perceived that changing position of the stars which fulfilled its cycle in a single revolution of the earth, while they easily recognised the fact that the heliacal rising of a star took place on a certain day in each successive year —

* Strabo, who probably flourished in the half century before Christ, and was well acquainted with Egyptian affairs, says (lib. xvii.), that in his time the Egyptians were wholly ignorant of their ancient learning and religion, though impostors continually pretended to explain it.

they could not so readily appreciate a subtle and minute change which all the while was displacing their indices, confounding those data which they at first regarded as invariable and infallible, and producing effects which, when they at length forced themselves upon their observation, must have struck them with dismay. This change was so slow and insidious, that it must have been long before it was recognized, and still longer before its cause was understood. The astronomer will know that I refer to the phenomenon known as the Precession of the Equinoxes — a phenomenon said to have been discovered by Hipparchus (the patriarch of astronomy, as Bailly calls him) about 128 B.C., but which I shall presently give reason to believe had been noticed long before his time. It is to a consideration of this phenomenon that we must look for the key to the fables of antiquity. That secular change which works so gradually, that many centuries probably elapsed before the ancient astronomers could bring themselves to believe in its existence, has, during the lapse of 4000 years, which have passed away since the commencement of the period of which we are writing, accumulated to such an amount, that we recognise with difficulty, in the *present* aspect of the heavens, the clue to that Sabæan theology which I imagine to be at the foundation of all the symbolical art and mythology of later times.

It is essential, therefore, that this phenomenon of Precession be fully understood, and it will not be out of place here briefly to allude to its action. Precession is one of the most remarkable of the secular inequalities — and by this term is understood, inequalities whose effects extend over very long periods of time before they come round to the condition from which they set out. The *tropical* year, or true year of the seasons, viz. — the period which elapses from the moment of the sun's path cutting the equator in spring, until it again intersects it in the succeeding spring, is 365 days, 5 hours, 48 minutes, 49·7 seconds; but the *sidereal* year, or that space of time which elapses between his leaving any fixed star, and again arriving at that fixed star, is shorter than the year of the seasons by 20 minutes, 19·6 seconds. This arises from the oblique and unequal attraction of the sun and moon upon the terrestial spheroid, giving it a motion about its centre of gravity, and forcing the plane of the equator to move from East to West. Now the sun, advancing among the stars at the rate of 59 minutes, 8 seconds of a degree in 24 hours, would, in 20 minutes, 19·6 seconds, have moved through the space of 50 seconds of a degree. It therefore cuts the equator every successive year 50·1 seconds short of the spot where it intersected it the preceding year — or in other words, the equinoctial points recede annually 50·1 seconds.* This space is small, it is true, when taken alone, but when it is borne in mind, that from all time this minute quantity has been annually accumulating, it will easily be understood, that since Astronomy was first cultivated, it has risen to a very considerable amount. Indeed, the whole circle being divided into 360°, and the precession being 50″ annually, it is easy to calculate that in seventy-two years the equinoctial points would retrograde through an entire degree — in 2160 years through a whole sign — and in a period of 25,867 years, they would perform a complete revolution, passing in turns through each of the

* I am aware that the *mean precession*, that is, the precession when deducted from that compensating tendency which arises from the action of the planets on one another and on the sun, is subject to minute periodic variations from the direct action of the sun and moon respectively upon the equator; but these are so small, that for all practical purposes they do not interfere with the main fact I am intending to convey; and indeed, a secular variation to which it is subject, has the effect of *increasing* precession, so that the tropical year is 4·2 seconds shorter than it was two thousand years ago.

signs of the Zodiac, until at the end of that period they would arrive again at that sign from whence they set out.*

We are accustomed to speak of the Sun as entering the Zodiacal sign of Aries at the vernal equinox, and for centuries the Ram has been the leading sign in astronomical as well as in ordinary parlance; but although our celestial globes make the vernal equinox coincident with the first point of Aries, it is only a conventional arrangement, the character or sign only of the constellation being placed at that point, the star which formerly occupied that station being upwards of 30° from it. For in reality, the sign of Aries has been altogether displaced by the precession of the equinoxes, and the next sign, Pisces, has been substituted for it. In the present year the vernal equinox is sidereally coincident with the second degree of Pisces. It follows however as a result of precession, that 2160 years previous to the entrance of the Sun into Pisces (viz. — B.C. 388), the first point of Aries *was* coincident with the vernal equinox; and it equally follows, that for 2160 years anterior to that epoch, the equinoctial point had been gradually retrograding throughout the whole of the Zodiacal constellation Taurus. The first entrance therefore of the Sun into that sign must have taken place A.M. 1456, and B.C. 2548.

