THE SPIRIT OF NATURE

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BEING

A SERIES OF INTERPRETATIVE ESSAYS ON THE HISTORY OF MATTER FROM THE ATOM TO THE FLOWER

BY

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PROLOGUE.

For reprinting this series of Essays in a collected form it does not become me to enter any plea or apology, but a few words of explanation seem to be here desirable, and indeed requisite. While I considered it no slight honour and advantage to be able to address the audiences that gathered in the rooms of the Pharmaceutical Society in Edinburgh, I did not write without reference to a larger public, and I was also aware that the long intervals elapsing between the delivery of these several papers tended, both with hearers and speaker, to impair the continuity and detract from the effect of the argument. It seemed due, then, to this argument, and to myself as a literary workman, that we should appear drawn up, as it were, on a war-footing, at highest fighting strength, with our full complement of war-paint and feathers, or like a Bedouin Swashbuckler, with all our available weapons stuck into our military belt. None the less would it be

unjust as well as ungrateful to withhold cordial thanks to my late audiences for the ample and valuable encouragement their kindly reception of my papers afforded me, and more especially to those officials of the Society to whose courtesy, liberal spirit, and appreciative interest I owe so much of the success I met with. But again, if the ultimate aim with which I wrote tended to some extent to render these Essays less appropriate to the immediate purpose for which they were used, so also in adapting them to that immediate purpose I was compelled to sacrifice in part their fitness for that ultimate aim. Hence there occur dislocations, repetitions, and omissions in the argument which nothing short of a complete recasting of the whole could remove. But I foresaw that in so radical a process I stood to lose quite as much rhetorically as I could possibly gain logically, and consequently decided against such a course. There seems, however, no objection to my stating briefly, here at the outset, the main basis of my position, one which has not hitherto, so far as I know, been taken up by writers on these subjects.

My general aim is not so much to discredit Darwinism proper, as held by the original author of the Doctrine, as to attack and if possible demolish that materialistic and

atheistic system, for whose bricks Darwin himself has but supplied the stubble. This materialist system involves the extension of what may be called a mechanical evolution not only to the whole organic world, but also to matter and force in their most simple and primitive forms; it undertakes, in fact, to explain and account for the upbuilding of the whole physical system of things by means of properties inherent in matter itself, without any direction, control or assistance from creative power or intelligence. In order to accomplish this it will be necessary, starting from matter in a single primal condition, to show at least the possibility of its having become, without any action but that of its own aboriginal properties, developed into that state of permanent difference which characterizes the chemical elements. That the exponents of this system have ever done this I deny, and in the essay on Poetry and Science (now published for the first time) I point out the immense and, to my mind, insuperable difficulties that lie in the path of such explanation. In the essay on Chemistry I show how completely that science, in its present condition, militates against any theory of chemical evolution. In this manner I endeavour to cut off the materialist from his only path of retreat. And now, even should he succeed in

establishing a mechanical theory of evolution for all *organic* bodies, it can avail him little or nothing, seeing there still lies behind him a complex system of matter, which he has failed to explain, and which is of itself quite sufficient to found an argument for intelligent creation upon. But if I seek to cut him off from this base, so that he cannot retire upon it, I likewise aim at rendering it useless to him, should it, by any change in the aspect of affairs, ever fall into his hands. Having entered the stronghold, I do not wish to leave it without spiking the guns. To this end I argue that Life is not explicable on mechanical or chemical grounds at all, that it is a new principle superseding and sublating, though not destroying, its predecessors. In the chapters on Botany I therefore aim at proving the inadequacy of mechanic or chemic forces to account unaided for the facts of Plant-life. This is a point of capital importance, and, if this position can be securely maintained, there is safety all along the line. Coming now to Darwinism proper, or Darwin's theory of Evolution, I take up the attitude of admitting the possibility, and even the actual truth, of evolution as a fact in the history of life on this planet, while denying the adequacy of those factors of "Survival" and "Natural Selection" upon which Mr. Darwin

so much relies. While quite ready to admit there has been a development, I decline to admit that it has been *accounted for* on these or similar grounds, and I consequently hold that a theistic argument may be as surely based on this historic creation as upon any summary or epochal one. If design and intelligence are but shown to be involved, it matters nothing whether they operated momentarily or continuously, for the space of six days or for millions of years. And if I have proved anything in the whole of this book, it is that intellect is inextricably implicated in this evolution, that apart from its workings there is no method of explaining those very occurrences and structures which Darwin cites in his own favour. The advantage of this form of argument, which I have here so nakedly set forth, lies in this, that the loss of one position leaves the others separately tenable. Even if the genesis of matter were successfully unravelled, a stand could still be made at the beginnings of life; if that position had to be abandoned, the arguments in favour of intelligent evolution of living forms would not have lost their force.

While it was repugnant to me as a theist to have the causation of the universe relegated to primitive matter, and to see the awful and reverend throne of Deity usurped by a

blind company of uncaused inherent Properties, none the less was it intolerable to me as a lover of Nature and her beauties, to hear her calumniated and them disregarded and desecrated. Hence I have exerted myself to the utmost to refute these calumnies and to obtain for these beauties recognition and reverence. What had elsewhere been argued in this direction I have endeavoured to supplement and even complete by the brief essay on "The Cruelty of Nature" with which the volume closes.

While I trust these studies may not be devoid of interest for those already well acquainted with or even learned in the sciences to which they refer, I have also aimed, by the avoiding of technical terms and the explanation of such as could not be avoided, to make the sense always intelligible to the unlearned reader; and such I would ask not to be deterred by the drier aspect of the earlier chapters, as the subject itself becomes more simple and more imaginatively suggestive as we pass onward from the mathematic strictness of chemic elements to the flowing graces of flower-forms and the greater variety and incident of plant-life. And I have stayed my review of this plant-life where I did, not because that which still lay before me appeared likely to prove less fertile in illustration and witness to my

propositions, but because I foresaw that the form of the argument must remain essentially the same and had already been sufficiently elaborated and insisted on.

It was gratifying to me to find that my attempt at a simplification of the "Law of Combination by Weight" in the first draught of my paper on Chemistry had not passed without notice, as was shown by my receiving a criticism thereon from a correspondent whom I am only at liberty to designate *initially* as T. B. G. I have endeavoured to profit by the correspondence that passed between us, the result of which is that I have altered the form in which the law is enunciated, so that I am in hopes it may now meet the approval of T. B. G. and critics of like calibre.

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THE CRUELTY OF NATURE.

I.

OF CHEMISTRY.

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TO Chemistry was intrusted the task of tracking matter back to its simplest forms or form, of discovering the alphabet of matter. The result is remarkable so far as present knowledge goes. There are found a considerable number—over sixty—elements which have hitherto defied all attempts to resolve them into a further simplicity, and are also indestructible, passing scatheless and invulnerable through every transformation. There is no apparent tendency on their part to lose their peculiar properties or to pass one into the other; although there are a few apparently anomalous instances of change of property accompanying change of temperature, as in the

case of phosphorus. While, of course, it seems open to the theorist to hold that these elements are varieties of some ultimate single substance, there seems no prospect that a proof will ever offer itself. No doubt the fact that all the elements have different atomic weights, and the fact that in some case we find elements which bear a family likeness, forming a series in regard to their atomic weights, afford, as it were, a glimpse of the wondrous staircase of creation, yet, as there appears to be no means of further analysis, this theory must apparently remain a theory. Thus brought to bay, for the time at least, by this imperturbable bodyguard of Nature's secret, chemistry proceeds to take them at their word, and treat them as ultimate elements whose mutual relations are to be studied. These relations, through their infinite variety, from the inorganic to the organic kingdom, with its ever-increasing complexity, does chemistry follow up to the very verge of thought and consciousness. A marvellous and a fascinating science truly; teaching the infinity of the universe as emphatically and perhaps even more clearly than astronomy itself. In astronomy one is out of one's depth from the very outset. The lesser distances, such as that of the moon from the earth, are equally inconceivable with the

greater, and the effect is soon lost. In chemistry we can commence with the utmost simplicity and go step by step to ever-increasing complexity till imagination and memory pause, impotent to proceed. Like all sciences it is full of unanswered questions. Mature and elaborate as it is, it has not surrendered the keys to its causation. We may talk glibly enough of chemical affinities, though we can give no reason for them. We say, for example, that acids and alkalies combine by reason of their mutual affinity, but by this we merely mean that those substances have a tendency to combine with each other, a tendency which is inherent in them, and which we have chosen to call chemical affinity. But why an atom should attract one kind of atom more than another is a question to which there is no answer; to say that it has greater affinity for the one than for the other is merely another way of stating the fact.

It is possible that at some future time a further step may be made. Some relation between the form of the molecules and the amount of attraction may be discovered; but this, from all previous experience, seems certain, that practically the same question will remain unanswered, a law being found according to which these molecules

attract each other but for whose existence no reason can be assigned. With regard to chemistry, then, we see that it tells us broadly, concerning matter, these facts: that there are a number of ultimate elements indestructible, irresoluble, immutable, and that these are controlled by mutual attractions, or by what we call chemical affinity. It may further be noted, the marriage of no two molecules, still less the union of a larger number, need be permanent, as there is always left out of the union some molecule which has a stronger affinity for one of the two than that to which it is united, and can thus set the other free to make fresh combinations. Thus a complete cycle of change is provided for. This is noteworthy, as it might have seemed at first sight that if molecules united according to affinity, those with the strongest affinity would ultimately get together and change would cease. This is, as we see, provided against by the affinities not being mutually equal. It is like waltzing, the hold you have on the lady is different from that she has on you. As an illustration, suppose we take an atom of free hydrogen. This may after combustion form part of a drop of water: this water may be seized upon by some sulphuric acid. The sulphuric acid coming in contact with some

chloride of sodium may give up its hydrogen to form hydrochloric acid. But the hydrogen is not safely caught yet. Add metallic zinc to the hydrochloric acid, and the hydrogen is again set free to begin its adventures anew.

