Introductory address delivered before the Devonshire Association for the Advancement of Science, Literature and Art / by Henry W. Acland.

Lord Archibald Clark
With kind regards of the Author

INTRODUCTORY ADDRESS

DELIVERED BEFORE

THE DEVONSHIRE ASSOCIATION

FOR THE ADVANCEMENT OF

SCIENCE, LITERATURE, AND ART

BY

HENRY W. ACLAND, F.R.S.

REGIUS PROFESSOR OF MEDICINE IN THE UNIVERSITY OF OXFORD

HONORARY PHYSICIAN TO H.R.H. THE PRINCE OF WALES

PRESIDENT OF THE MEDICAL COUNCIL

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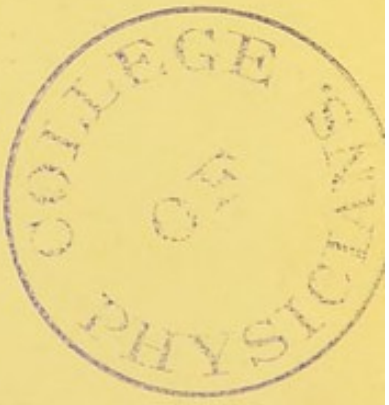

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OXFORD:

BY E. PICKARD HALL, M.A., AND J. H. STACY,

PRINTERS TO THE UNIVERSITY.

PREFACE.

By the rules of the 'Devonshire Association for the Advancement of Science, Literature, and Art,' the Address by the President is printed. Had it been otherwise these observations would have been made to those only who were present at the Totnes meeting. These rules must be the excuse for putting in type a paper adapted for a temporary purpose.

That purpose is to give in the small space allotted to an Address some idea of the relations of modern Physical Science to modern Literature and Art; and to remove the notion which some entertain of antagonism between them.

It was quite requisite to use a few illustrations like the touches of a rough sketch. In the examples that have been selected there is a prevailing tone which helps to give unity to the picture.

Special stress is laid on Physical Science because a mixed audience would, out of the variety of their Literary knowledge, readily add Literary illustrations. Therefore only a few striking passages in Literature are quoted to act as a key-note to the chord that was to be struck in the thoughts of the listener. Anything like a copious selection would have been impracticable as well as useless, or impertinent. I have been a 'Wordsworthian' for nearly fifty years, but I choose the 'Highland Reaper' under the ægis of Matthew Arnold, whose

Essay on Wordsworth seems to me one of the loveliest of his lovely compositions.

To some young persons it may be of service to be referred, with relation to certain passages, to Professor Newcomb's 'Astronomy,' to Boole's 'Laws of Thought,' and to Maxwell's article on Atoms, in the 'Encyclopædia Britannica.' Should only a few read these now for the first time, the rule of the Association will not have been in vain. I have thought it better not to give illustrative references, nor to fill in details which there was no time to relate at the meeting. Both would be far too numerous for an ephemeral discourse, which lays no claim to originality, and advanced students of the subjects touched on would not need them.

H. W. A.

Oxford, 1880.

ADDRESS.

THE wide range of knowledge, and the high aims of thought, which the Devonshire Association for 'Science, Literature, and Art' seeks to promote, impose on all who attend its meetings, and on those especially who by your favour are called upon to address you, no small responsibility.

There are two methods, one or other of which is generally followed in an Address introductory to such a meeting. The first is, to take up a special subject for consideration; the second is, to consider more generally the present condition or progress of Science, of Literature, or of Art.

It is not proposed on this occasion to follow either of these courses, but to consider during our brief time *what are the relations which Science, Literature, and Art bear one to the other in modern thought.* The attempt may perhaps seem to be rash, and one which

ought to be undertaken only by such persons as could speak with some authority on all. But it may be not without use that one who has no such claim in any of your three subjects, but who has had many opportunities for observing the progress of all should attempt to convey the impression which the growth of modern thought in this direction has made upon him, during a long working life.

It might appear at first sight that the terms Science, Literature, and Art, included the whole of human knowledge. And in a certain sense it is true that almost every department of knowledge, of action, or of free-will, might be properly classed under one or other of these great divisions.

Politics, for instance, have a scientific as well as a practical side. Philosophic enquirers endeavour to establish principles which aim at promoting the highest good of man; while practical politics range from wise and experienced statesmanship down to the baser schemes of designing demagogues. Medicine too has a Science, the roots of which lie in the comprehension and mastery of Nature in most widely extended relations, with a Practice capable of being brought down from the level of wise usefulness to that of imposture or superstition.

But each of the divisions of human thought and

human knowledge which are under consideration have limitations which should be laid down with care, and illustrated with judgement.

And first, I may define for the present purpose,

Science as organised knowledge ;

Literature as the record of cultured thought bearing chiefly on human interests;

Art as the appreciable expression of that which is beautiful in any department of human energy.

As regards the progress of Physical Science, it must be conceded that, notwithstanding the truly astonishing accumulation and growth of human knowledge concerning the material world from the time of Eratosthenes and Aristotle to that of Bacon, Newton, and Linnæus, the mass of accurate conclusions, depending on precise data, has increased in the last hundred years, in a manner without precedent, and wholly baffling any complete description. The reason of this will hereafter appear.

In two more decades this century will be ended. Facile locomotion and instantaneous intercommunication with nearly all parts of the world will have changed the thoughts and habits of every tribe of the human race wherever situate. A knowledge of the chief

laws of the material world, of the configuration of the universe, of the material history of man, will, by the help of elementary schools and scientific primers have permeated the masses of every civilised community. Ancient beliefs on many things will have been shaken, revised, new-modelled. Fundamental laws of Sociology will have been rediscussed, and, wherever ancient usages and associations are supposed to interfere with modern material knowledge, will be more or less modified.

The statement of a few principles and the consideration of a few illustrations will serve to show the character and present attitude of physical science as compared with much of that of former periods. Scientific enquirers were doubtless engaged at all times in seeking the causes as well as the nature of things. But these causes were in ancient times made matter of speculation and imagination, not of actual observation and experiment. The older cosmogonies were framed on arguments derived from the probable and assumed rather than the actual and proved. The strictness of logical conclusions was held to be of more account than honest labour in ascertaining the correctness of the data, on which the conclusions were built. It is now far otherwise. No assertion in science stands long unchallenged. Speculations or

hypotheses are counted as mere slaves, employed and dismissed.

The conception of the framework of the universe depends now on a series of observations of a kind which fifty years ago were unattainable and, for the most part, unimagined. The dimensions with which we have to deal are in truth inconceivable, yet they must be briefly stated in the outset. They demand a concentration of attention of no ordinary kind.

We may attempt to realize them by taking familiar objects such as the Sun and Moon. The distance of the Moon from the Earth is about 240,000 miles. The diameter of the sun is about 858,000.