The dispersion of the post-diluvian race upon the plains of Shinar took place B.C. 2247† — 101 years after the flood; and the astronomical observations began at Babylon, according to Callisthenes, B.C. 2234, at which period the vernal equinox must have been coincident with the 5th degree of Taurus; or in other words, the sun rose cosmically with the head of Taurus at the vernal

* This is the grand Chaldaic *period of restitution* referred to and explained, in connection with the Indian Kali-zug, at page 11.

† See the Chronological tables in Barker's Supp.

equinox; it was literally the period referred to by Virgil long afterwards; —

> "Candidus auratis aperit quum cornibus annum
> Taurus." *

Or as Dryden has rendered it —

> "When with his horns the Bull unbarred the year."

We have now arrived at a view of the condition of the sideral heavens at this remote period — and while it will be at once recognized as offering peculiarities which those who regard the heavens as unchanging, either in their real or apparent aspect, will view with surprise — it will also become evident that a full appreciation of these remarkable antecedents is necessary before we can duly estimate their influence on the minds of the earliest astronomers, or enter into the spirit of the founders of the ancient religious systems.

It does not appear that the Chaldæans produced any celestial sphere previous to that which originated with the Egyptians. That extraordinary people made rapid advances in scientific astronomy, outstripping their teachers, the Chaldæans, who devoted the principal portion of their attention to the elaboration of astrological theories. "Testimony" says Greswell † "is unanimous, that the sphere of the Egyptians, the first and oldest delineation of the sphere, was graduated from Aries;" and yet Taurus was the traditional first sign. If further proof were wanting, that the phenomena of precession were known to the Eygptians, it is to be found in the fact, that they had two kinds of sphere — an ecliptic or sidereal, and a tropical one — and the first degree of the tropical sphere was laid down on the 15th degree of the sphere of Mazzaroth,‡ thus telling a tale of a thousand years anterior observation or information.

* Georgics i. 218. † Greswell's "Fasti," vol. ii. p. 71. ‡ *Ibid*, p. 74.

In the erudite "Inquiry into the Symbolical Language of Ancient Art and Mythology" of Mr. Payne Knight, he has collected from various authorities very remarkable proofs of the universality of the Taurine symbol, and I have the more satisfaction in quoting so great an authority, because he does not appear to have perceived its immediate bearing upon the question before us, or at all events he does not allude to it in that work.* He tells us (Sect. 31), that in addition to the Bull being, under the titles of Mnevis and Apis, one of the most distinguished of the sacred animals of the Egyptians, the Arabians appear to have worshipped their God under the same image. The Chinese have still a temple called the Palace of the Horned Bull, and the same symbol is worshipped all over Hindostan and in Japan. In the latter island — at Meaco — the organization of matter is represented by a bull breaking a colossal egg with its horns; and such a colossal egg exists in the Island of Cyprus, near Lemissa, with a bull sculptured upon it. † The Cimbri, in the extreme West, carried a brazen bull with them as the image of their God when they overran Spain and Gaul ‡ — the name of the God Thor, the Jupiter of the ancient Scandinavians — signifies in their language, a bull, as it does also in the Chaldee; while according to Plutarch, it was the Phœnician for cow. He was represented, moreover, in the ancient temple at Upsal, with the head of a bull upon his breast, according to Rudbeck. Further, it may be added, that according to Bentley, Siva — the greatest of all the Hindoo Gods — was always

* In another work, however, printed more than thirty years earlier, to which this reference will be sufficient for the learned, he has shown a thorough appreciation of the subject.

† See Frontispiece to Landseer's "Sabæan Researches."

‡ Plut. de Mario; while Cæsar (de Bell. Gall. lib. vi. c. 21) says they worshipped the Sun.

accompanied by a bull. Seeing then the very widely extended adoration which the bull received under various forms, we cannot help looking for some common origin to which we may refer these similar forms of worship, and the Zodiacal bull at once presents itself to our attention.