Thus, while the elements themselves are indestructible, their capacity of change of association seems inexhaustible. Of course, if, as the physicists say, motion must ultimately cease, so also would chemical change. Now, had this arrangement concerning chemical affinity been the invention of a human mind, it could not fail to excite admiration by its simplicity, ingenuity, and completeness; yet, according to the latest utterance of a modern leader of science, its invention is not to be attributed to a person—nay, not even to a cause. I hope, as this matter has come thus in our course, you will bear with me if I make a short excursion from what may seem the immediate subject to mention explicitly the utterance to which I have just referred—I mean, of course, Mr. Tyndall's article in the November (1875) number of the *Fortnightly Review*.

Before entering upon this I would disclaim any feeling of bitterness or rancour against Mr. Tyndall, such as is

displayed in some quarters. While thinking him seriously —ay, dangerously—astray in his beliefs and his teaching, I can see no reason to attribute to him anything short of complete sincerity and disinterested desire for truth. A man, doubtless, well versed in many departments of science, he is not necessarily an able thinker on subjects which are really metaphysical, and, it seems to me, beyond the range of his mental vision. He commences his article by comparing theologians to "squatters," that is to say, people who take possession of and occupy land to which they can show no title. Undoubtedly science has been repressed and even persecuted in the name of religion. It was once considered necessary to orthodoxy to believe that the sun went round the earth, not because it had ever been proved to do so, but simply because to believe otherwise was considered inconsistent with Scripture, or the teaching of the Church. So, even now, there were those who were very angry with Mr. Darwin and others for the doctrines they promulgate; there are even those who would willingly suppress that gentleman and his works, believing them to be closely connected with a most ancient gentleman and his works. The point is to distinguish between those matters upon which such

writers must be accepted as authorities and those upon which they have no special claim to deference. In such a matter as the age of the world or the antiquity of man the geologist and antiquarian must be allowed a hearing. To assert *à priori* that unless the result of their researches tallies exactly with the ideas of the Hebrew writers they must be wrong, is of course to beg the question, and is equivalent to a declaration of the futility of all human inquiry. Mr. Tyndall is then right in protesting against this intolerance. He would fain, it seems, establish a rule of the road whereby he and the theologians might pass and repass without collision. What I would complain of is that he is the first to break his own rule. He is not content with his "matter" and its laws, but must needs touch upon theologic questions. Nor does he merely graze the theologic vehicle; he must, if successful at all, demolish that vehicle completely, and leave its late occupants helplessly floundering in the materialistic slough. In handling, as he does, the question of the existence of a Deity, he is not impugning any particular conclusion of the theologians, he is abolishing theology itself. There can, of course, without a Deity be no theology; and Mr. Tyndall declines to acknowledge a Deity. If theologists be squatters, what

is Mr. Tyndall? There is no name for him, even in Webster.

This is so far a digression, but when we come to consider the relation of chemistry to Mr. Tyndall's ideas of matter, we find ourselves again on the main line of the subject. In "matter" he asserts that he finds the "promise and potency of all terrestrial life." Very pretty alliteration truly! Though it may seem strange that a leader of a class of men, one of whom denounced poetry as "sensuous caterwauling," should slip into a rhetorical trap. He finds in pure matter the promise of terrestrial life. What does this mean? Does it mean that there is nothing but matter in existence? If so it is contradictory to his admission of the mystery of mind, which would become the mystery of nothing, if mind did not exist. Does it mean that the material universe is material?—which is tautologic—or does it mean that matter traced back to its simplest forms gives promise of its future destiny? If the last, it can flatly be denied. Matter in its simplest form consists of a number of separate elements. So long as you keep these apart from each other they exhibit peculiar and distinct properties; but take two whose single properties are known, allow them to combine, and straightway

appears what is practically a new creation. The combination possesses qualities different from those of either of its constituents. Neither of these, therefore, could be said to afford the promise of what the combination would be. There is here no process of development, there is but a transformation, wonderful, sudden, complete. There is a performance certainly, and that a marvellous one, but no hint of promise or prediction. In this case Mr. Tyndall indulges in a practice which he would be the foremost to condemn in a theological writer; he takes certain facts which are acknowledged to have come to pass, and says they must have been prophesied because they have come to pass. But, further, he tells us that pure matter contains the "potency of all terrestrial life;" which is to say, we suppose, that it is capable of producing everything we know. Now our materialist distinctly acknowledges the existence of mind; he further admits that between mind and matter there is a gulf no thought can span. He therefore asserts that matter is capable of producing mind —*i.e.* of producing that from which it is separated by an impassable gulf! This seems absurd enough. The fact is that materialism is upheld by a logical fallacy by means of which any absurd admission can be forced from one.

It consists in taking up a position which can be at once freely admitted, and approaching by inconsiderable degrees towards its contrary. Suppose a person says to you that he considers himself a poor man because he has only a few hundreds a year. You may say to him, "I can prove you are a rich man. Do you consider a man with a thousand a year rich?" "Well," he says, "yes." Starting from that admission, and merely lowering the sum by small amounts, you must at last force him to admit that his income is sufficient to make him a rich man, although he is not a whit more convinced of the fact than when you began. This is the plan adopted by the materialist. He takes inanimate matter, and proceeding step by step forces you from point to point till he comes to your own brain. But then the metaphysician could do just the same thing for mind. Beginning in the domain of pure thought, as the materialist begins in that of pure matter, he could make you admit that you can be cognizant only of your own sensations, and that, for all you can prove, the physical universe may have no objective existence. The sensible person believes neither of these, but leaves them to knock their respective heads together as long as they choose. He does not believe roast beef and plum-

pudding to be a mere chimera of his brain, nor yet does he believe that in pure matter "lies the promise and the potency of all terrestrial existence."

It may be well here to note the significance of chemistry with regard to the doctrine of evolution. This doctrine in its broadest form means merely that as a matter of fact and cosmic history the whole of terrestrial life, whether vegetable or animal, has proceeded, as it were, from a single seed. It asserts it to be possible, and even holds it the only possible, that all varieties and species we now behold have been developed from a common ancestor. At first sight the theory has to our mind an intense incredibility and absurdity. Differences and disparities are so prominent, decided, and immense, that to believe them the result of an original identity is extremely difficult. In studying nature, however, one must never be turned aside by mere antecedent incredibility. Many facts now completely established must have appeared incredible at first, and even now, are practically disbelieved by uncultured minds. We can easily imagine with what contemptuous incredulity the first announcement that it was not the sun that moved round the earth but the earth round the sun would be received. What, for example, would seem more insane

to the untutored and uninitiated mind than the announcement that the earth was supported on nothing, was suspended in empty space. In like manner the evolution theory must not be summarily dismissed because at the first blush it seems ever so unlikely. It would seem indeed that in this case the men of science had some such theory forced upon them by the facts rather than that they wantonly conceived it. For the sake of vindicating my own consistency, I would here remark that evolution by no means necessarily involves materialism. If proof is wanted I can quote Emerson, who, though certainly no materialist, believes in evolution of a kind. He says, for instance—

> "A subtle chain of countless rings,
> The next unto the furthest brings;
> The eye reads omens where it goes,
> And speaks all languages the rose;
> And, striving to be man, the worm
> Mounts through all the spires of form."

In another passage, though when wishing to verify it I did not succeed in doing so, he says, so far as my memory goes, referring to the intense sympathy through which the poet becomes *en rapport* with nature—

> "He hears the poor grass plot and plan
> What it will do when it is man,"

thus going back even to the vegetable kingdom for the origin of man. But the point we wish to get at now is not the general question of the truth or falsehood of evolution, but the bearing that chemical science has on the doctrine. That bearing, we must recollect, can only be one of analogy. Analogies must not be despised, however, though scientific fact cannot be based on mere analogy, for they are often very valuable and significant. In order to furnish an analogy favourable to evolution matter must be resolvable into one simple ultimate element. This it certainly is not, and, as I said before, is not likely to be; indeed it is completely inconceivable that one solitary kind of matter could ever have differentiated itself and assigned to or acquired for its parts new and permanent properties. Hence the chemical analogy threatens continued hostility to the theory of evolution so long as that theory maintains a unity of source for all life. But, again, were the evolutionists to postulate a certain number of elementary organisms, chemistry would seem to furnish a completely favourable analogy. Such seems to me to be the relative attitudes of chemical science and evolutionist speculation.

Although it is very unlikely that on a subject so long known and so well considered as the laws of chemical

combination I should find anything fresh to say, it presents too tempting a topic to be passed over in silence. What did occur to me, however, when I came to look into the wording of these laws, as it is generally given, was that it is not satisfactory. The law of combination by weight is usually enunciated in the form of four distinct laws. On examining these one finds they give not merely the result of investigation but a plan of its order. They stand thus in Fownes' "Chemistry:"—

"1. All chemical compounds are definite in their nature, the ratio of elements being constant.

"2. When any body is capable of uniting with a second in several proportions, these proportions bear a simple relation to each other.

"3. If a body, A, unite with other bodies B, C, D, the quantities of B, C, D which unite with A represent the relations in which they unite among themselves, in the event of union taking place.

"4. The combining quantity of a compound is the sum of the combining quantities of its components."

If it seem to you that it is presumptuous to criticise the mode of statement of these laws, it will, I think, be sufficient to remind you that unlike the three laws of motion,

which may be regarded as models of simplicity, these laws are differently stated in different works (Professor Attfield, for example, improves very much on the usual practice by putting the facts in the form of two laws with a third subordinate law or corollary), and to remark that a man may be an excellent chemist and yet not hit upon the most concise and complete formula for his results. Let us recur to these laws in Fownes' enunciation of them; and read over the first three. The first states merely a result arrived at in an early stage of chemical knowledge, viz. that chemical compounds, unlike mechanical mixtures, are definite and constant in their constitution. The second is meant to convey the rule of multiple-combination. The third shows the steps by which we reach the further condition that a chemical atom has a fixed weight-proportion to the atoms of all the other elements. I submit, and I trust you will agree with me, that these, taken together, do nothing more than complete the notion we have of what the law of combination by weight is. The fourth law, so called, must be held as a natural corollary from the other three, as it merely declares, as might be expected, that compounds act in the same way as elements. But it will be said, if the law be one it must be capable of ex-

pression in a single sentence. If we define, as we may do, a chemical atom as "that moiety of an element which is capable of combining with such moiety or more of any other element," we may enunciate the law of combination by weight in saying,

"That the weight of the atom of each element is a constant quantity, so that elements can only combine with each other in certain constant proportions or in multiples thereof."