A man can now easily travel round the earth in three months, or ninety days. At the same rate it would take him to go round the Sun above twenty-seven years: or put in another way, the distance of the Moon from the Earth is between a third and a fourth of the diameter of the Sun. Probably there are Stars some thousands of times larger than the Sun. The Solar System is but as a speck in the system of the Stars. The visible Stars have been calculated as something fewer than fifty millions. There is no reason for supposing that all the stars which exist can by any human means become known to us. Moreover each Star may be

the centre of a system greater than our own. 'A general conception of the distribution of the stars around our system,' Mr. Stone, the distinguished astronomer, writes to me, 'can be formed by supposing a set of thin Strata, of great extension, arranged nearly parallel to the Milky Way and with the number of Stars in any given space, and the Star density, rapidly decreasing as we separate from the Stratum which contains the Milky Way.' Our little Solar System is near the middle of this universe of Stars, as far as we are able to judge. The component parts of the universe are in constant motion—a motion in some parts so rapid as almost to defy expression, and such as at present is inexplicable from any data which we possess.

Without a knowledge of the data which have been accumulating since the discovery of the telescope, philosophers of every period have speculated on the origin of the Matter of which this inconceivable mass of countless systems of worlds is composed. Of the origin of this Matter modern Science tells us actually nothing. What we first know of it is, it has its being, it moves: it moves in a way which is seemingly absolute, necessary. This way so far as we know is the same unchanged from age to age. The 'laws,' it is said, are the same at all time and

everywhere. But this assertion rests in great part on man's limited experience. What has occurred before this experience is unknown. What will occur we can only conclude with safety, on the double assumption that we have all the data, and that these data will undergo no change.

Some forty years ago a work called Vestiges of Creation, from the boldness of its speculations and the beauty of its collected facts, caused no small stir among educated persons unacquainted with Physical Science. It appeared shortly after men had begun to doubt the correctness of the interpretation put on the Mosaic Cosmogony. That Cosmogony, so simple, so grand, so consonant under certain limitations with advancing knowledge derived from actual observation, constructed and peopled our planet with living things. Of the stellar universe it implied something, but too faintly for analytic discussion; it could not have been intended for scientific instruction.

In modern times, beginning perhaps with Kant, the Nebular hypothesis of the Universe has received general acceptance. This hypothesis is that the Nebulæ which we find in various parts of the Heavens are collections of matter loosely aggregated, and generally undergoing the process of being con-

densed into more solid bodies. These bodies are to become Stars. These Stars may be like our Sun, with planetary bodies revolving about them like our Planets and our Earth. The processes which have to be gone through in the condensation of this nebular universe of incandescent matter are still under discussion. But much is known of them. Either the central mass (or Sun) was formed first, or the revolving planetary bodies. There are reasons, arising from recent observations, for supposing that either may have been the case. But in any case a series of consecutive condensations in the rarer nebulous material took place, leading up to the orderly and consecutive evolutions which we now know for certain to have occurred in our globe.

It is the nature of this comparatively sure knowledge and the mode of its ascertainment that we have to consider. It has been established without question that within our system, and, as we may infer, within the Universe, no loss occurs in either Matter or in Energy. Matter is in its combinations ever undergoing change. Energy takes new forms and development. It must open to any intelligent mind a new world of wonder and of thought when it first realizes that Heat, and Light, and Gravitation operate in the most distant orbs as they do in our

Solar Centre, which maintains the Earth and her sister Planets in their courses, and makes Life on our globe possible and continuous, and produces results, as we shall see, progressive in their character.

The observations, which have been made within the last twenty years by the Spectroscope, in great measure by the skill and perseverance of Dr. Huggins, tell of similar constitution of Matter, the same effects of Heat, the same properties of Light in Stars and in Nebulæ as in the Sun and in the Earth.

From these and other observations it is inferred that, as the nebulous matter was condensed from incandescent material, a process of cooling took place. Heat could not be emitted without loss of volume in the mass which produced it. This implies change; it implies motion. The heat which reaches the Earth is so much heat lost to the Sun. The Earth is warmed and the Sun is cooled. The extent to which the Sun has cooled and the extent to which it may have diminished in volume has been calculated with great exactness. The calculation has been made from data attainable by direct observation on the rate of increase of temperature as we descend into the Earth. They are mainly due to the genius and learning of Sir William Thomson.

While it must be admitted that some of these

statements — condensed and therefore rude — may hereafter require modifications, they lead irresistibly to the conclusion that our Earth has been gradually formed out of a heated mass, cooling at the surface and undergoing definite and orderly changes in its crust. These changes, the study of a science almost created in our own day, are in the course of being described, in the most precise manner, in every portion of the globe.

The position and thickness of early igneous rocks, the first product of the contracted mass, is becoming known over a considerable portion of the world. The undulations and upheavals of this crust (perhaps about forty-five miles in thickness); the penetration through the crust of this still molten volcanic mass; the dislocations thereby of the exterior; the successive deposits formed in tens of thousands of years in the uneven hollows of the surface; the gradual appearance of life in the successive so-called layers or strata; the structure of the beings, whether sentient or non-sentient, so appearing; their similarities and their differences, are all being duly noted in every part of the earth, the rivers, the lakes, and the sea. The regions which are suitable to the different forms of life are recorded. The conditions which seem to accompany the appearance of one form

and the disappearance of another—conditions of temperature, moisture, elevation, soil, inheritance—are becoming understood in every civilised spot of the globe, nay in every spot which civilised man can reach—not only as regards the present state of the earth's surface, but in reference to its conditions in previous periods. The duration of the periods is being calculated. The length of time which it took the water to deposit the clay or the minute organisms to form the chalk, the depths of the clays and the thickness of the chalks, these are subjects of enquiry, and of conclusions; enquiry carried on with every aid of precise instruments and previous training, conclusions tested by every criticism, which honest acumen or fierce partizanship can apply.

The recent increase of our actual knowledge in these directions is astonishing. Professor Prestwich, for instance, lately pointed out, that, whereas in the year 1822, only 752 species of organic remains had been recorded as previously existing in this country; in the year 1874, no fewer than 13,276 species had been described. Mr. Etheridge informs me that since 1874 they have now (1880) been increased to 14,142. Within a shorter time a still greater change, now universally accepted, has been made in our ideas as to the early History of Man on the Globe. Though

this subject is far from complete—indeed is only in a 'robust infancy'—yet we now know that Man existed at periods far antecedent to any that had even a few years ago been imagined, viz. at a time when the climate of the different parts of the globe and the distribution of animal life were very different from those now existing. This subject is specially interesting to Devonshire men, since Mac Enery, Buckland, and especially Pengelly have, by their researches in connexion with it made this district for ever famous in the History of Science.

Though time will not allow any complete detail to be given of the methods of work in any one of the departments of Science thus hinted at, it may be well to cite three, as examples of the mixed character of accurate enquiry and consequent result or hypothesis which modern Science presents.