In the earliest ages of astronomy, the true relations and bearings of the heavenly bodies were by no means apprehended by their ancient observers. The regularity of their movements could not fail to strike with wonder and awe those who paid special attention to them, and the apparent sequence of cause and effect as applied to those movements, cannot fail to have exercised a powerful influence upon minds in which the religious sentiment is naturally implanted. Hence the Sabæans early established certain mutual risings of the Sun and fixed stars as unerring signs of the forthcoming seasons; and mistaking coincidence for causation, they fell into the not unnatural error of transferring the veneration due to causes, and which they would have paid to the *cause*, had they been able to recognize it, to the *signs* of those causes. Hence their astronomy was their religion, viz.—Sabæism or Astro-theology, and their astronomers were the priests—for regarding the heavenly bodies as the efficient causes of good and evil, they reverenced them as divinities.* Now, tradition and history both point to the fact, that the coincidence of the heliacal rising of Taurus with the vernal equinox was a very ancient discovery, and among the earliest of the astronomical data. But the vernal equinox was just that period, which to an agricultural people was the most significant and most important; for then it was, that nature started into new life after the

* Φαινονται μοι δι πρωτοι των ανθρωπων * * * * τους μονους Θεους ηγεισθαι, ὁυσπερ νυν πολλοι των βαρβαρων, ἥλιον, και σεληνην, και γην, και αστρα, και ὀυρανον.—*Plato in Cratylum.*

sleep of winter.* The generative attribute, symbolized in most ancient times by the Zodiacal Bull butting with his horns against the Mundane egg, and in later art by more gross forms,† was supposed to be especially developed at the vernal equinox. Hence, in the Scandinavian mythology, the Sun was fabled to recruit his strength by sucking the white cow Adumbla, the symbol of the productive power of the earth, said to have been the primary result of warmth operating upon ice,‡ a fable manifestly in analogy with the spirit of Sabæan art. The Bull of the Zodiac was thus regarded as the sign or cause of returning life and vigour of regeneration, or in fact of re-creation.§ Now, says R. P. Knight,|| speaking of a mode

* Thus in the mythological arrangement preserved by Manilius (derived originally from Sabæan principles) Venus, the passive principle of generation, had her mansion in Taurus :—

" Taurum Cytherea tuetur." — *Manil. Astro.* ii. p. 439.

† "Jamais les institutions religieuses n'ont eu dans leur commencement la depravation des mœurs pour motif. Il faut donc chercher ailleurs cette origine." Des Divinites génératrices, ou du culte du Phallus.—*Paris*, 1805. This remarkable volume, which has come into my hands since writing this essay, traces very clearly the gradual corruption of the pure symbolic adoration of the Zodiacal Bull, through its descending phases of worship of a material animal, and finally, a characteristic part of the animal. Hence undoubtedly the veneration of the Phallus—a worship which in its origin was pure and sacred, but which from its very nature could not continue so — a worship which has extended itself over the habitable globe, and the abuse of which has been the ruin of every nation, which having once cultivated it, could not fail to fall into excesses the most incredible, and the most horrible. It was this worship which was a constant snare to the Jews, as we learn by innumerable allusions in the Old Testament; and it is this worship which is still rampant in Hindostan, and while on the one hand it cannot be canvassed above a whisper, on the other, it effectually prevents the evangelization of a people by whom the foulest, the most unredeemable vice, is committed as a passport to heaven, and under the guise of Religion.

‡ Oläus Rudbeck. Atlantica, quoted in Knight's Inquiry, Sect. 53.

§ Hence Dionysus, the Greek Bacchus, the Sun of corrupted mythology, is called *ταυροκεφαλος* in Orph. Hymn. li. 2., and in the Bacchæ of Euripides, Pentheus says to Dionusos

κὰι ταῦρος ἡμῖν πρόσθεν ἡγεῖσθαι δοκεῖς.—*Bacch.* 920.