To this I would attach a corollary to the effect that "compound bodies behave according to the same law as simple ones, their combining weights being the sum of the combining weight of their constituent elements." It is right to give this last its subordinate position, for it is but an extension without change of the principle of the law, and it is difficult, if not impossible, to conceive how the former being true, the latter could fail to be found valid also.

It must seem to the truly reverent mind a species of profanity to extol or pronounce panegyric on a natural law, as though it were in need of our advocacy and our poor tribute of praise and admiration. But there are those who seem to take all the excellences, beauties, and orderli-

ness of Nature as a matter of course, as to be demanded and expected, but in no degree to be rejoiced in or commended, however perfect; they say virtually to Nature, "When thou hast done all thou art an unprofitable servant." They view the wonders of Nature with the same imperturbable apathy with which the haughty barbarian beholds the marvels of civilized life. He is resolved not to be surprised, not to be betrayed into admiration or wonder by anything he is shown; he imagines that to do so would be to confess inferiority: if he succeeds he is aided as much by his ignorance as by his pride. In order to wonder at or admire a thing it is necessary to understand it partly, therefore the more utter his ignorance the more easily he can stifle those feelings. So it is with those who are impervious to the beauty and order and marvellousness of Nature. They seem to be gifted with no imagination to picture to themselves a different scheme of things that might have been barren of beauty, devoid of order, and marvellous only in the horror of its discord and degradation of its chaotic darkness. Some even consider Nature a bungling dunce. John Stuart Mill denounced certain natural processes as eminently unsatisfactory, and considered that he could have devised something much

superior. We may hope, however, that if plans for a new universe should be required that philosopher may have due warning, so as to give the architect the benefit of his advice.

To you who are all, I trust, of a different spirit, it will not be necessary to make exposition of such a law, as that which I have just endeavoured simply to enunciate, to convince you of its fitness and beauty. So fit and beautiful is it that it seems as though nothing else could have been the truth. It is as sublimely simple as the law of gravitation, though applying to matters much more complex, and we may believe it no less universal. Knowing, as we do, that the same chemical substances as those we have experimented with enter into the constitution of the remainder of the physical universe, we cannot avoid the conclusion that the law that works in our little test-tubes is fulfilled in the furthest constellation. Perhaps nothing is more stimulating to the confidence or self-reliance of the human intellect than a reflection such as this; and, if any be inclined to commit the philosophic solecism of confounding mind and matter, let them consider the antithesis between them that such an achievement as the discovery of a universal law reveals. So far as his material existence

and mere corporeal frame are concerned man is a prisoner of the closest kind in this inconsiderable planet of an insignificant system. The heights to which we can rise above the earth's surface are infinitesimal compared with inter-planetary spaces; they are but as the leapings of a wingless insect. Without bar, or bond, or fetter, we are confined in this air-bound island without hope of escape: one only door of exit is there, and passing that we must leave our corporeal part still captive in the unrelaxing grasp of gravitation. But the mind—it is born free citizen of the universe; it has a speed mocking lightning and light, a power beside which steam and gunpowder are puny indeed. By its spell, sun, moon, and stars are brought near, are interrogated and compelled to answer, perhaps to divulge their history, to betray secrets which bygone æons had seen and kept silence. By its spell also we can behold those things which were once as much removed from our ken by their minuteness as the stars and planets by their distance. Telescope and microscope are matter too, as are our eyes and hands, the materialist may say truly enough without gainsaying; but their whole power and usefulness arise from their construction and organization, the former owing these to the knowledge,

labour, and skill of man, the latter to a knowledge, labour, and skill far higher.

Yet the mind, we must remember, depends for its possession and acquirement of universal knowledge on what may be called moral qualities in Nature. We hear a good deal of declamation against Nature nowadays; she is between two fires, and is eloquently denounced by the Christian, and roundly rated by the atheist. The poet laureate, unfortunately, I think, says—

> "Nature red in tooth and claw
> With ravin shrieks against our creeds,"

and the lines have passed from platform to platform till the author must, one would think, be as sick of the uncouth libel as he deserves to be. There is not time nor fit occasion here for any attempt to vindicate Nature against her accusers. I certainly would never expect to find the chemical elements practising the cardinal virtues or even observing the golden rule. Nor would I anticipate finding among the lower animals a practice of that mercy and justice often so sadly amissing amongst men. This is by the way. The point aimed at is to show how powerless the human mind would be, were it not for the fundamental virtue of Nature. Nature as revealed by science

displays an inexorable consistence and incorruptible veracity. There is no magic, no jugglery anywhere to be found; a result honestly obtained in the laboratory yields a fact true for uncounted worlds. Nature plays the game fairly throughout; never recants or takes back a move; pays her losses promptly, ay, generously. And the qualities she rewards are excellent too. Untiring vigilance and unexhaustible patience, incorruptible fidelity to fact joined with an unclouded cool reason, a lucid strong imagination, and an absolutely fearless loyalty to truth are the virtues that win her confidence. No shrieking to be heard hereabouts then. Rather a wonderful and calm process of culture to be witnessed.

It is time we left this subject, so rife with suggestions for reflection, to consider the second great law of chemical combination, that of combination by volume. This law, while not so universal as the former, nor so well established, presents the relations between chemical atoms in a yet simpler form. It is found, as you may know, that elements in a state of gas usually combine in equal volumes, or in volumes bearing a very simple relation to each other, such as two to one or three to one. It follows from this correspondence of volume that the number

representing the combining weight and that representing the specific gravity of an element is generally the same. Even in compound gases this law holds. But it is ascertained that a compound gas, whatever the number of atoms of each kind that go to form it, occupies invariably two volumes. As soon, however, as we pass from the gaseous to the liquid or solid conditions of matter we find all trace of this law lost, or at least it holds good in so very few cases, and is so completely violated in the majority, that it seems some entirely different principle must prevail in these regions. Still the law is none the less admirable in its supreme simplicity; and as we may regard the gaseous as the free and native state of the elements, it would be difficult to find a more beautiful example of the symmetric impulse which Nature so constantly displays. With regard to these three conditions of matter, the gaseous, the liquid, and the solid, as on all points involving molecular laws, we are as yet very much in the dark. This much we know, however, that the molecular forces in a gas seem repulsive, while in a liquid or solid they are more or less strongly attractive. It is, therefore, no symptom of discord, nor should it be matter of astonishment, that liquids and solids fail to conform to

the laws respecting relations of weight and volume which hold true for gases. We know, of course, that the motion of large bodies in space, such as the planets and stars, is controlled by the force of gravitation, which is believed to arise from the fact that every portion of matter in the universe attracts every other with a force which varies inversely as the square of the distance between them. According to this law, unless some adverse forces come into play, or matter be infinitely distributed, all matter must ultimately be assembled in one immense mass. Again, when the conduct of smaller bodies at the earth's surface is examined into, this same force of gravitation is found in operation, but practically all attractions except that of the earth itself, as a whole, may be left out of account, as the comparative remoteness of the sun and other large bodies, and the comparative minuteness of terrestrial objects in respect to the mass of the earth, make their effect relatively insignificant. All bodies, then, near the earth's surface, may be regarded as under the control of terrestrial gravitation, a force continually dragging them towards the earth's centre. But besides this terrestrial gravitation dragging at every particle, there are, in the case of liquids and solids, molecular forces often capable

of resisting gravitation. For example, if I hold this piece of paper up, every particle of it is attracted downwards, and the reason no particle falls is that the molecular attraction which holds it to its adjacent particles is strong enough to resist the downward force exerted by the earth. It becomes a question whether this molecular force is not the same attractive force which in another phrase we call gravitation. When we consider the expression for the force of gravitation, which is $\frac{\text{Mass}}{(\text{Distance})^2}$, we see there are two ways in which the force may be made as great as we please, either by increasing the mass or diminishing the distance. Now we know that the particles of any kind of matter in a gaseous state are further apart from each other than in a liquid or solid form. We also know that cold and pressure are the two means we employ when we wish to reduce a gas to a liquid or solid, which of course can be done. Both these agents tend to bring the particles nearer together. Does it not, then, seem probable that when the distance between the particles becomes indefinitely decreased, as it must be, this same force will become great enough to hold the particles firmly to each other? The mutual repulsion of the particles of gases

arises apparently not from any change in the direction of this force, but is purely the result of the heated state in which the matter is. In solids and liquids the attractive force is still great enough to retard and limit greatly the repulsive force which heat develops, but in a gas the particles, having no hold on each other, are freely repelled by heat. We have now come back to the point we started from, viz. the different conditions of matter which we called gaseous, liquid, and solid. Unless I have gone hopelessly wrong they are all to be accounted for by the same law of attraction which governs the motion of planets, stars, and systems. What has been said seems to give us some clue to the rationale of the diffusion of gases —a remarkable and apparently anomalous law. But if we regard each gas as in a state of heat, *i.e.* of motion and that of a repulsive kind, it is by no means difficult to see why and how this diffusion should occur. Whatever be the rationale of the law, it is certainly one of the most necessary of all provisions for the preservation of life in this globe, and were it suspended but for a short period, all life would be extinguished. The gases would form separate strata, the carbonic acid would extinguish all animal life which it overflowed, and the

undiluted oxygen would cause the consumption of the rest.

Two topics now present themselves as equally allied to that we have just been considering, viz. the circulation of gases and the phenomena of crystallization. By the circulation of gases, I mean the alternate transmutation by means of which those gases required for the support of vegetable and animal life are in turn prepared for the support of the one by the operation of the other. Thus, as we know, the vegetable world with few exceptions decomposes carbonic acid and liberates oxygen, while the animal absorbs oxygen and gives off carbonic acid; and the one is busy assimilating nitric acid and ammonia, products which the other persistently concocts. I doubt if it be possible for the human mind to conceive an arrangement more beautifully simple or more completely adequate than this. This is one of those laws which, to use Emerson's expression, "come full circle," as we trust finally all will, and which, therefore, is a source of delight and hope to the mind that contemplates it.