1. The modern Theory of Atoms.

2. The recent enquiries into the Development of Living Beings.

3. The scientific hypotheses on which certain Diseases are to be prevented.

It was said above that it requires a special attitude of mind to grasp the vast dimensions and the distances with which we have to deal in considering the distribution of Bodies through the

Universe as a whole. An analogous but different effort is called for, in considering the ultimate constitution of the Matter of which these Bodies are composed.

In one of the essays, charming from their lucidity and force, in which Maxwell, valde deflendus, treats of the constitution of Matter, he says, 'We begin by assuming that bodies are made up of parts, each of which is capable of motion; and that these parts act on each other in a manner consistent with the principle of conservation of energy. In making these assumptions we are justified by the fact that bodies may be divided into smaller parts, and that all bodies with which we are acquainted are conservative systems, which would not be the case unless their parts were also conservative systems.' . . . 'We may also assume that these small parts are in motion.' . . . 'We make no assumption with respect to the nature of the small parts—whether they are all of one magnitude. We do not even assume them to have extension and figure. Each of them must be measured by its mass, and any two of them must, like visible bodies, have the power of acting on one another when they come near enough to do so.' . . . 'The first step in the investigation is to determine the amount of motion which exists among the small

parts independent of the visible motion of the medium as a whole[1].'

On investigation of the properties of Gases the hypothesis is proposed that they consist of molecules in motion. It is hardly possible to raise an argument against this. The nature and the velocity alone seem to be capable of question. It is almost susceptible of proof that the Molecules (e.g. of Hydrogen) are of equal masses. When in motion if they have not equal masses they have nevertheless equal velocities. The distance that the Molecules travel without collision is believed to be (under certain conditions of temperature and pressure) 'in the case of Hydrogen the 25,000th of an inch, or about $\frac{1}{5}$ part of a wave of green light.' The actual diameter of the Molecules has been estimated by Sir W. Thomson (1870) from considerations derived from the thickness of soap bubbles and the electric action between zinc and copper. From these enquiries it is concluded that 2,000,000 Molecules of Hydrogen would occupy a $\frac{1}{25}$ of an inch, and 200,000,000,000,000,000,000 weigh a $\frac{1}{55}$ of a gram. These are compared with what we can see with the microscope. M. Nobert can draw 4000 lines in the breadth of a millimetre ($\frac{1}{25}$ inch). 'A cube whose side is the 4000th of a millimetre, may be

[1] Encyclopædia Britannica, vol. iii, 1875, p. 38.

taken as the minimum visibile for observers of the present day.' 'Such a cube would contain from 60 to 100 million Molecules of Oxygen;' 'but since the Molecules of organised substances contain on an average about fifty of the more elementary atoms, we may assume that the smallest organised particle visible under the microscope contains about two million Molecules of organic matter.' Into the physiological conclusions to be drawn from this statement it is not the time now to enter.

Maxwell has elsewhere shown in his graphic way that, from these and other considerations of properties too intricate and detailed to be here noticed the Molecules of Air (in a room for instance) are rushing in all directions at the rate of about seventeen miles a minute, a rate exceeding that of a cannon ball. They only do not destroy therefore all with which they come in contact, because by perpetual collision one with the other and by constant change of direction they neutralise each other's force and maintain just that pressure which is necessary for our existence.

The subject must not be quitted without the remark that, however startling may be the facts and numbers here brought forward by Maxwell, they shrink into insignificance when compared with those now under consideration by Mr. Crookes, who has

endeavoured to prove by experiment the existence of particles of matter as much smaller than gaseous Molecules, as they are than those of solid bodies.

The second instance of Scientific enquiry and result to be named, is that of the DEVELOPMENT of organised beings. All organised beings, all having either life, or life and consciousness, are necessarily constructed of the matter of the planet on which they are placed; matter, that is, collected together in the manner already indicated, and having properties ultimately derived from the Molecules that have been described.

The smallest organic matter visible is calculated by Professor Beale to be 'less than the $\frac{1}{100,000}$ of an inch in diameter. The actual size of these potential germinal particles is worth noting. The dimension of $\frac{1}{100,000}$ of a linear inch means that a cubic inch would contain very many million times as many particles as the whole of the human species living now on the globe. But each particle possesses properties of its own; is probably capable of development, and as far as we yet know, it must have been derived from a parent stock to which itself becomes more or less similar.

Two questions arise thereupon. 1. Have the present forms of life existed from the beginning of the cooling of the Earth's crust down to the tem-

perature known to be now compatible with organic life on the Earth? 2. If not, what process of formation has been gone through by each individual in its life-history, and inheritance viewed as a whole? The first question has been answered by Palæontologists; the second is undergoing the most searching investigations by Physiologists. The general answer to the first is, that some forms have apparently existed unaltered for many hundred thousands of years; that great numbers of forms have come into existence and great numbers have ceased to exist; and that there has been a general progress from the earliest dawn of life on the Earth until now; progress being reckoned by the development of Intelligence, that is, by an increasing supremacy of Mind over Matter. These two questions, as is known to the least instructed, have been the subject of active discussion for the last twenty years, chiefly through the writings of Mr. Darwin. Every year adds more and more facts towards their solution. The present attitude of the second question is the outcome of improvements in the mode of Microscopic Research in the last forty years, and especially in the last twenty. The answer to the second question is incomplete. It cannot be completed for many years to come. The Continent of America will, it may be said with certainty, pro-

duce new evidence of the mode of development of Species, in Time. Minute Embryological research is only now beginning to put the whole problem of individual growth and formation into a complete form. On this last aspect of the subject it is expedient here to say something.

There are existing several hundred thousand species of animals, and at least an equal number of plants, each recorded and described under intelligible characters and by definite names. All have originated by off-shoots from individuals more or less like to themselves. In their growth from their early individual life to their complete form, all the higher and more complicated kinds passed through several stages more or less similar to those which were permanent in lower and less complicated forms. Hence it is often erroneously stated that each higher animal, such as a Mammal, actually had the form of a much lower, such as a Fish, at one stage of its existence. This carries the statement too far. The Embryo or parts of the Embryo of a Higher Animal pass through stages in growth which are not unlike the condition and form of a Lower Animal. But they are not identical; because among other notable reasons, the Higher Animal at each stage of its existence contained the invisible and inexplicable

potential properties of its own further individual development. On the theory of Evolution of all higher organisms from lower, the lower had necessarily this potentiality of all its subsequent development in time, just as the yolk of a Fowl's Egg has of its future organs and of the complete Bird. Of the full significance of this potentiality in a scientific sense we can at present form no conception.

Nevertheless, a certain generalisation, though on imperfect knowledge, has been arrived at. The 'omne vivum ex ovo' of Harvey, if not universally true, is so generally true as to express fairly the starting-point of the large proportion of living beings. The tracing up the germ of all living structures, and comparing their growth one with another at every stage, constitutes Modern Comparative Embryology. The foundations of this vast and difficult science, as it now exists, have been laid within the memory of many of us. They have been attainable through the great improvements in the manner of making microscopic sections, and by the facilities of observation in aquaria. Through these several agencies, by the thousands of observers in Europe and America, and the activity of the better kind of periodicals, the relations of embryonic stages in typical species to allied or re-

mote genera and to extinct forms, as they are being unveiled to us, seem to be looming into view. At the same time it must be acknowledged that various prejudices, some of them much to be respected, have hindered men from accepting some statements which demand acceptance, and have induced them to make other statements, which calmer judgments would have avoided.