Compare with this the Invocation to Bacchus in Sophocles' Antigone (1146) where the Chorus exclaims, *ἰὼ πῦρ πνει-*
όντων χοράγ' ἄστρων.

|| Knight's " Inquiry," &c., Sect. 78.

of astrological prediction which seems, he adds, to have been originally Chaldæan "the act which gave existence, gave all the consequences and effects of existence, which are therefore equally dependent upon the first cause; and how remote soever from it, still connected with it by a regular and indissoluble chain of gradation." This first cause, as I before observed, they referred to the sign representing it; so that the commencement of the year, and the return of the vernal equinox, was considered by them an event of the utmost importance, the greatest of astronomical epochs.* This return then being marked by the coincident rising of the Sun and of Taurus, the Bull was regarded as the leader of the Saba-oth, or host of heaven, and Aldebaran† received its name as signifying the *leading star*.‡ And again, since "the general movement of this great whole was supposed to be derived from the first impulse," the symbol of the Bull became of the most significant import to a people with whom astronomy was synonymous with astrology.§ There cannot be much question, says Greswell, that the ancient tradition and belief of the Persians connected not only the origin of time, but the origin of things, with the sign of the Bull.

Hence the veneration it received, and thus I would account for the fact of the Bull being the symbol of the

* La reconnaissance populaire, et les hommages rendus au dieu du jour, au soleil ramenant le printems, se dirigèrent naturellement vers un objet plus à la portée des sens, vers le signe du Zodiaque qui en etait le symbole, vers le signe du *Taureau* qui, participiant en quelque sorte à l'action du soleil régénérateur, fut à cet egard identifié a cet astre.—*Des Divinités Génératrices, Paris*, 1805, *p*. 5.

† The earliest sidereal observation of the Egyptians is one of Aldebaran.—*Greswell*.

‡ It is not a little remarkable in connection with this subject, that the Hebrew letter א, which is the same as the Chaldee, signifies a bull in the connection of a leading animal—"*dux* a leader—*bos*, a bull, or the chief of cattle."—See "Gesenius' Lexicon." "A," says Court de Gibelin (Monde primitif. Allegor. p. 30), "prononcè Alph, l'alpha des Grecs, signifie dans ces anciennes langues, *un bœuf*."

§ Le signe de la constellation céleste qui portrait ce nom (Taureau), représenté sur les Zodiaques artificiels, fut considéré comme le symbole du soleil printanier, du soleil regenerateur de la nature.—Divinités génératrices.

Assyrian empire — that land in which the Zodiacal sign first obtained a position of such vital importance in the Sabæan system, and from which its worship radiated to the remotest confines of the habitable globe.

Before proceeding any farther with the subject, I will call attention to the sculptured Bulls of Assyria, which have been the cause of these remarks. These differ from all other known composite figures, in their possessing a human head, surmounted by the horned cap; and being, in addition, winged.* Sir Henry Rawlinson, in his religion of the Babylonians,† asserts that the man-bull is the emblem of a doubtful god, whose names, read phonetically, are Bar, or Nin-ip. This god he, etymologically, connects with Saturn; and moreover, he gives a few out of the hundred titles by which he is known; of which are — the supreme god; the first of the gods; the eldest son; the light of heaven and earth; he who, like the Sun, the light of the gods, illumines the nations. But this acute scholar "supposes the Assyrian year to commence with Aries," and therefore it cannot be a matter of so great surprise that he disregards the significance of the Zodiacal Bull. And yet one cannot help wondering, that great authorities like Rawlinson and Layard should so utterly cast aside astronomical assistance, and endeavour to thread the mazes of these remote eras without the aid of a key so interesting and so important as it affords. There are many who have rendered important service in the elucidation of this subject; but in this country few have been more sagacious, considering the small materials at his command — few more penetrating than the late Mr.

* A winged bull from Egypt is figured by Denon, pl. 129.

† "Rawlinson's Herodotus," vol. i. p. 619. In reading this undoubtedly erudite Dissertation, I could not help thinking of a passage in the work of old Gregorie, where he says, "But, as in their Gods, so in the names of their Gods, he that readeth shall find notable confusion."—*Rise and Fall of the Assyrian Monarchy*, p. 121.