The phenomena of crystallization present both to the eye, which beholds the resultant forms in all their precise and polished symmetry, and to the mental sense, which

rejoices in unity and discipline, a field of unmeasured delight. Every flake of snow that floats irresolutely down from the drab wintry sky or drifts with dizzying multitudes over the dim white fields is itself a miracle of crystalline beauty, more graceful and more brilliant than any galaxy of diamonds empress ever wore. The surface of ice is perforated into beautiful patterns, which betray also the secret of its expansion. How these molecules of water acquired this architectic power we cannot say, nor do we yet know the manner and method of its action. Whether the molecules are polarized, or whether molecules of different substances are of different shapes, no one can be said to know. But it matters little to the reflections the facts suggest. We may even agree verbally with Mr. Tyndall, and say the forces producing these results are inherent in the matter, not in matter generally, for matter differs in its conduct. We may say in like manner that the power of thinking is inherent in the mind, the power of loving in the soul. To my mind, the teaching of the fact of crystallization is higher than that of any facts we have yet dealt with: it declares most distinctly the connection of purity and beauty. The tendency of the crystal is to cast out all chemical impurity. Without this

tendency the majority of chemical substances could not be obtained pure. Before a substance takes upon itself its form of permanence, beauty and lustre, it rejects as far as it can all that is foreign. If not successful at first, it will on a second attempt attain nearer to success, and will ultimately purge itself to perfect purity.

It is, however, a curious fact that a *perfectly pure* solution, kept unagitated, refuses to crystallize although concentrated beyond the point at which it usually does; but the moment a foreign substance is introduced, the whole becomes a mass of crystals. It is like some perfectly organized community that remains on a peace-footing to the last moment possible, but immediately offence or invasion is offered, becomes transmuted from a people into an army.

Enough has now been said, in view of what will be suggested by what we shall meet with in other natural domains, to vindicate Nature and her laws from some of the aspersions cast on them, and to show that in them, in their Mosaic dispensation, there is some prophecy of that morality and those virtues that become conscious and declared only in man. I have at least endeavoured to point out to you, as they appeared to me, the bearings of the

science of chemistry on thought, and especially modern thought. We have considered laws of great beauty, simplicity, and fitness, and we have met with facts pregnant with hope and awe-inspiring significance. We are not, I would believe, of those who fear free inquiry; we claim a higher faith than theirs, a faith that, holding it wiser and more manly to wrestle with difficulties than to avoid them, is content to struggle and suffer, doubting not the final issue of the contest, and yet content for truth's sake to risk all.

II.

OF BOTANY.

Matter and Force—Phases of Force—The organic or vital—The cell—Nature's legerdemain—Darwin's Darwinism; its weak point—Science *formally* atheistic—Functions of science and philosophy—Our view of evolution—Lower forms of vegetation—Their functions in economy and ornament—Faculties of the root—Vegetable instinct—Root-form—Beauty *versus* Darwin.

IN resuming our subject I would ask you first to look broadly and generally on the contents of the universe, and mark the two great divisions into which the whole may be divided. They may be denominated Force and Matter. But let us at once guard against the crude error of supposing that because these two between them embrace all phenomena, that either of them is necessarily homogeneous, so to speak, that is, that either all force or all matter is the same in kind. They are mere generalizations, and are incapable of definition or conception apart from each other. Force is that which moves, changes, constructs, organizes, animates matter; while matter is

that which is moved, changed, constructed, organized by force. Force acts, matter is acted on. Force is the active, matter the passive. Let us bear in mind that at this point we have attained to no knowledge regarding either force or matter, but have simply agreed to use these two words as equivalent to the active and the passive states of being in the universe. It is just like the beginning of a sum in algebra, when we write down—Let x = so and so, and y = some other thing, both unknown for the time, and only ascertained at the conclusion of the problem. We cannot go further back and define either force or matter more simply. It cannot be said that matter is that which is perceptible by our senses, for apart from force it is not perceptible. So at the outset we must content ourselves with agreeing to make force stand for all the active, and matter for all the passive.

There are a series of relations between force and matter, which by the nature of things and the constitution of our minds we are compelled to regard as distinct. The lowest and most universal we must style mechanical or dynamic, though the phrase is not specially happy. All matter is subject to, and is even to be regarded as constantly under the influence of this mode of force.

Newton's announcement of universal gravitation referred to this moving or mechanical force as existing between every particle of matter and every other, and drawing them together by a force inversely proportional to the square of their distance. Molecular force may also be classed as mechanical, and indeed, as I suggested before, may be absolutely identical with gravitation. The definition of this force authoritatively given is "that which produces or tends to produce motion." Under the spell of this force every particle of matter animate or inanimate lies. But it will be clear to you that such a definition does not apply except in an indirect or metaphorical manner to all force, so although this force is universal it is not the only one. Indeed the next mode of force we come to consider is also universal, though not constant in the sense that gravitation is; it is known as chemical. Now, if we may regard gravitation as the *constant* force possessed by each particle in common with every other by virtue of its being in some respects *identical* in quality with all these, chemical affinity must be regarded as a *varying* force possessed by each kind of matter by virtue of its *differing* from other kinds. No chemical affinity exists between substances chemically identical. Instead of like

drawing to like it is unlike to unlike. This, I think, is as near as we can get to a definition of chemistry or chemic force. The one may be called the study of the differences of matter, the other that force which binds the different kinds of matter together. Hence chemical affinity is a very distinct phase of force to the mechanical or motor, represented by gravitation. Before proceeding to the higher modes of force, it will be well to note a mode which seems to take rank between the chemical and the organizing, and still to bear a relationship to the mechanical; it is the constructive or crystallic, which arranges matter into definite forms, and is for inanimate matter what the organic is for vitalized. It represents Nature's primal effort at definite and beautiful form.

Those forces or modes of force which we have already noted are those which influence all matter, whether animate or inanimate, dead or living, but that which now comes to be treated of is peculiar to living or vitalized matter. And here, it must be admitted, lies no small difficulty, for in living organisms both mechanical and chemical forces are constantly at work, so that it becomes frequently a very perplexing point to decide whether certain phenomena are due solely to chemical or mechanical

agency, or are to be attributed to a special vital force. While the attempt is constantly being made to explain all vital phenomena on purely mechanical and chemical grounds, it may safely be said that such attempts, however far they may have seemed to succeed, have never attained anything like complete and permanent success. I will, therefore, make bold to assert that neither chemical nor mechanical force, nor the two combined, ever yet produced an organism. It will, therefore, be the most distinctive title to confer on this phase of force peculiar to living matter if we call it organic, meaning by that term the force which forms and maintains organisms. It is usual to divide these organisms into two classes, vegetable and animal, although there is no doubt that primitive organisms are so slightly differentiated that it is a delicate task to assign some of them their respective class. For the present we shall confine ourselves to the consideration of vegetable organisms.

In vegetable life the simplest organism is the *cell*, which is to botany what the atom and the particle are in chemistry and dynamics. A plant may be said to consist of one or more cells; when matter is organized into a living cell that cell is a plant (or animal). There is

sometimes a distinction made between cells and vessels; but it seems to me an arbitrary and dangerous one, for it is quite impossible to mark the point where the one passes into the other, and the best authorities seem to agree in regarding the so-called vessels as modified cells. It is, therefore, perfectly correct to say that a plant consists of one or more cells. The characteristic of a cell is that it has an inside and an outside, an envelope, and something enveloped, unlike the particle and the atom, which are conceived of as solid and homogeneous. Let us consider, then, this cell as it exists in its simplest and most primitive form, a new-born being amid dead deserts of matter, a plant complete in all its functions, and yet but a tiny bag of matter without a single defined organ. We would fain surprise this marvellous entity at the moment of its making; catch, as it were, the maker or makers tool in hand. We are anxious to know the receipt for this genuine elixir of life, and we shall be, I suspect, like the alchemists of old, for ever on the verge of its discovery. Scientific men are not even agreed as to whether this organism can arise spontaneously, as it is called, or whether germs must be present before the plant can be produced. Whichever way it be, the wonder, the miracle is the same.

Nature seems smilingly to confront us like a confident and accomplished *prestidigitateur*, when he says to the audience, in regard to a trick he has just performed, "Oh, it's quite simple! That's how it's done!" and no one is a bit the wiser. So Nature's miracles are worked before our eyes and she seems to say, "Oh, I've no secrets, no concealments, I assure you! That's how it's done!" and we gaze at the proceeding up a telescope or down a microscope, and rub our eyes exactly as wise as ever. Yes, this simple cell marks an era in creation; it is the tiny ancestor of all plant-life. That from so simple and apparently insignificant a beginning the whole of the plant system, from the lowliest lichen that grains the bare boulder with silver, emerald, crimson, and ebon, to the stateliest mountain pine and the delicate sweet-breathed primrose of the wood, should have been slowly evolved throughout the patient centuries, ere eye of man beheld them, seems an idea so stupendous as to be almost incredible. Yet it is an idea not degrading nor humiliating, not irreverent nor revolting, but sublime and solemn and beautiful. Its contemplation bows the spirit down with a sense of infinitude, akin to that we experience as we gaze upward on the countless companies of stars, and strive to realize some-

what their magnitude and distance, till the mind falls back abashed from the enterprise. Equally impossible is it for us to trace in imagination those gradual and imperceptible mutations, those insidious invisible changes by which this astounding evolution has been accomplished. In all this there is for the mind, though at first inclined to start aside from the apparent incredibility of the notion, a fascination almost irresistible. For this conception of the history and origin of vegetation appeals to two of the strongest, though seemingly antagonistic, mental instincts of man, the delight in the marvellous and the passion for simplicity.