At this point it may be properly observed that the phenomena of growth in the early embryo of an animal cannot be counted as a whit less marvellous, or at present less transcending our powers of conception, than the molecular changes in the infinite ether or the nebulous matter diffused through the universe which was spoken of at the outset.

The principle of growth, omitting many details, each of which is probably of essential importance, is as follows. A compound cell specially organised and prepared, containing millions of molecules, undergoes segmentation, i.e. division into two: each half carries off the half of a central nucleus. This group repeats itself till 4, 8, 16, 32, 64 and so forth, are similarly formed—coming at length to numbers which prevent the process from being further observed. The process itself has many modifications when pursued through the animal series, though

the general principle is the same. The whole of the ovum may be equally divided or partially, this having relation to the amount of food-yelk contained, so that there is said to be equal segmentation, or unequal segmentation, or superficial segmentation. The innumerable offspring-cells of the original process henceforward pursue a complicated course of self-arrangement. This proceeds along certain broad lines of demarcation, grouping the future animals into great classes, and culminating in the marking out and definite formation of the textures and organs of which the adult is to be the possessor, and which have been potentially contained in the germ.

And now if this rude sketch has been followed, it has to be remembered that we can only conceive that the millions of molecules which are contained in each of these organic germs are each endowed with the properties of inorganic matter before hinted at, and with certain peculiarities of whose essential nature we know absolutely nothing, but that they pertain to organic beings. And further, that it is only familiarity which can make us forgetful of the obvious truism that every common egg which we see or know of, whether of the fowl or of the meanest insect, in any one of the infinite number of individuals of the animal world which are spring-

ing into existence by millions at each moment of time, is as marvellous and inconceivable by us, as the whole planetary system astronomically considered. The egg contains potentially the material frame with all its marvellous mechanical adjustments, belonging to the species of which its adult is an example. It has moreover the power of transmitting this same material organisation to successive generations, in inconceivable numbers, for unknown time; and it has, potentially, stored up within itself its animal wants, its instincts and its passions; its character, its emotions, and its mental attributes; and its free power of action.

Of all the marvels, perhaps the greatest is; that it preserves the even tenor of its way obedient to certain tendencies; and yet that it is liable to be swayed by a mysterious relation to other organisms to which it has been linked through unknown ages by some common bond.

In this direction our knowledge has been increased and classified of late years by Sars, Rathke, Von Baer, Martin Barry, and more lately by Parker and Balfour, to that extent that few can follow it. None who do not can conceive either the intricacy, the marvel, or the beauty. The intricacy —for it is manifest there are principles of unity which binds things most dissimilar through the

almost infinite diversity of arrangement and form of living things; the marvel—for unexpected adaptations, unforeseen laws spring up into view whenever the great storehouse is opened by patience and skill to human gaze; beauty—for the delicacy of texture and of form of these microscopic growths ravish the sight, as do the golden stars set in the blue depths of the stillest night. The rare industry and devotion of Professor Parker have made an epoch indeed in minute anatomical research into the history of animal growth.

One only hint remains to be given as to this second illustration of the aims and enquiries of modern science, viz. that *Disorder* would seem to be almost an essential incident to this amazing mass of order, and to this scheme of things; and that the disorder being an incident of the scheme itself, itself obeys a rule and has its bounds and its laws. These laws are in themselves complicated, and perhaps dependent partly on the circumstance of unceasing *change*, in the arrangement of Matter, of which illustrations have been given; and partly on the various relations of inheritance and fitness which organic beings have one to the other and the world external to them. Of this disorder the third instance furnishes an illustration which will now be described.

The third instance of modern scientific investigation then has relation to *Dis-order*. There is a whole class of diseases called zymotic—from the theory that they depend on a Fermentative change. The nature of the Ferment in certain diseases has been the subject of many enquiries. One of these is selected as an illustration of such.

It has been long known that the growth of a plant called the Yeast Plant, *Torula cerevisi*, is the cause of Fermentation in saccharine fluids, bringing about the formation of Alcohol and of Carbonic Acid. It is believed by many persons of authority that the putrefaction or fermentation which takes place in Blood is caused by the multiplication of minute living organisms — Bacteria — and not by a mere chemical change brought about by non-living substances. It was desirable to ascertain the truth or untruth of this belief, from its bearing on the treatment of wounds and the management of surgical operations. Professor Lister, famous for his discoveries in Antiseptic Surgery, determined to solve this problem. He therefore studied with great care the fermentation of *Milk*. He found that there was a special form of Bacterium which belongs only to milk, and that this Bacterium, when it is present, keeps at bay all other organisms of the

kind. Where it is absent, other Bacteria flourish and produce a result analogous but not exactly the same. Good fresh milk has not originally, in it, these 'Bacteria Lactis.' If the Bacterium Lactis be added to it, the souring of the milk is the immediate result. If kept from it, the milk remains fresh for many weeks. Professor Lister devised methods for isolating the Bacterium Lactis. He was able to experiment on exactly the $\frac{1}{50}$ of a minim or drop, to count the number of Bacteria in that $\frac{1}{50}$ minim, and then by diluting it with one million parts of boiled distilled water, he obtained an average of one bacterium to each minim of the diluted mixture. With this strength of the ferment (if it may be so called) he could measure its exact effect upon the milk. He discovered that the curdling of the milk took place with rapidity proportioned to the strength of the applied ferment, that is, to the number of Bacteria; that when there was no Bacterium there was no curdling, no other growths of 'mould' appeared. The curdling or ferment of milk depends therefore upon a definite, observable, and attainable, but rare organism, which moreover can be kept out of the milk. It may indeed, says Mr. Lister, 'seem strange that the ferment that leads to the souring of milk should be rare, but such is the fact; in dairies it appears

to be universal, but in the world at large it is scarce[1].' Full-sized specimens measure about $\frac{1}{20,000}$ of an inch.

The papers in which Mr. Lister details the steps by which these conclusions have been reached are well worth perusal, as illustrating by what careful measures such results are obtained. In this case they are well worth the skill and the labour. For it may be taken as almost proved, that the souring of milk is produced by one minute and almost invisible organism. The inference is, that it is a fact, and not an hypothesis, that analogous organisms produce analogous fermentation or putrefaction in other organic fluids and in wounds. The conclusion is, that operations which by putrefaction and foulness of the wound may be, and constantly are, fatal, can with appropriate care become manageable and safe; not in one instance nor in many, but always, and for the whole Human Race.