Landseer, whose volume of "Sabæan Researches" is a model of acuteness. But it has always been a matter of surprise to me that Layard, surrounded by interesting cylinders similar to those which Landseer so admirably elucidated, should be content to dismiss his ingenious researches with a line which savours less of acknowledgment than of unappreciating indifference.*

The heliacal rising of Taurus was symbolised by the ancient Assyrians, by placing a disc of stone or metal representing the Sun, between the horns of the Bull. Many such sculptured Tauri are still extant, of Phœnician and Assyrian workmanship; and we are not left merely to speculate as to the signification of the disc, for Herodotus (Euterpe. c. 132) describing the image of a cow at Sais, tells us that "μεταζυ δὲ τῶν κερέων, ὁ τοῦ ἡλίου κύκλος μεμιμημένος ἔπεστι." This disc was of stone or metal, and was often moveable, and probably placed *in situ* at the great vernal festival, for which purpose a deep square hole was cut in the head of the bull. Such appearances are by no means uncommon † in the remains of ancient art which have come down to us. Now, in the celestial sphere, the head of the Bull is that part of the asterism which was turned towards the constellation Gemini, consequently the part which in the most early age was first reached by the Sun. In later periods of art, we find the disc transferred to the back of the animal, as in the oblong Zodiac of Denderah, marking the gradual recession of the equinoxial point through the sign — and proving further, that precession was known and observed at a very early age. It becomes highly probable that the Brahmin Bull, so extensively worshipped in India, and which has a hump upon its back, derives its claim to adoration from that significant circumstance. Such a bull appears to have been known

* Layard. "Discoveries in Niniveh and Babylon:" Second Journey, p. 609, note.

† Knight's "Inquiry," sect. 32.

in Babylon (whence its worship probably spread to Hindostan), a small bronze figure of one having been brought from thence by Captain Lockett; and in Rosellini's plates (xx.) is a figure of a true Indian Bull, copied from a Theban tomb. At the same time it must be conceded, that we cannot determine the date of the monument solely by the position of the solar disc, for so accustomed were the ancients to the tradition of the Bull being the leading sign, that we find Virgil, as before quoted, so writing, although astronomically it had in his time ceased to be a fact for nearly 400 years; just as we, at the present day, speak of the coincidence of the first point of Aries with the vernal equinox, although it is in fact more than 30° removed from that point.

Now the *Sun*, and the *King of Heaven*, were one and the same at Babylon,* and called Bel or Baal; † and I would suggest in explanation of the human head — the placid bearded face which surmounts the taurine symbol, that it represented this same god Bel, and signified precisely the same as the moveable disc between the horns. How could the Assyrians, I ask, in representing this grand conjunction of the Sun, or Bel, with the constellation Taurus, more aptly personify the great Intelligence in which they seemed to "live, and move, and have their being," than by placing the "human face divine" in the situation ordinarily occupied by the solar disc?

In later times, notwithstanding that the custom of speaking of the Bull as the leading sign was preserved, the mythology, of Egypt especially, underwent a change,

* Landseer. "Sabæan Researches," p. 139. Compare also the fourth inscription of the Heliopolitan Obelisk, which begins "Helios, the great God, the Lord of Heaven," &c.

† "Belus (the successor of Nimrod) perhaps first called the sun so, and himself afterwards; as Nimrod did the sun by the name of Bel; which name the sun still kept in Phœnicia long after these times, for there they called the Sun Baalsemen, that is, the Lord of Heaven."—*Gregorie*, "*Assyrian Monarchy.*"

owing to the recognition of Aries as having supplanted the former constellation. Hence arose all the forms of Ammon, and avatars of Jupiter in the form of a Ram, which so much tended to the confusion of later mythology. The meaning of these monuments in which the Ram takes a prominent position is precisely the same as those of the Bull, except that they belong to a more corrupt age. In Æthiopia, and some parts of Egypt, it appears to have received as much veneration as the Bull had done before it, although the cause was as little generally known. In Egypt, colossal rams are met with in abundance; the great palace of Karnak was approached by two avenues, one of rams, and the other of criosphynges, all of colossal size, monoliths, and to the number of many hundreds; the stupendous scale of the Egyptian monuments being nowhere more remarkable than in these majestic approaches.* Many of these rams' heads are hollowed out for the reception of the solar disc — one such, the head of a colossal crio-sphynx which appears to have formed part of the above avenue, is in the British Museum. Among Mr. R. P. Knight's bronzes in the same collection, is a small ram-headed human figure, which may be regarded as similar in meaning to the human-headed bulls, being Jupiter represented by the human form "godlike, erect," surmounted by the symbolical head of the Ram.† I am not aware of the existence of any symbolical rams in which the solar disc is placed in any other position than between the horns; nor could we expect it to have been transferred to the back, until A.D. 700 or 800, by which time all those nations which acknowledged the change from the Bull to the Ram had perished.