From what I have just said it might be expected that I should declare myself an enthusiastic Darwinite. But I am not. I have read a great part of Mr. Darwin's "Origin of Species," and although he certainly does remove many apparent objections, brings forward much that tends to show that great modifications have taken place in structure, and that the difference between species and variety is chiefly in degree, and has gallantly assailed several very formidable difficulties in the way of accepting his theories, still on the whole there is very little that is conclusive or quite satisfactory in the work. But this should not

occasion surprise, nor should it be considered derogatory to Mr. Darwin's merits as an investigator, seeing how vast is the field he has undertaken to explore, and how extremely fragmentary and imperfect is the record we at present possess of the past history of our globe. He is continually compelled to pull up short with the admission that too little is known to warrant conclusions. But there is about his writing a conspicuous candour in admitting the magnitude of the difficulties his theory encounters, while at the same time he vigorously defends his position. The main points in his favour are these: the extensive modifications producible on plants and animals under domestication with artificial selection; some remarkable cases of reversion in various breeds to certain characteristics of a common ancestor; the close anatomical similarity in particular points observable in creatures of extreme diversity; the existence of rudimentary organs; and last, but not least, the absence of any definite opposition theory on an adequate scientific basis. The weakness in Darwin's Darwinism seems to me to lie in the insufficiency of his great factors, the struggle for existence or survival of the fittest and sexual selections to account for all forms of life. I will not attempt at present to go into details, but must

be content to observe generally that the survival of the fittest is a most objectionably elastic phrase, which sometimes comes to mean merely the survival of the survivors, and as regards sexual selection, to which Mr. Darwin attributes so much, while he has shown the operation of the principle he has forgotten to account for the origin of the instinct for the beautiful thus assumed as existing in animals. If the above statements as to the present condition of the controversy are correct, it follows that while a strong case may be made out for evolution as a fact, the Darwinian modes of accounting for this fact have not as yet proved themselves efficient.

Assuming the foregoing to be valid, I would proceed to strengthen the case for evolution (considered as a fact) by pointing out the notable analogy between life generally considered as an evolute, and the origin and history of the individual life. If it is thought incredible that in the course of long ages the various forms of life should have been developed from a small and simple origin, is it not equally incredible that a highly organized plant or animal can be evolved from a minute spermatazoon or seed in the space of a few weeks or months? Yet we contemplate the wonderful birth-evolution daily without surprise, be-

cause it has become so familiar and is, indeed, so universal. Nor does the use of the term evolution, in regard to the genesis of the individual, lack some confirmation from clear fact, for the embryo does in a manner seem to pass through evolutionary stages, and the embryos of widely different species, even belonging to different classes, are at some stages indistinguishable. Evolution is, indeed, but the generalization or fulfilment of the dictum, *Natura non habet saltum*, wherein lies the alpha and omega of physical science. Whoever admits this maxim to be universally true is not only entitled but committed to a belief in evolution, whatever cause or causes he may have to assign for the phenomenon. If there have been no leaps or breaks in Nature, either in the present or the past, creation has been an evolutionary, gradual process, as all growth is, and not a series of creative efforts after which the creatures produced were, so to speak, left to take their chance. It is extremely unfortunate that the term creation should have become so narrowed in meaning as to be applied only to a sudden instantaneous calling into being of what before had no sort of existence. From this it arose that Mr. Darwin, while able as a man of science, was too little of a philosopher to avoid the use of this

word in this very sense. Thus, in his anxiety to avow his deism, he banishes the action of his Deity to a remote period of the past, leaving Him as it were at the very verge of His own universe, in such a position, too, that He must recede continually before the advance of science. That Mr. Darwin by no means intended to leave the deistic idea in this perilous position may well be believed; it was his ill-timed zeal in giving his bow of belief at the end of a volume which he could not but be aware was of an atheistic flavour, that did most of the mischief. His followers have seen the weakness of his position, and have many of them gone on to atheism. Now I trust I shall not be misunderstood, but that you will bear with me till I have fully explained myself, when I say that science must always be in a sense atheistic. By atheistic here is meant not what denies deity but what leaves it out of account. Science, so far as it seeks to pierce to causes and not merely record and classify facts, seeks only the particular, finite, intelligible, or secondary cause, and has no concern with the universal, infinite, or first cause. When, for example, we say to a child that God made such and such a thing, we give the child no scientific information whatsoever, though we impart a religious truth. If,

however, we proceed to give a scientific account of its origin, we find ourselves unable to exhibit the deity as acting in the matter, except at the point where our knowledge of particular causes ceases, when we are reduced to a simple acknowledgment of ignorance or reference again to the deity as an immediate agent. Here there is apparent the necessary and inevitable antithesis between the religious or theologic and the scientific aspect of Nature. Now this fact that of necessity science must look at things from the atheistic standpoint deprives its apparently atheistic drift of all final significance as militating against a belief in the deity. For it only arrives at the point from which it started. Having assumed the causes of phenomena to be finite, intelligible, natural, it comes back with the same belief; for time and space, the great magicians, work the miracle of breaking up the infinite into an infinity of finites, each intelligible in detail. Still the true province of science is not the discovery of the ultimate reason or cause of phenomena; its true function is to observe, discover, register, classify, and accurately denominate and particularize phenomena; the other is the function of philosophy. And the simplest way of discriminating the aims of these two is to say,

philosophy seeks an answer to the question, Why, by what cause and for what reason is a thing so? Science asks merely, How, in what manner, by what stages does a thing become so? Philosophy seeks to comprehend, science merely to know. Science must thus invariably form the material to which philosophy seeks to give shape, or the substratum or foundation over which philosophy builds. We are rather apt to imagine science to be a modern growth, whereas in fact it begins with the beginning of man, being at first small in the number of facts known and almost devoid of classification. But the veriest savage knows a certain number of facts, and has probably discriminated them into classes in his mind, and this is as much science in *kind* as the works of a Faraday. This, no doubt, is putting an extreme case; but when we are told that Solomon knew every plant, from the cedar to the hyssop, it is clear that he is entitled to be called a scientific man (however little we may know of his system of classification) just as much as a Darwin or a Huxley. Upon his science, then, whether it be the few and ill-assorted facts of the savage, the extensive acquirements of a Solomon, or the great and carefully classified information of a modern scientist, does a man found his rationale of things, in short

his philosophy. The distinction thus indicated is highly important in this regard, that, as the functions of science and philosophy differ, so also do the mental faculties which they call into play and require for their prosecution. Hence a man may distinguish himself in science and yet prove a mere tyro and blunderer in philosophy, while another, ill-adapted for laborious observation, calculation, and experiment, may wield the results of science in a masterly manner to philosophic ends. The requisite faculties and tastes for both might be combined, it is true, but we must bear in mind that the probabilities are greatly against such a combination, and therefore should be chary of accepting the attempted philosophy of a scientific man, as though it were necessarily of authoritative weight. In the converse case the warning is not so necessary perhaps, as a philosophic writer usually prefers reference to acknowledged scientific authority to original investigation. By all means let science become as powerful and perfect as she can, but let her not be suffered to lay on our souls the yoke of a coarse and mechanical philosophy.

Before we leave the consideration of the evolutionary hypothesis as a general scheme, I would like to state as

clearly as I can what my own conception with regard to the creation or origin of the physical universe is, in order that you may perceive the drift of my remarks. Of course it is merely an individual opinion or belief, the result of the interaction of my individual mind and the facts which have been laid before it. It is best expressed by saying that I conceive the becoming of physical phenomena to have been evolutionary as to mode, but miraculous or divine as to cause. To illustrate more definitely I would say, that if a human being had awoke to intelligence and consciousness at any period of the creative process, howsoever remote, and had been a perpetual witness of it up to the present time, it would have presented to his mind a series of gradual changes and imperceptible mutations as apparently natural as the aspect of nature we now ourselves perceive; but, at the same time, that the process thus perceived was not automatic, still less accidental or tentative, not the result of a fortuitous concourse of atoms but the work of the supreme and eternal Power of whom it has been sublimely said that with Him "one day is as a thousand years, and a thousand years as one day." Such a creed appears to me to include and sublate in itself the theologic and the scientific creeds,

and in this position the mind may abide without any fear that new facts or novel theories can imperil its security or invade its peace.

Let us now revert from these generalities to consider more in detail the phenomena of vegetable vitality, the manifestations of vital force. In doing so, we naturally commence with the lower phases of plant-life. Now there is a certain modern school of philosophy, if it be worthy of that august title, which is so eager to exercise a destructive dialectic and disintegrate thought into an irrational chaos, that its exponents might cavil at the use of such terms as lower and higher, and demand at the outset a justification of their employment. Let it be remembered, then, that we are men, and as such, either really the highest visible phase of being on the earth or, at the lowest, are compelled by some inherent conceit to think ourselves such. The main characteristics of man are that he lives, thinks, feels, wills. Inanimate matter is incapable of any of these actions, and thus stands as the antithesis to man at the bottom of the scale of being. Between the two extremes there are a series of delicate gradations. That, then, which is further from man by defect of these powers and nearer to mere matter, we are

justified in calling lower than that which approaches man in these faculties. If we add that in man the functions are more specialized, we shall be in a position to arrange creation in its true order. There are no doubt many cases in which it might seem difficult to balance claims. It might be pleaded that an oak is higher than an earth-worm or some low parasitic form of animal life. But we are, nevertheless, justified in saying that an animal is higher than a plant, because an animal can be produced possessing faculties more nearly approaching the human than any plant does. It is perfectly legitimate, then, to class all flowerless plants, *i.e.* those which do not specialize their reproductive organs, as lower than flowering plants, and also to assign to what are called cellular plants a lowlier position than those exhibiting a varied tissue.