Of a similar but of a yet more immediately practical kind is an investigation now being carried on by Professor Rolleston at Oxford, at the instance latterly of the Royal Agricultural Society, to determine the cause and mode of prevention of the 'Rot' in sheep. As is well known this depends on the ravages of an

[1] Transactions of Pathological Society of London, xxix. 1878.

Entozoon. The study of the Natural History of Entozoa has become as extensive as fertile in result. Most animals are infested by some parasites. But some parasites require more than one kind of animal to bring them to maturity. The *ova* for instance of the tape-worm, to become completely mature in man, have to pass through another vertebrate, usually the pig. And according to the enquiries on which Professor Rolleston and Mr. Thomas are engaged, the parasite which kills the sheep, has probably to pass through the common snail or the slug. In this case, if the snails can be destroyed, the sheep are saved.

This is a yet further and more complex instance than Lister's of the practical value and far reaching result of purely scientific Biological investigation, since it promises in the end to be of vast importance to the food of man. The third instance may, when taken in connexion with the previous instances, suggest some reflections, that cannot be now pursued, as to the ultimate nature of organic matter; its minuteness, its uniformity; and as to the definiteness and complexity of its laws. It gives an explanation of much that we have already believed to be true of the character of certain animal poisons; it shows the reality of some of our unseen enemies, and of the forces of destruction which sur-

round us: it gives new hope of preventing much evil, which when existing we cannot cure. It helps to explain one of the many ways in which the long existing practice of Medicine is being strengthened by Scientific research into the constitution of things —research that the ignorant too often assume to be barren of practical result, and therefore to be of little value to Man. But the world is learning that any addition to Truth, as Truth, is itself of the highest value; not only as Truth, but because it is in the end the surest way of quickly winning practical good. The history of modern times is full of instances of this kind, as in Photography, the use of Chloroform, and Telegraphy.

To describe the methods and temper, in which the organisation of the pursuit of Physical Science is to be undertaken, would occupy far more time than is at our disposal. These have indeed been the subject of some of the highest efforts of human thought. Aristotle and Bacon, notwithstanding their respective errors and short comings—without mentioning enquirers of more recent times, who had access to far more material knowledge than their predecessors—made their memory great by their instruction in the way of handling the problem of the Material Universe more perhaps than by any other

of their enquiries. Here it is enough to say that Physical Science, as I have shewn it by the examples above given, seems to deal chiefly with the nature and order of material things, from the infinitely great in space and time to the infinitely little in both. It seeks the causes of all things which it can handle, can measure, can weigh, can examine. It scans alike the chemistry of the Sun, and the operation of the invisible imponderable particle. It asks the laws of insentient matter. It pierces to the beginnings of life, whether in the growth of the individual, or in the evolution of the globe. It traces each up to its maturity as far as each is mature. Indeed, it calculates in many directions the problem of the Future from the laws of the Past. Falteringly too, though sometimes too presumptuously, it strives to connect the mind of man with the matter of which his frame is composed; and so seeks to place the spirit that can only be discussed in *Literature* in the Crucible of the Chemist or in the Balance of the Physiologist. For the essence of Literature, which we have to consider in its relation to Science, is, that it is the record of the Nature of Man as truly Man. His struggles to free himself from the lower parts of his material organisation are its special object, and its highest theme. It is permitted to

indulge in a certain freedom, the offspring of Faith. It claims a play of imagination, which is denied to the rigid accuracy required for the data of Physical Science, and to the stern logic which at every stage is indispensable for any safe step in its advancement.

It may seem presumptuous to attempt a brief definition of Literature, and it is hopeless now to describe it at length. A few words only may be allowed in stating the characteristics of its present relation to Science on one hand and to Art on the other. It was said by no mean authority, the late Bishop Thirlwall, that there is an antagonism in modern times between Science and Literature; an antagonism depending on mutual distrust. If this be true the reason is plain. Literature in its confessedly highest flights rests more on the imagination than Science can allow to be safe for correct conclusion. To which Literature may give answer, that Science has often laid claim to an infallible Logic, when its data did not warrant the trust imposed upon them. Two instances from a single modern English poet may serve better than any words of mine to put this point in a clear light.

> Behold her, single in the field,
> Yon solitary Highland Lass!
> Reaping and singing by herself;
> Stop here, or gently pass!

Alone she cuts, and binds the grain,
And sings a melancholy strain;
O listen! for the Vale profound
Is overflowing with the sound.

No Nightingale did ever chant
So sweetly to reposing bands
Of Travellers in some shady haunt,
Among Arabian Sands:
A voice so thrilling ne'er was heard
In spring-time from the Cuckoo-bird,
Breaking the silence of the seas
Among the farthest Hebrides.

Will no one tell me what she sings?
Perhaps the plaintive numbers flow
For old, unhappy, far-off things,
And battles long ago:
Or is it some more humble lay,
Familiar matter of to-day?
Some natural sorrow, loss, or pain,
That has been, and may be again!

Whate'er the theme, the Maiden sang
As if her song could have no ending;
I saw her singing at her work,
And o'er the sickle bending;—
I listened till I had my fill,
And when I mounted up the hill,
The music in my heart I bore,
Long after it was heard no more.

Sweet is the scene which the minstrel brings telling of the peaceful joys of a Rural Home! Who

does not see the sunlight and the wavy corn, and hear the music of a simple heart beating timely to its human affections? Who does not feel the glow reflected in his own breast, when he remembers the picture indelibly stamped upon him,—the joys and the sorrows of an innocent and simple life, the scene, the singer, the melody, the poet who has lifted him away from his daily cares? And then listen to the lofty strains as the same Bard reaches forth to tell of the highest destiny of Man, and to paint for you his vision of enjoyed eternity, his hope of realised immortality.

> O joy, that in our embers
> Is something that doth live,
> That Nature yet remembers
> What was so fugitive!
> The thought of our past years in me doth breed
> Perpetual benediction: not indeed
> For that which is most worthy to be bless'd;
> Delight and liberty, the simple creed
> Of childhood, whether busy or at rest,
> With new-fledged hope still fluttering in his breast:—
> Not for these I raise
> The song of thanks and praise;
> But for those obstinate questionings
> Of sense and outward things,
> Fallings from us, vanishings;
> Blank misgivings of a Creature
> Moving about in worlds not realised,

High instincts before which our mortal Nature
Did tremble like a guilty thing surprised:
But for those first affections,
Those shadowy recollections,
Which, be they what they may,
Are yet the fountain light of all our day,
Are yet a master light of all our seeing;
Uphold us, cherish, and have power to make
Our noisy years seem moments in the being
Of the eternal Silence: truths that wake,
To perish never;
Which neither listlessness, nor mad endeavour,
Nor Man nor Boy,
Nor all that is at enmity with joy,
Can utterly abolish or destroy!
Hence, in a season of calm weather,
Though inland far we be,
Our souls have sight of that immortal sea
Which brought us hither,
Can in a moment travel thither,
And see the children sport upon the shore,
And hear the mighty waters rolling evermore.