Before passing on to any other portion of the subject, I will venture a few remarks concerning the wings with

* Denon. pl. 44.

† Compare Herod. Euterpe. c 42.

which the Assyrian Bulls are furnished. These appendages, although in the composite figure before us, they are placed in that position which we might conceive natural to the animal, belong, I imagine more especially to the solar part of the composition, and render it equivalent to the winged disc or globe, which we so often meet with in Egyptian symbolic art. In the most ancient Babylonian cylinders, the wings are figured in a more rude and simple manner, so that they would seem to be composed of rays of light, or sunbeams, and are thus "appropriate to the sun, as denoting that light was either its moving power, or was produced by its motion." So in an Orphic Hymn (v. 5,) where the Sun is evidently referred to under a symbolical name, we read

παμφαές ἔρνος

*   *   *   *   *

πάντη δῖνήεις πτερύγων ῥιπαὶς κατὰ κόσμον
λαμπρὸν ἄγων Φάος ἁγνὸν.

And following out the analogy which I have endeavoured to trace between the Assyrian Bulls and the Ammonian Rams, it may be mentioned that in the great French work on Egypt,* the Ram of Ammon is represented *winged.*

But although the Bull is the emblem most frequently met with, and most strikingly prominent in the Assyrian sculptures, there are others which cannot be passed over in silence. Bulls of a colossal size are accompanied by winged Lions, which rival them in magnitude, and are clothed with the same attributes; and the smaller Bulls on the walls of the temple, are generally observed to be placed in juxtaposition with three other emblems, viz.—a lion, an eagle, and a man; and these four figures, while they occur under various modifications in all parts of the temple, are placed upon the walls, separate and distinct,

* Egypte. Planches, vol. ii.

and in the above order. Now the mind cannot long dwell upon this combination without being at once led in two very different directions. In the first place, the Zodiacial sign Taurus being supposed to mark the Sun's place at the vernal equinox, it follows that the solstitial colures, as well as the autumnal equinox, would be placed in different signs from those which mark them in our times. Thus the summer solstice would be in the constellation Leo, the autumnal equinox in Scorpio, and the winter solstice in Aquarius. Now the ancient Sabæists divided the twelve signs into tropical, fixed, and common; the *tropical* were those in which the seasons began to change — Aries, Cancer, Libra, and Capricorn — the *fixed* were the strongly characteristic or typical signs which marked the equinox and solstices — and the *common* were those intermediate between the other two. As we might suppose, the fixed signs were those which received most veneration, and in these were placed the four *royal stars*, as they were termed, viz.—Aldebaran, the leading star, in Taurus, Regulus* in Leo, Antares in Scorpio, and Scheat in Aquarius. † Here, however, we find a discrepancy, which it will not be easy to clear up. The Eagle has no representative in the Zodiac; the place to which we should look for it is evidently that occupied by Scorpio, a sign which for a long period occupied the space of two — the body and claws stretching across 60°. It was afterwards contracted to make room for the more appropriate sign of Libra, which well signifies an equinoctial point, where day and night are equally balanced. I meet, however, with the following statement in Landseer, ‡ which, inasmuch as I cannot find the original reference

* Regulus was so named by Copernicus; it was called Βασιλικος by the scholiast on Aratus; and *stella regia* by Pliny.

† Duncan. "Religions of Profane Antiquity," p. 24.

‡ "Sabæan Researches," p. 331, note.

I will take on his authority. He says, "Sir William Drummond goes near to demonstrate on the authorities of certain Hebrew writers, and of scriptural facts, that the stars which are now those of Scorpius, had been constellated as an Eagle in the Zodiac of Abraham and his grandsons." I must confess, however, that I know of no direct evidence of this theory; while at the same time I would call attention to the curious and significant fact, that the constellation Aquila, is the paranatellon of Leo.