There is no objection, then, to our calling, as all scientific men do, the *Algæ*, *Lichenes*, and *Fungi* the lowest orders of plants. It is remarkable, with regard to the two former, on what a slender and hard fare they seem able to exist. Well fitted do they seem to be the first hardy colonists of a naked planet, while as yet there was no true soil formed, and the one had to bivouac on the rude boulder and cliff, and the other fastened upon the

submerged rock, the first missionaries of life to a sterile land and a barren ocean. The one to weave with lithe green arms the wondrous labyrinth of submarine vegetation, the haunt of forms of strange beauty and horror, as though they were not meant for the gaze of man; the other working humbly, and, it would seem unselfishly, by insensible accumulations preparing the place for another till it dies the victim of its own industry, and yields to a workman the modest Moss, more active but hardly any prouder, building itself up by its own decay, and yielding with no less pathetic self-surrender. Beautiful is it to observe these two still at their silent labours, covering with secret assiduity the nudities of Nature, or borne on the great trunk or limbs of a forest-tree whose life their bygone generations had laboured to make possible. To the *Fungi* seems to belong, in the main, the less noble function of promoting and flourishing by the decay of organisms higher than themselves. Some indeed appear of purer instinct and sweeter feeding, as the creamy-skinned mushroom with its dainty flesh-pink gills; but for the most part the fungus is a minister of decay and corruption. On the dank and moribund tree-stump its blackened, rot-bringing ridges extend; it squats in dark

hollow of the fated trunk, curling its cancerous lip, as though it were some imp of corruption leering in malign pleasure over its anticipated triumph,—at once the slow assassin and the sexton of its nobler fellows. Still it is as much the servant of Nature as others of gentler office. So long as an organism can attain its vital activity, and thus keep on duty, as it were, the matter it has absorbed into itself, Nature seems to lend willingly enough. But as soon as the vitality flags, Nature with stern economy demands back the loan, and despatches her certain ministers of decay to restore it again to her bosom. From this view of the diverse functions of these classes of plants it will be amply evident that either the *Algæ* or the *Lichenes* must be the primal order of vegetable organisms, because there must first be life before there can arise that mode of life which subsists by decay. One might expatiate long on the variety and beauty of these humble ranks of plant-life. It would be difficult to over-estimate the precious effect of the *Lichenes* alone in adding to the delight we reap from the appearance of natural objects. Even in looking at a wide landscape we must always owe somewhat to these lowly artists. On the boles and even the branches of the trees, and on ruin, cottage, fence,

wall, and boulder, they have been at work, and with their silvery whites and greys, cool greens and bold blackness, must have greatly assisted in producing those subtle harmonies of tone and colour which delight our æsthetic sense. By this agency it is that the artificial structures of man are reconquered into the realm of Nature. And if we look more closely every stone appears a study of colour and of blending arabesque outlines. To the *Algæ* also, apart from the strange splendours of submarine vegetation, we owe much of beauty that is visible from the land. To their presence, I apprehend, is partly due that play of shoaling colours, mainly green and purple, near the shore, which is one of the most brilliant and gorgeous aspects of the sea. Such are a few mere random hints on an extensive subject.

It is both according to the natural and the acknowledged order that we now proceed to consider the *Filices*, *Equisetaceæ*, *Musci*, and *Lycopodia*, the Ferns, Horsetails, Mosses, and Lycopods. Here first of all we find the plant aspiring to rear itself above the earth, and it is significant that, in order to do this, it also descends into the earth. The stem and the root appear simultaneously, and seem to involve and imply each other. Hitherto the func-

tions of nutrition and assimilation have been carried on by the general surface of the plant, now a certain portion is directed downwards in search of nutriment of one kind, and one directed upward to reach influences and support of another kind. The former we call the root, the latter the stem. The plant in this stage is more individual, more distinctly a vegetable *ego* or self than in the lower forms, and asserts more clearly its vital properties. The root exhibits faculties separated from anything merely mechanical or chemical by an impassable gulf, faculties such as its selective power, which is thus described by De Saussure: "Each plant can take up from the soil a different amount of each substance contained in it, even though these substances should be all in the same proportion in the soil originally; in other words, roots have a selective power, and only take up what is necessary to life, and that too in the proper proportions." And the proposition that this power is super-mechanical may be maintained even in the face of such ingenious suggestions as that of the same author, who contends that the preference of a plant for one substance before another in the same liquid, is due to the different degrees of fluidity or viscosity of the different substances; so that the roots of

plants are filters of the most perfect and delicate description possible. This will not do; for it is surely incorrect to conceive of a liquid containing different salts in solution as consisting of solutions of differing degrees of fluidity and viscosity. This viscosity depends on the aggregate of the dissolved substances, and is constant throughout the liquid when solution is perfect. Besides, if this theory were the true one, the proportion of the substances taken up would vary inversely with the amount in solution, which it does not do. Filters in a sense the rootlets are no doubt, because, like filters, they allow no solid matter to pass through them. But solid matter is not concerned in the question, since it is never taken in by any plant at all. Unpalatable, then, as it may be to the scientific mind, it seems to be an inevitable conclusion, that this discriminative faculty is more nearly allied to a sense or instinct than to a purely mechanical arrangement. Nor need the fact that a plant will absorb energetic poisons invalidate this conclusion, seeing that, apart from the probability that the poison first destroys the sensibility of the surface before it is absorbed, it is a strong characteristic of what we term instinct that it is not equal to unusual emergencies, but invariably fails

before them. Vegetable instinct, also, is doubtless very dim and dull in comparison with that of the higher animals, who, it must be remembered, possess also thought, but it is also wonderfully adequate to its own ends. It is surely much more scientific to describe such properties as this, and that of storing up in summer supplies for autumn use, as vegetable instincts, than to attempt to reduce them to mechanical contrivances. With regard to this economic and provident instinct which roots display, the exponent of the survival of the fittest would doubtless argue that those which stored up had an advantage over their competing fellows, and so the practice was increased and perpetuated. This will not, however, account for the fact: for, if we suppose, as the Darwinian would, that some of this supply was stored up by a chance in one root first of all, it would be of no use to it, unless there arose simultaneously the faculty for using this supply, the power of performing the necessary transmutations, and this power cannot be supposed to have been pre-existent to the necessity for it, and could hardly have sprung into existence by a mere varietal freak, just when wanted. In such attempts as the above example to reduce the progress from lower to higher forms to an

automatic and necessary process, and which is the stock form of argument with the Darwinian school, the aim seems to be to get rid of the notion of contrivance and design and replace them by the notion of adaptation. That this vital elasticity or power of self-adaptation exists there can be no reasonable doubt; we see it in the hardening of the mechanic's hand and in a hundred everyday circumstances. What the Darwinist with his lack of metaphysical acumen fails to see is, that this very adaptability is itself the most perfect of contrivances and the deepest of designs. And this elasticity, this principle of yielding within certain limits, is a universal one. Nothing is absolutely rigid. The stone or piece of hard metal yields to the pressure of a finger enough to be ocularly demonstrable under the microscope. The mechanical elasticity of dead matter consists in the power of both yielding and resuming its form when pressure is removed. Vital elasticity, or the adaptive power of organisms, consists in the faculty of recovering from a temporary disadvantage by a change which meets the fresh exigency and even turns it to advantage. This is obviously distinct from and an advance upon the other. But here we are getting too far afield into the general question, and must return to the

special point under consideration, which was the selective sense exhibited by the roots of plants. In addition to this sense, as it may best be called, the roots of plants show also an instinct for method and symmetry. In proof of this I will quote the summary of Clos's discoveries on this subject, given in Brown's "Manual of Botany:"—

"The regular arrangement of the radicles is chiefly observed in the young plant, and gets less and less apparent as the plant increases in age. All the radicles in every root are produced one above the other, so that they appear in the form of longitudinal lines. However, in certain cases the lines follow an oblique and not a rigorously vertical course. This Clos calls 'the Law of Superposition.' The number of these longitudinal rows is fixed and determined either for the plants of the same order or for those of the same genus, or at least for the individuals of the same species. The rows are separated from each other by equal spaces: in number, according to the vigour of the plant, from two to five, the latter number being rare."

By such facts as these the supposition of some dull-witted scientist that the radicles come through just where the epidermis happens to be thinnest, at the points of least resistance as he phrased it, is shown in its naked and

native absurdity. No doubt the radicles come through at points they have power to come through, but that is surely no discovery. It is also certain that the root, in contest with an obstructive soil, gets warped from its symmetric ideal, so to speak. Nevertheless, I believe, though of course it would be a point very difficult to establish, that even in adult roots there exists a subtle and complex symmetry on which the eye reposes with pleasure, though the mind cannot completely analyze the concurrent sources of the effect. Whether it arise from this original arrangement of the rootlets from their truly graduated tapering, their wayward, yet balanced, division, their suave or sharp flexures; from a conspiracy of all these or from the suggestion of a delicate and discerning energy, this to me is a matter of experience that an accurately drawn engraving of a root yields generally a pleasant sensation to the eye. Here, then, we discover in a plant-root, delving arduously for nourishment in a resisting soil, a dim aim at and instinct for beauty, which, how unconscious soever it be, links it with the loftiest achievements of the sculptor and the architect, exhibiting, as it were, the signature of the same Spirit who appoints to the planets their pathway and controls the course of suns and systems.

At this point it was, when we first encountered the root as a distinct organ in plant life, that it appeared opportune to enlarge somewhat concerning its structure and function. It would not be so convenient here to make any general comment upon the stem and its function, both because the subject is a larger one, and because it is in this part of the vegetable kingdom in what we may call an early and imperfect stage of its development. It will, therefore, be a preferable course to take a general view of those classes which were mentioned as succeeding to primitive ones in superiority of rank. The moss, as was said before, succeeds to the lichen. This process we can see going on before us. The one is the forerunner of the other, and prepares for its support, as certainly as though consciously aiming at that end. For the under surface or root-face of the lichen has the power of slowly disintegrating the stone it grows on, and in course of time by absorption from the atmosphere and from elements acquired from rains, and other sources of moisture, and finally by the decay of the lichen itself, a soil is prepared capable of supporting a moss. Nor does this moss exist for itself alone. By its method of growth, which Mr. Ruskin has lovingly discovered and described, it accumu-

lates by the decay of its lower leaflets a deep rich mould, wherein it flourishes, but wherein in due time alights also the spore of the fern, which declares itself heir to the legacy of the moss. Such may the historical succession of plants, even on one spot, be ascertained and observed to be. These lowly mosses and lichens are the true elves and fays of the wood, decking it with delicate tissues from their secret looms, dyeing it with sweet and brilliant colours in their viewless vats. Benign sprites they are and innocent, though they possess the power of ploughing the rock and reaping the stone. How the moss seems bent on padding and cushioning the hard stone, lest even a falling bird should be bruised thereon! If it had but its way, earth would be carpeted till silent to the tread as a mosque. Nowhere throughout creation do we find a finer, more exquisite workmanship than among the Mosses. We call them velvet only because we can find no better and fuller expression. Who has not seen slanting sunlight enfilading a moss-grown wall, striking the myriad tiny stems of the moss into lustre as of silk and splendour as of burnished bronze, till the old wall seems transfigured in a glory of chrysophras? Such sights seem to unveil for a moment the divinity of the

universe: yet some would have us believe that these things were in no wise made for beauty nor for the delight of man.