And O, ye Fountains, Meadows, Hills, and Groves,
Think not of any severing of our loves!
Yet in my heart of hearts I feel your might;
I only have relinquished one delight
To live beneath your more habitual sway.
I love the Brooks which down their channels fret,
Even more than when I tripped lightly as they;
The innocent brightness of a new-born Day
Is lovely yet;
The Clouds that gather round the setting sun

> Do take a sober colouring from an eye
> That hath kept watch o'er man's mortality;
> Another race hath been, and other palms are won.
> Thanks to the human heart by which we live,
> Thanks to its tenderness, its joys, and fears,
> To me the meanest flower that blows can give
> Thoughts that do often lie too deep for tears.

Between these two aspects of human life how manifold is the history! How wide apart the simple tale of individual innocence, and the prospect to the human race of awakened intellect and perfected goodness, varying in power, through infinite time, infinite knowledge, infinite immeasurable joys!

How unlike these thoughts, are to the rigid conclusions of the Mathematician and the Scientist it is not needful to spend time in describing. The essence of Physical Science being the collection of Fact and the deduction of Law in the Material Universe, there is almost an aversion in its votaries, as such, to the baseless imaginings, as it seems to them, of human interest and the human heart. On the other hand, to the Moralist and Theologian such material enquiries are counted as dross in comparison with the aims and the discipline of the human Soul. This mutual repulsion did not always exist, nor has it existed even in later days, in the greatest minds. Aristotle and Galen among the ancients, Bishop Butler

almost in our own day, testify to the contrary. Nor need we hesitate to name Galileo, Newton, Herschel, Faraday, and hosts of others to whose temper the highest aims of Literature and the keenest search into material truth were alike congenial.

Hegel and the Hegelians have inflicted in later times grievous injury on the harmonious investigation into truth viewed as a whole. By advocating methods independent of experiment, and by claiming for subjective reason a higher place than for patient objective research, they provoked and received a Nemesis of retaliation and of prejudice harmful alike to themselves and to physical enquirers. The history of Science teaches that not unfrequently an excessive reliance on the evidence from Final Causes has done a similar though perhaps not so deep a mischief to the cause of the comprehensive study of Nature.

The Aims of Literature do not differ from those of Physical Science as much as do the Methods. It was well said by G. H. Lewes, 'A Theory may be transferred from Metaphysics to Science, or from Science to Metaphysics, simply by the addition or the withdrawal of its verifiable element.' 'Thus the law of Universal Attraction becomes pure Metaphysics if we withdraw from it the verifiable specification of

its mode of operation. *Withdraw* the formula "inversely as the square of the distance and directly as the mass," and Attraction is left as a mere "occult quality[1]." ' It is therefore a confusion between the 'Method' and the 'Aim' which causes the feud, if feud there be, between Science and Literature. Both Science and Literature deal with *facts* and with *ideas:* if either seeks to use exclusively one branch of the arms, which should be used in their proper proportion during the onslaught they both wage on error or on ignorance, they must in some measure fail of success.

It may seem perhaps that in these statements a confusion is made between Literature and Metaphysic. The essence of Literature, it has been already said, is the dealing with matters of Human Interest. The vehicle of Literature is Language. The Language has to be employed in conformity with rules attained partly by experience—as it would seem empirically acquired — partly by intrinsic organic laws, partly by the culture and skill of experts, such as is acquired by experts in any Art, partly by the special inborn Gift of Style. The skill so attained is to be used in a form agreeable to the best aims of a pure nature. Thoughts for children,

[1] Aristotle, by G. H. Lewes, p. 84.

are expressed so as to meet the best instincts or emotions of the child, according to its race inheritance and surroundings; thoughts for women, so as to touch the tender chords of the purest and most unselfish love; thoughts for men, so as to nerve the impulses of patriotism and bravery; thoughts for all, so as to evoke those instincts of strife against all Evil, and those yearnings for the good and the noble, which are by a Hidden First Cause implanted indelibly in the Human Heart.

This Language so employed is expressed either in Prose or in Verse—Prose being Language employed in all cases where either narrative, history, description, or any subject-matter proper to Literature is needed. It rises at times to that kind of culture and elaborateness which emulates the musical cadence of Verse. Verse relinquishes the freer and less measured speech, and binds itself in certain chains of Form. It claims the right to the highest flights of imagination, to the hopes and fears of mortal man in his yearning for immortality and his reaching up to the Infinite Good and the Personal Father of all. If the first attempt at Science by the Classification of Knowledge was though with inadequate, and even with erroneous *method* made by the dwellers in Greece, so also unquestionably (if we except the

lofty strains that sprung up from the Seers and Psalmists of Palestine) was the foundation laid of the purest and most perfect forms of Literature, Poetry and Prose, beneath the hills that stand round about the Acropolis of Athens, and among the dark olive groves that are washed by the pleasant rills of Ilissus and Cephisus. But the precious gift of cultured speech belongs to no Period and to no race. Eloquence is a gift of the Heart. It will burst forth with the gesture of the Savage, the stern thoughts of the Philosopher, or the violence of the Patriot, and then when committed to writing it becomes part of the prose Literature of the people. Facts which would be related for a scientific purpose in precise, perhaps bald terms, may become eloquent and poetical in the highest degree when represented by a great Master of Language and expression. Witness the following :—

Stand upon the peak of some isolated mountain at daybreak, when the night mists first rise from off the plains, and watch their white and lake-like fields as they float in level bays and winding gulfs about the islanded summits of the lower hills, untouched yet by more than dawn, colder and more quiet than a windless sea under the moon of midnight; watch when the first sunbeam is sent upon the silver channels, how the foam of their undulating surface parts and passes away; and down under their depths, the glittering city and green pasture lie like Atlantis, between the white paths of

winding rivers; the flakes of light falling every moment faster and broader among the starry spires, as the wreathed surges break and vanish above them, and the confused crests and ridges of the dark hills shorten their grey shadows upon the plain. Wait a little longer, and you shall see those scattered mists rallying in the ravines, and floating up towards you, along the winding valleys, till they couch in quiet masses, iridescent with the morning light, upon the broad breasts of the higher hills, whose leagues of massy undulation will melt back and back into that robe of material light, until they fade away, lost in its lustre, to appear again above, in the serene heaven, like a wild, bright impossible dream, foundationless and inaccessible, their very bases vanishing in the unsubstantial and mocking blue of the deep lake below. Wait yet a little longer, and you shall see those mists gather themselves into white towers, and stand like fortresses along the promontories, massy and motionless, only piled with every instant higher and higher into the sky, and casting longer shadows athwart the rocks; and out of the pale blue of the horizon you will see forming and advancing a troop of narrow, dark, pointed vapours, which will cover the sky, inch by inch, with their grey network, and take the light off the landscape with an eclipse which will stop the singing of the birds and the motion of the leaves together; and then you will see horizontal bars of black shadow forming under them, and lurid wreaths create themselves, you know not how, along the shoulders of the hills; you never see them form, but when you look back to a place which was clear an instant ago, there is a cloud on it, hanging by the precipices, as a hawk pauses over his prey. And then you will hear the sudden rush of the awakened wind, and you will see those watch-towers of vapour swept away from their foundations, and waving curtains of opaque rain let down to the valleys, swinging from the burdened clouds in black, bending fringes, or pacing in pale columns along the lake level, grazing its surface into foam as they go. And then, as the sun sinks, you shall see the storm drift for an instant