But while on the one hand the attention is drawn to the Zodiacal signs by the sculptures of the Assyrian temples, on the other it is directed in a singular manner to certain highly figurative passages, both in the Old and New Testaments. The vision of Ezekiel* has puzzled commentators as much or more than any other of the prophetic parts of Scripture, and the remarkable description of the heads of the Cherubim admits of no rational explanation upon known principles. "As for the likeness of their faces, they four had the face of a man and the face of a lion on the right side; and they four had the face of an ox on the left side; they four also had the face of an eagle." We naturally recur to a precisely similar passage in the book of Revelations, where the Apostle is describing the four beasts which were round about the throne.† "And the first beast was like a lion, and the second beast was like a calf, and the third beast had a face as a man, and the fourth beast was like a flying eagle." In the case of Ezekiel's vision, it is set, as it were, in the midst of denunciations against Israel for her abominations, as her imitation of the idolatries of her captors was termed by the prophet. Ezekiel had been carried away captive by the Babylonians, under Nabopo-

* Ezekiel, i. 10, and x. 14.

† Rev. iv. 7.

lassar, along with Jehoiachin, King of Judah, and was evidently in the midst of a colony of his own people on the banks of the river Chebar (Chabour). The earlier chapters of his prophecy are generally considered to relate to the impending punishment of his nation and the destruction of Jerusalem — but commentators are in general sadly at fault in their attempts to explain the details of his wonderful visions as related in the first, eighth, and tenth chapters. The eighth chapter is especially interesting. It is evident that he had been an eye-witness of the Assyrian mysteries, and that his vision of the Cherubim alluded to the leading symbols of their worship, though I am not prepared to say in what connection. With regard, however, to the eagle and the eagle-headed figures, so often noticed in the Assyrian sculptures, it may be observed that not a few* have been inclined to identify this figure with a god mentioned in the 2nd Kings, xix. 37, where Sennacherib was said to be "worshipping in the house of *Nisroch* his god;" for NISR in all the Semitic languages signifies *an eagle.*†

A remarkable passage occurs in Gregorie's "Rise and Fall of the Assyrian monarchy."‡ He says, "who or what this Nisroc should be, is so doubtful, that Peter Martyr could find nothing in all the ancient writers to explain the matter; his own opinion dependeth upon the etymon of the word *Nesrac*, which signifieth, as he saith, *Deum fugæ mollis*, a God or a Jove Φύξιος, whither, as to a sanctuary, Sennacherib might betake himself: it may be so. I rather suppose, if I may be so bold, that RAC in this place signifies the Sun; for so this people sometimes called the Sun — as Francis Junius hath noted upon SHADRAC in the prophet Daniel. So then this temple

* As Layard. "Nineveh and Babylon," 1st Journey, vol. ii. p. 459.

† "Majores (aquilæ) Arabico idiomate *Nesir* vocantur."—*Leo African: Descr. Afr.* ix. 56.

‡ 1683. Barker's supp. p. 120.

was an asylum built at Ninive, to the honour and under the protection of the Sun, who was therefore called Nesrac, that is the *sun of flight*, for the reason given." So far Gregorie; and I would direct attention to another reason why the "sun of flight" should be an appropriate name to the eagle, if he really were what I have imagined him to be, viz. — the autumnal sun, crossing the colure of the *descending* equinox. This is a coincidence not a little curious, as supporting the somewhat defective evidence concerning the Zodiacal Eagle.

In the 8th chapter of Ezekiel, in which the "image of jealousy" and the "chambers of imagery" are described, we have an account of the interior of one of the mysterious temples of Assyria, and of the worship which the Jews had either joined in, or imitated for themselves. "When I looked, behold a hole in the wall * * * * so I went in and saw, and behold every form of creeping things, and abominable beasts, and all the idols of the house of Israel pourtrayed upon the wall round about. * * * Then he brought me to the door of the gate of the Lord's house, and behold there sat men and women weeping for Tammuz." It is highly probable, that what the prophet saw in the chamber of imagery, was the constellations figured upon the walls — beasts, clean and unclean, and creeping things, arranged perhaps like a concave planisphere, for purposes of worship. There can be little doubt that such things were used in the celebration of mysteries, and that sometimes merely the asterism or congeries of stars was pourtrayed, and at others the figures which they were supposed to represent, such as we see them marked on a celestial globe. Such an idea explains the remarkable words of Proclus, who writing in the fifth century upon the Polity of Plato says: — In all initiations and mysteries, the gods exhibit themselves under many forms, and with a frequent change of shape—sometimes as light defined to no particular figure (*i.e.* constellations as we *see* them) — sometimes in a human form, and sometimes in that of some other creature" (*i.e.* as constellated figures). Perhaps, had Proclus written this passage at an earlier age than he did, he would not have escaped punishment for his temerity.