Perhaps it may be thought that this last sentence implies a libel on those at whom it is aimed, but the following quotation from the "Origin of Species" gives it ample justification. Mr. Darwin says of "some naturalists" who object to his utilitarian doctrine, "They believe that many structures have been created for beauty in the eyes of man, or for mere variety. *This doctrine, if true, would be absolutely fatal to my theory.* Yet I fully admit that many structures are of no direct use to their possessors." Here, with a resolution almost dogged, Mr. Darwin places his back against his utilitarian theory, and stands grimly at bay against every admirer of Nature and votary of the beautiful who may gather together against him. The very audacity of the position must embarrass his opponents. It is like a man stepping out into the blaze of noonday, and declaring there is no sun. What bystander would attempt argument? That natural objects are for the most part beautiful, is a proposition that can hardly be denied, and will be most enthusiastically affirmed by those who have most closely studied Nature

from the æsthetic or artistic standpoint. If, then, we are to agree with Mr. Darwin, we must suppose that all this beauty has arisen incidentally and accidentally, without design or purpose, and this supposition is surely all but absolutely incredible. The truth is, and this is what misleads a one-ideaed observer, that in the architecture of Nature, as in that of man, the useful and the beautiful are indissolubly connected. Discover, if you can, the most thoroughly convenient and serviceable form for any article, and depend upon it it will also be the most truly beautiful. We must not of course confound the ornate with the beautiful, or the ugly with the simple. Ornament is but an apology for the lack of that beauty which a completer fitness and finish would have bestowed. True is it that beauty unadorned is adorned the most. The human figure as we have it idealized in the marble of the sculptor is more beautiful than any costume can make it. Take also, as another example, that vessel best fitted, by avowed means, for traversing the ocean with safety and with swiftness. Look at a clipper-yacht running before the wind or cunningly slipping up sideways against it. As a study of clear and sweet curvage, sharp and clean meeting and crossing of straight lines, and grace of motion

nothing out of Nature itself can excel it. So in Nature fitness, which is here but a synonym for usefulness, goes hand in hand with beauty. But still Nature evidently regards beauty also. If not, why so careful the external aspect of an animal should be so much more seemly than its internal? Why should plants hold aloft their flowers, as though in triumph at their own beauty? Why should —but one might ask many such questions. Suffice it to say that if Darwin stakes his theory on such an issue, and he avowedly does, the first snowdrop of spring shall confute him and the lowliest daisy look denial to his face.

And now, although so little of my subject is exhausted, it is time for us to draw it to a conclusion. I have endeavoured to point out and illustrate the different phases of force manifested in the external universe. After a brief notice of the mechanical and the chemical we proceeded to the organic, which has since engaged our attention, and it will be always out of our province here to refer to those higher phases which are called mental and spiritual. Already we have, I think, seen sufficient evidence to warrant us in maintaining the position that vital phenomena are distinct in kind from mechanic and chemic, and cannot be regarded as

the product of one or both of these. I have given you my opinion on the state of the great evolution question, to the effect that while the earth does seem to have arrived at its present condition by a gradual process, this process has not been satisfactorily accounted for by the automatic theories of Darwin and his followers. We then began to pass in review some of the lower orders of vegetable life, and marked their offices in preparing for higher forms or assisting their decomposition, and the utilization of the materials of which they were built-up. Thus we saw that although in one view each organism struggles to maintain itself, yet whether wittingly or unwittingly, it subserves nobler ends and paves the way for the approach of higher forms. We saw also that dim instincts for order and beauty exist even in these lower organisms, and that the aims are attained to a remarkable degree. But, while yet occupied in tracing the beginnings of these vegetable aspirations, we find our allotted space of time is nearly exhausted. So for the present I would leave the subject, trusting that through your indulgence I may have another opportunity of pursuing it. But ere I release you, in case no other occasion should come, I would like to say that I fear there is little really

fresh in thought in this paper. I am very largely indebted to the influence of other minds. To the American philosopher Emerson, and to our Scotch philosopher Dr. Hutchinson Stirling, I feel I owe largely, less perhaps on this occasion to the former than to the latter, who has made more energetic and effective attacks on the mechanical and materialistic schemes of modern scientists than any writer I am acquainted with. For matters of fact I had recourse to what I considered standard authorities.

III.

OF BOTANY.

Automatism—What an automaton is and what is not an automaton—Nature vital throughout—The Fern, heir to the Moss—Nature's art—Ferns, the classics of the plant-world—Improvisation of Stem—Sentiment; its validity and the method of estimating its value—The creative prelude—Is Nature both miser and spendthrift?—Our Thermopylæ—The Leaf, an unsuccessful explanation—Fitness and beauty of Leaf-forms—Nature's aims—Creative evolution.

IN my last paper I submitted to you some reflections which had occurred to me when contemplating those facts which the science of botany makes known to us. The reflections I had made and the arguments deduced from them tended to combat and refute the views of certain eminent scientific men, whose philosophy may best be denominated Automatism. Broadly stated the thesis of this school is that the universe, especially the physical universe, is self-acting, self-evolving; that no external control, no guiding intelligence, no creative energy beyond the necessary and inherent properties of matter are required

or have been engaged in producing the present state of things. That this Automatism is characteristic of their whole scheme is shown by the fact that they push it forward even into the very highest ranks of being, and invite their followers to consider not only plants and animals, but man himself as automatic. To the uninitiated common sense of mankind this seems arrant folly, yet to those who would be our teachers it appears to be the supreme wisdom. The error, as I deem it, into which these philosophers have fallen has arisen in a manner sufficiently simple for a youth, if not a child, to understand. The proposition that man is an automaton is precisely as true and yet as incomplete as a description of man, as a hundred other assertions that could be made. Man is a heavy body, man is a locomotive being, man is a biped, man is a mammal, etc. etc. Each of these propositions embodies a truth, but not the whole truth; and it is the same with regard to the statement that man is an automaton. Man, regarded as a mechanism, is an automaton, the most wonderful ever yet produced; he *goes by himself* more completely than any other machine can be said to do, is more thoroughly automatic than any other automaton. But regarded from other points of view, the

term automaton ceases to be applicable. Thus to say that a man thinks or loves automatically is either a contradiction in terms, or is merely equivalent to saying he thinks or loves. For an automaton is, by our very notion of the thing, *a machine capable of accomplishing through some physical impetus an action or movement which in the first instance it required conscious intelligence to perform.* That instrument is not automatic which is, like a spade or hammer, directed immediately by intelligence; but that which, like a reaping-machine, dispenses with this intelligent direction in part, is so far automatic. Thus by its very notion and nature an automaton opposes itself in meaning to any conscious being: if conscious, it is not automatic; if automatic, not conscious; and yet we are presented with the phrase *conscious automata,* which are phenomena just as likely to exist as solid liquids or hot ices. So the theorem which those of this school are committed to maintain is that animals, *i.e.* conscious beings, are also automata, *i.e.* unconscious machines, for other meaning than this for automata the usage of the language disallows.

This, so far, is by the way and introductory, intended to elucidate my own position by means of defining that to

which it confronts. For the difference between our views is exactly analogous to the difference between an automaton and a living being. Nature from their point of view is a huge automaton, started somehow at some time, and threatening eventually to run down and stop, hanging thereafter through eternity idle and impotent as a rusted and disused water-wheel over a channel deserted of its once forceful waters. To me Nature seems vital throughout, instinct to the minutest particle with immortal energies, not in the same sense and degree vital in all parts, any more than the human frame is equally vital in its parts, yet nevertheless a living whole, not devoted to dissolution, but destined to eternal existence and everlasting growth. In thus regarding Nature, it is hardly necessary to say I do not confine my regard to Nature in its narrower sense. The Nature I refer to includes man in all his faculties, and will include higher beings that may succeed us, or which may already exist; and this, I do not hesitate to assert, is the truly philosophical notion of Nature, that which by virtue of its very breadth escapes the errors into which less extended conceptions of it are constantly leading men. Nature in this sense is identical with fact, reality, whereas in its narrower senses it

corresponds only to certain classes or groups of facts, or to facts viewed in some special relation. As, for example, *Natural* Philosophy is a purely physical science, and Natural History a zoological one; with one poet Nature means external non-human nature, with another the original forces, impulses, and desires seated in man. These and many other uses of the word are legitimate and even necessary, but we must be careful to mark in which sense we are using it. For now we are about to continue an appeal to Nature, and, directly, only to a certain class of natural facts; but we intend to bear in mind that the Nature to which our appeal is embraces many departments, and of these that to which our attention is directed is but one. Thus will we guard against becoming materialists, because we happen to be considering a physical subject, as in the converse case we would fortify ourselves against falling into mysticism or spiritualism, because the subject under our notice chanced to be of a metaphysical character. And this warning which we take to ourselves suggests, or perhaps is suggested by, the indictment to which it seems certain high scientific authorities lay themselves open, viz. that they allow the results of their special studies too largely to dominate, too completely to determine, their con-

ceptions of the universe at large, which universe is too mysterious and complex to render trustworthy answers to those who interrogate it in only one manner.

In my previous paper on this subject I had commenced to trace, in a summary manner no doubt, some of the progressive stages in the history of vegetable life, to mark certain epochs in the creative epic. We had begun to consider what we called the second stage, which embraced the *Musci, Filices, Lycopodia,* and *Equisetaceæ,* the Mosses, Ferns, Club-mosses, and Horse-tails, but had only reached the first of these orders, so that it is now the *Filices* or Fern family to which we naturally direct our attention.

The Fern may be regarded as the heir or successor to the Moss, seeing that in the history of soil formation it appears requisite that the one be preceded and prepared for by the other. The one, like a prudent sire, has accumulated the capital upon which the other may subsist. The fern, though requiring as a rule but a slender portion of soil, and evidently nourishing itself mainly by means of the moisture that reaches it, still does require the said capital with which to start. It demands, it implies a predecessor.