from off the hills, leaving their broad sides smoking, and loaded yet with snow-white torn, steam-like rags of capricious vapour, now gone, now gathered again; while the smouldering sun, seeming not far away, but burning like a red-hot ball beside you, and as if you could reach it, plunges through the rushing wind and rolling cloud with headlong fall, as if it meant to rise no more, dying all the air about it with blood. And then you shall hear the fainting tempest die in the hollow of the night, and you shall see a green halo kindling on the summit of the eastern hills, brighter—brighter yet, till the large white circle of the slow moon is lifted up among the barred clouds, step by step, line by line; star after star she quenches with her kindling light, setting in their stead an army of pale, penetrable, fleecy wreaths in the heaven, to give light upon the earth, which move together, hand in hand, company by company, troop by troop, so measured in their unity of motion, that the whole heaven seems to roll with them, and the earth to reel under them. And then wait yet for one hour, until the East again becomes purple, and the heaving mountains, rolling against it in darkness, like waves of a wild sea, are drowned one by one in the glory of its burning; watch the white glaciers blaze in their winding paths about the mountains, like mighty serpents with scales of fire; watch the columnar peaks of solitary snow, kindling downwards, chasm by chasm, each in itself a new morning; their long avalanches cast down in keen streams brighter than the lightning, sending each his tribute of driven snow, like altar-smoke, up to the heaven; the rose-light of their silent domes flushing that heaven about them and above them, piercing with purer light through its purple lines of lifted cloud, casting a new glory on every wreath as it passes by, until the whole heaven—one scarlet canopy,—is interwoven with a roof of waving flame, and tossing, vault beyond vault, as with the drifted wings of many companies of angels; and then, when you can look no more for gladness, and when you are bowed down with fear and love of the Maker and

Doer of this, tell me who has best delivered this His message unto men!

This splendid description from Mr. Ruskin of certain natural phenomena following the account given above of the 'Universe of Stars,' will recall to many minds the well-known lines—

Thou Sun, of this great World both eye and soul,
Acknowledge him thy greater; sound his praise
In thy eternal course, both when thou climb'st,
And when high noon hast gained, and when thou fall'st.
Moon, that now meet'st the orient Sun, now fliest,
With the fixed Stars, fixed in their orb that flies;
And ye five other wandering Fires, that move
In mystic dance, not without song, resound
His praise who out of Darkness called up Light.
Air, and ye Elements, the eldest birth
Of Nature's womb, that in quaternion run
Perpetual circle, multiform, and mix
And nourish all things, let your ceaseless change
Vary to our great Maker still new praise.
Ye Mists and Exhalations, that now rise
From hill or steaming lake, dusky or gray,
Till the sun paint your fleecy skirts with gold,
In honour to the World's great Author rise;
Whether to deck with clouds the uncoloured sky,
Or wet the thirsty earth with falling showers,
Rising or falling, still advance his praise.
His praise, ye Winds, that from four quarters blow,
Breathe soft or loud; and wave your tops, ye Pines,

With every Plant, in sign of worship wave.
Fountains and ye, that warble, as ye flow,
Melodious murmurs, warbling tune his praise.
Join voices, all ye living Souls. Ye Birds,
That, singing, up to Heaven-gate ascend,
Bear on your wings and in your notes his praise.
Ye that in waters glide, and ye that walk
The earth, and stately tread, or lowly creep,
Witness if *I* be silent, morn or even,
To hill or valley, fountain, or fresh shade,
Made vocal by my song, and taught his praise.
Hail, universal Lord! Be bounteous still
To give us only good; and, if the night
Have gathered aught of evil, or concealed,
Disperse it, as now light dispels the dark.

Thus Ruskin in prose, and Milton in lofty verse, handle the contemplation of Natural objects: Heber dashes a saddening touch of Scientific prophecy into similar poetic enthusiasm for Nature.

I prais'd the Earth, in beauty seen
With garlands gay of various green;
I prais'd the Sea, whose ample field
Shone glorious as a silver shield;
And Earth and Ocean seem'd to say
'Our beauties are but for a day!'

I prais'd the Sun, whose chariot roll'd
On wheels of amber and of gold;
I prais'd the moon, whose softer eye
Gleam'd sweetly through the summer sky;
And Moon and Sun in answer said
'Our days of light are numbered!'

Lastly, as all observations and collections of Fact cannot claim to be classed as Science, but only such as have been arranged, co-ordinated, classified, in relation to fundamental principles or laws, so a great portion of recorded knowledge, however valuable, is excluded by common consent from the special term of Literature or Belles Lettres. Technical treatises of every kind, are excluded. Yet we often speak, and rightly, of the Literature of Science and of Art. In other words, writing that is purely narrative and technical, in every department of human knowledge, may often be, and is in the present day, wrought with so much skill, and is as a work of Art so pleasure-giving, that often the meanest subjects justly claim praise as expressed with literary sentiment and skill. The so-called Periodical Literature has become so powerful and so voluminous, that, without it, progress, especially in Physical Science, is impossible to the student. The thousands of treatises which deal every year with new points of knowledge, and which appear in Transactions and Serials, have made Indices and Subject Catalogues as necessary for men of Letters and of Science as Highways have been to Commerce.

Since therefore Literature includes the record of all Moral and Subjective knowledge, and Physical

Science includes all material and objective truth, they must not be held to be antagonistic one to the other, or in subjection one to the other, but as veritable sisters jointly occupied in promoting the common work of human progress; progress that would be without this union as incomplete as if an attempt were made with a warpless woof to weave a complex web.

Notwithstanding the admitted danger of Analogies, ART may be compared in its relation to Science and Literature, with the Colour which gladdens the complex pattern, when woof and warp are deftly intertwined.

ART is the expression of the yearning after Beauty in design and in execution of every work of Man. Art is unwritten language. It has been graven in every country, under every sun, in every time, by every race. It employs material of Wood and of Metal of Ivory and of Stone; of Pottery and of Parchment. It has given more than life to the cold marble of Pentelicus. It has fixed on panel and on canvas the light of the Sun, and the prism from the Rainbow. It is impressed on Jewels of the mine, and on colossal Sandstones in Egyptian deserts. The unlettered Eastern plays with it in matchless combinations of colour which the self-satisfied Western seems doomed to destroy. It

has impressed every attribute of delicacy and of force, on every substance through which the temper of man may be expressed, from the rudeness and brutality of the Savage to the playfulness of the Comic and the rage of the Tragic Muse. Setting forth as does Literature the loftiest aspirations which language can fix of our better nature, ART has left to instructed and wondering generations the thoughts of Phidias and his fellows, telling of the inner sense of religious patriotism which stirred the heart of the cultured Greek By the recorded pathos of Fra Angelico and Francia, by the delicacy of Lionardo and of Raphael, by the brilliancy of Georgione and of Titian, by the force of Signorelli and Michael Angiolo, by the individualisation of Holbein and Reynolds, the naturalistic splendour of Memling and Van Eyck, Art has fixed, in touches yet more indelible than words, the yearning of man's holier nature after that godliness, which is revealed by the true followers of the Son of Man; and it has placed for ever before us, in scenes of sadness and of peace, the Passion and precious Sacrifice of the Son of Man Himself.