The limits of this paper will not allow me to refer to the *weeping for Tammuz*, an astronomical mystery, for Tammuz is synonymous with Adonis and Osiris, and the mourning for him was doubtless connected with the disappearance of an asterism which Landseer gives strong evidence for identifying with Böotes, the husbandman, or constellated patriarch Noah.

Before concluding, however, I must touch upon one symbol not unfrequently met with in the Assyrian sculptures; I mean the pomegranate. Besides its occasional occurrence upon the monuments in question, the ancient statues of Juno and Proserpine sometimes held a pomegranate in the left hand, of which Pausanias says, *τα μεν ουν εις την ῥοιαν (αποῤῥητοτερὸς γαρ εστιν ὁ λογος) αφεισθω μοι.** It is evident from this that it was a religious symbol of some importance, which he was fearful of betraying. In the Second Book of Kings, v. 18, we read of the King of Syria worshipping in the house of *Rimmon*, which word literally signifies a *pomegranate;* defined also by various authorities as the exalted one; — the exaltation and breaking forth of divine light. The form of a pomegranate might not unnaturally be chosen astronomically, to signify the conjunction of a star with the Sun, the large calyx giving the appearance of stellar rays surmounting a disc, which we know to have been emblematical of the sun. It might thus have had the same signification attached to it as the winged bull, viz. — the conjunction of Aldebaran with the Sun at the vernal equinox;

* Pausanias. Corinth. c. xvii. s. 4.

or the winged Lion, *i.e.* the conjunction of the Sun with Regulus at the summer solstice. Respecting the pine cone in the hands of the Eagle-headed figures, I can say nothing with certainty. It was long afterwards a symbol consecrated to Bacchus, though no writer with whom I am acquainted gives any satisfactory account of its origin or meaning. The thyrsus so frequently wielded by the Bacchants, is usually surmounted by it, though almost as frequently with the ivy or vine-leaf with which it appears to be interchangeable. Payne Knight imagined that the cone surmounting the thyrsus, or in the hand of Ariadne, signified the same as the pomegranate in the hand of Juno, or the sacred tau in that of Isis; but he had not met with the Assyrian cones.

My limits, however, will not permit of my dwelling any more at length upon these subjects. Enough perhaps has been said to prove that these symbols have a meaning, and that a deep and significant one; and the more we endeavour to penetrate beneath the protean exterior of ancient fable, the more we shall be struck with the depth of philosophy (doubtless mingled with error) which it exhibits. At all events it is my conviction, that the earlier myths are founded upon grand natural truths; and although the thirst for dominion and power led the ancient depositaries of secrets to conceal them with a jealous guardianship — that mysterious veiling of philosophy — that attempt to restrain truth to the narrow circle of a few initiated — succeeded but too well; and has had the effect of retarding science, of sowing confusion and discord among the otherwise harmonious systems of ancient religions and mythology, and of bequeathing to posterity erroneous ideas of the frivolity of the ancients (to call it by no worse name) which the modern mind will hardly be at the pains to correct. Still, enough has escaped the vigilance of the priesthood, to show that philosophy and not caprice was their guide; and I coincide with the opinion expressed by the great Lord Bacon, who, piercing with his keen glance through the dense veil of fable with which these systems are overlaid, says — "I am not ignorant how uncertain fiction is, * * * but let not the follies and license of a few lessen the esteem due to parable, for that would be profane and bold, since religion delights in such veils and shadows; but reflecting on human wisdom, I ingenuously confess my real opinion is, that mystery and allegory were from the original intended in many fables of the ancient poets." *

* Bacon. "Wisdom of the Ancients," Preface.

15, Oxford Street,
Liverpool.

PRINTED BY H. GREENWOOD, 32, CASTLE STREET, LIVERPOOL.

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