Art is, generally speaking, in its essence, either purely Imitative, or Creative. It may therefore be Imitative of the meanest, or Creative of the bravest, the purest, and the most lovely. It may be em-

ployed on Still Life, on external Nature, on Human Interests, on the noblest and most airy conceptions of Imagination or of Fancy. It can do therefore what Science does not attempt, and ranges parallel to and in some way beyond the best and completest efforts of Language and of Literature. There are thoughts of devotion and of love which words cannot express. There is no emotion which the brush and the chisel cannot record.

What the degradation of its lowest performances, what the full effect of its noblest efforts, there is no time now to consider. Art is neither Science nor Literature. She adds to them both what neither can alone attain. She dare not claim for her pure votaries what the precision of Science can give, and she inflicts a stern Nemesis on any that would surrender themselves wholly and arrogantly to her supposed entire service, giving them too often only a stone when they think they have obtained bread. But she cannot be banished without grievous harm, often great in proportion to the real excellence which men may have attained in the service of her two sisters. When divorced from Religion she herself falls into decay. 'The utterance of her language,' says Mr. Newton, 'is feebler or more emphatic, its range of expression narrower or more varied, according to the

character of the religion, and the genius of the race.' And she is to be read therefore only by the light of the History of the people whose works are the object of study.

From the assumed definitions of Science, of Literature, and of Art, and from the general illustrations of their nature, some elementary conception may be formed of them, either individually or in their relation one to the other. It would seem that Science chiefly seeks to know the established order and evolution of the material Universe; that Literature deals mainly with the interests and history of Man as such; that Art has especially to discover the nature of beauty in the world of matter or of mind, and to record the yearnings of the Human Soul in its search. It is in this, and in a yet more mysterious, sense, that the highest kind of Music, partly by Association, partly by actual effect of Emotion, partly by pure Intellectual Pleasure, has a place in the domain of the highest Art.

One branch of the work of Art, viz. Landscape painting, was described with much interest by your able President of last year, and need not now therefore be further alluded to. I cannot refrain from adverting to a recent article on the state and prospects of Art in England by a truly noble Artist,

Mr. Watts, in which he speaks with pathetic force of the hopelessness of prosperity in true Art, unless the prosperity of the nation depends on high aim and nobleness in the people—a lesson urged by Mr. Ruskin for many years, with a splendour of illustration and power of language, which have made him the greatest Critic of Art that the English race or perhaps any race has hitherto produced.

While to reach any one of these departments of Human Energy is almost beyond the opportunities of the most fortunate and the strength of the most powerful; yet to pursue any one exclusively is certain to distort, if not to dwarf the mind.

The Literary man and the Moralist may be blinded to the astonishing revelations of material power which has been unfolded by Physical Science, and to the evidence and proof of infinite Order, nay even of Design, which is almost implied by the ascertained facts of the material world. The Scientist, by dwelling exclusively on the very facts which are the subject first of observation, and then of test by experiment, may by virtue of the intensity of his gaze become insensible to the light of moral and religious evidence, to the charm and the instruction derived from the high sensibility to beauty of form and of colour, to the operations of the Human Mind

through works of Art, and to the suggestions derived from the sublimity or from the fascination of simple external Nature when untouched and unexplained by the Analysis of Physical Science.

What remains therefore to be said on this head is, that no training is complete which does not give to us some insight, according to our powers, into the groundwork of Science, of Literature, and of Art; and does not provide a deeper knowledge of some chosen department in one or other of them. Such training indeed we find to have existed in most, if not in all, of the greatest masters in any one branch of human thought.

It were indeed well if it were possible to speak at length of the nature of this training in each. But time forbids.

A Devonshire man, of rare genius, beloved for his personal qualities by those who knew him, but cut off from many by reason of some of his speculations, writing of the aims and instruments of scientific thought, says, 'The aim of scientific thought is to apply past experience to new circumstances; the instrument is an observed uniformity in the course of events.' And he adds this suggestive remark, that 'by the use of this instrument it gives us information transcending our experience, it enables

us to infer things that we have not seen from things we have seen, and the evidence for the truth of that information depends on our supposing that the uniformity holds good beyond our experience.' The limitation of our knowledge therefore, present and to come, is derived from our defective means of observation, of experience, and of reasoning. History shows us that each of these processes has been capable of improvement truly astonishing. The limits of improvement time alone can show.

And as to our means of training for the purpose of rightly dealing with human interests as distinguished from mere material fact, it has been said by one of the acutest of modern thinkers, in writing of the constitution of the intellect, that our means of progress depend on 'the ability inherent in our Nature to appreciate Order, and the concurrent presumption however founded, that the phænomena of Nature are connected by a principle of Order.' No one can look at the course of human affairs, nor scan their history, without feeling that the elements of disorder introduced by untruth into the world must be compatible with some Higher Order which allows the exercise of a free choice to responsible beings. There is in the world a terrible choice of falsehood, injustice, and sin. Moral order

must tend to suppress them all. But we seek in vain for a solution of the difficulty solely in the conduct of intellectual Man, just as we fail to find it solely in the stern laws of the material world.

And if to the light which Science and Literature have given to us we add the bright gleams which the Creations of Art have flashed upon us, regions of thought and hope and peace seem to rise up from afar, regions in which search may be merged in knowledge, and where we look for the highest conceivable joy in the presence of All Good. But such concepts belong to the domain of Faith, and the rules and usages of your Association properly require that these heights should not be scaled from here. In the words of Bacon, 'da Fidei quæ Fidei sunt.'

I add but one remark, one which perhaps may have a special interest rather to the Physician than to those who, in the full pride of life, can scarcely dwell on the sufferings and sorrows of Man. The progress of Man lies in the just proportion in which his faculties are developed. The mental qualities which Science, which Metaphysic, which Art respectively evoke are each made more perfect when duly related to one another. And the physical power, the discipline, and care of the Body are not to be forgotten even in the reckoning up of the require-

ments for mental improvement. May we all seek so to promote the means and conditions of healthy life in every class and in every occupation, that we may omit nothing, in this age of unexampled struggle for existence, by which all pure Science, all useful Art, and all manly Culture, may have their fullest effect on the intellects and on the hearts of the masses of our people.

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