Had Nature been the blind, mechanical, mindless, soul-

less automaton which some seem to regard her as, it must be thought highly creditable to such a mechanism, a matter remarkable in such a cosmic musical-box, that it should have produced in the humble orders already present on the earth forms so exquisite and variety so exhaustless, but now, when it would have seemed quite sufficient that the soil should be covered with giant mosses, or lichens of monster growth, this versatile machine plays, as it were, a fresh melody, a harmony of larger compass, a movement of grander volume and more stately progress. From the lowly film-fern, content to consort with the mosses of the ground, to the graceful fern-tree, surmounting its slow-built stem with crowning lace-like fount of leafage fairer, if less proud, than any palm's, the fern world is the home of ever-fresh and finished beauty of form, of ever-assiduous originality and delicacy of design. Not, be it at once admitted, that all forms are of equal beauty, or that some are not by comparison even homely, but that, contemplating the order as a whole, it is characterized by a clearness and cleanliness of surface and of shaping, a mastery, simplicity, and subtility of curvage, a thorough and elaborate symmetry, which seem to represent nature's final self-defying effort in the direction of leaf-beauty, where that beauty is to depend

mainly upon form. For Nature, like a wise human artist, in the midst of her boundless resources appoints herself laws and limits. Thus colour in the fern would seem to be held subordinate to form, and used rather to define and illustrate form than put itself forward as a distinct beauty. Yet a worthy and helpful servitor it proves itself, throwing as it were into relief the grace and perfection of Nature's draughtmanship. This is well seen in the brownness of the wire-drawn frond stems characteristic of the Adiantum.* Thus coloured, the stem gives to the light pinnæ an unobtrusive and almost invisible support and attachment, thus greatly enhancing the aerial, weightless elegance of the plant. To this the Maiden-hair owes much of its matchless grace. Matchless, I say advisedly, for this fern appears to me a very miracle of ethereal elegance, the very embodiment, as it were, of a sensitive maiden soul, tremblingly alive to the lightest influence, and yet strong and safe in its very delicacy and refinement. To me this seems one of those creations that touches the zenith of its possible excellence, and defies the energy that produced it to produce its peer again. No doubt it may be argued that the lightness and strength displayed by this plant may

* Maiden-hair.

be the very cause of its survival. But, apart from the fact that this is a mode of argument which can obviously be adopted in any case wherever anything appears well adapted to its environment, and which is merely equivalent to saying that a thing exists because it is adapted to exist—we need not stint our wonder and admiration that utility and beauty should thus blend in one perfection, nor need we abate our incredulity that a blind, aimless, unconscious automaton should exhibit at once adaptation so perfect and design so delightful.

As you will have already perceived, the main argument upon which I am depending, both in this paper and in those that preceded it, is what may be called the argument from beauty. It contains a challenge flung to the Darwinist to account, on his hypothesis, for the existence of so much that charms the senses of man, to explain away, if may be, the apparent control which a subtle and exquisite sense of beauty seems to exercise over natural objects. It may be described as a flank attack on the utilitarian, automatic and atheistic position, from the æsthetic or artistic standpoint. We shall first require to establish, and this in reference to the vegetable kingdom we shall be abundantly able to do, that at least beauty of some

kind is arrived at as a rule by the plant, and that, great as may be the disparity in grace and charm between different individuals, still in the existence of each there is observable an effort usually, if not always, successful to contribute to the earth's adornment and the delectation of man. If this be true, the burden of explanation, a burden, so far as my reading has gone, never yet undertaken, still less removed, lies upon those of the automatist school. A single analogy may render the position more clear. If I were to find a piece of paper upon which were a series of ink-marks, I might go through the following stages of inquiry and deduction as to the origin or originator of these markings. If I could find in them no method or law, I might say they were produced accidentally or mechanically. But supposing I at length concluded they were not mere marks but written characters, I should infer the author of them to be at the least a child of sufficient age and intelligence to form letters. If then, further, these characters were found to form words, and these words to form a rational sentence, one would, naturally, attribute their production to some person at least capable of understanding language, and of thinking. But, finally, if the communication were wise, or learned, or beautiful, or elevating, it

would be only logical to ascribe the qualities wisdom, erudition, poetry, or nobility to the author (it being of course assumed for the sake of simplicity that *one* person is the author both of the actual writing and the idea expressed). From which illustration we are, I think, entitled to infer, that as it would have been foolish to suppose that the wisdom, beauty, etc., of the communication was the result of a haphazard arrangement of letters, so it will be irrational to conclude that the wisdom and beauty Nature exhibits are accidental, automatic, and authorless. And as it would appear not only irrelevant but irrational to put forward the physical properties of pen, ink, and paper as affording the efficient causes of the writing, so is it equally irrational, as well as irrelevant, to attribute to causes purely mechanical and chemical the phenomena of life, sensitivity and consciousness.

We may here, however, frankly admit that while we have never yet been able to discover *matter* in a condition in which it is free from the impress of mind, so likewise, so far as our present experience goes, mind has never yet been found capable of existing, disassociated from matter. Hence the obvious, it would seem, impossibility of settling the dispute as to priority of existence on anything like

scientific grounds. For although, doubtless, mind, as existing in the finite beings, man and other animals, is a phenomenon which is, in the history of the physical universe, subsequent to the phenomenon of unconscious matter, nevertheless the most primitive conceivable form of matter seems to involve a pre-existent idea or scheme. Thus, if matter can in any sense be said to afford the promise and the potency of all terrestrial existence, it is only as thus endowed initially by a pre-existent intelligence.

But now let us recur, before passing onward to other instances, to our contemplation of the Fern genus. Ferns appear to me to stand in the same relation to other orders of plants as the ancient Greeks do towards the various races of men. They are the Classics of Nature, owing their charm to symmetry, balance, refinement, restraint. As the Greek statue or poem seems to be conceived and executed with such an exact prudence, such an accurate estimate of the limits and possibilities of art, so seems the fern, as though instinct with a power of exquisitely true precalculation, as though aware with precision of its own resources and capacity, to succeed in realizing its own dream of perfection. Its aim is rather to be than to produce. Neither fruit nor flower, in the ordinary sense, is

for it, content as it is to be beautiful and no more. And in compensation for this restraint, in reward for this—in its place—beautiful self-sufficiency, there is for it no blight and withering of flower-bell, no fall and decay of fruit. Even the very fronds refuse to fall away, but dwindle with a gradual decline, and, restoring their elements to the spot whence they sprung, bequeath their bodies as true patriots to the soil of their nativity. Nor in its historic function is the fern tribe dissimilar to the Hellenic race, for as the latter has accumulated and bequeathed the fundus that underlies and renders possible all modern culture, so the former, through slow conquest and gradual accretion, has collected and compiled the rich soil, the fertile compost, in which plants of greater growth and higher aspiration may dwell and flourish. And it is this function which assures us of the fact that, broadly speaking, the fern must have been the immediate successor to the moss, although there is no necessity to rely exclusively on such an argument, seeing that the main facts of palæontology tend strongly to support this conclusion. It is also instructive to note in this reference that ferns are but little adapted to contribute to the necessities of man or even of animal life as at present

existing, the inference being that they belong originally to a natural economy in which such animals had no place.

Before finally parting from this portion of our subject, I should like to draw your attention to what may be termed aspiration and ingenuity in Nature. As originally organized and constructed the fern is adapted for covering and adorning the surface of the ground to a height limited to that of the individual frond. But, uncontented with that, the ardour of the race, as we may call it, carried it on to an attempt to exalt itself further above the earth's surface, to form for its frondage a pedestal or column whereon it might be borne aloft in honour and beauty. Having no power of producing in this instance a true stem, it would puzzle human ingenuity to predict how Nature would surmount the difficulty. The expedient used is one which at once by its felicity, simplicity, and success cannot but compel our admiration. The strong leaf-bases of the old fronds are, so to speak, economized as a platform within and upon which the succeeding generation of fronds is reared, to leave in their turn a higher platform for its heirs. And thus, with the infinite patience characteristic of natural processes, the column is slowly raised, season after

season and tier on tier, till the feathery frondage uncurls on high from the summit of a taper shaft.

At the risk of appearing to press the analogy too persistently, I would remark that, as Greek sculpture remains unrivalled in point of pure grace, so the leafage or frondage of ferns remains peerless in Nature in respect of gracefulness, variety, and refinement of form. Nature it would seem, being for this genus shut out from the possibility of those effects that may be produced by a combination of leaves with twigs, branches, and stem, and also for the embellishment of blossom or flower, has thrown all her fictive genius into the designing of the leaf pattern and the contrivance of charmful modes of frond arrangement and curvage. By how exquisite an adjustment of relative strength and weight, for instance, must the parabolic curves of some fronds be attained: some having the aerial spring of a rocket as it rises and spreads towards the zenith of its flight; others the energetic shoot of a stream over rocks; one the idle curl of an ostrich plume; another the strong poise of a gull's wings stretched over sea. Nor, with however wild a grace she may carry it off, does Nature disregard method in the order and manner in which the fronds are given

off from the root. There are some collected in a nest or crown, some flinging themselves up, as if on tiptoe, each higher than the last, and yet others waywardly following each other through the woodland, as though they played at some fairy follow-my-leader.

This is not mere sentiment, sentiment at least that may be used as a reproach. It is statement of facts, facts of human experience. For the proposition that these ferns are delight-giving and beautiful depends for its validity on experience, just as directly and purely on experience as the most commonplace and universally accepted proposition, such as that honey is sweet. The appeal lies, as in all scientific matters, to the tribunal or test of human perception, and that appeal is for us the ultimate one; and the process of establishing the one proposition would be closely analogous, if not identical, with that which must be employed in the establishment of the other. Honey has been put to the test of taste by innumerable human beings, and has by an overwhelming majority been pronounced sweet. Certain other things, such as pearls and diamonds, have been pronounced beautiful. The one verdict is no more open to be stigmatized as mere sentiment than the other. Still, let us at once

admit that there is a difference. It is quite conceivable and highly probable that if they could communicate their opinion many animals besides men would vote with the majority in the matter of honey; but it is difficult to perceive and highly improbable that any animal except man has the faculty of discerning between what is beautiful and what is the reverse.* It is even extremely likely, if it has not been already proved, that this faculty exists to a very slight extent in the lower races of mankind, and there can be no doubt of its having developed along with the progress of the race. Still it is remarkable that one of the earliest instincts of the savage and the child is towards the acquiring of objects of bright and, even to our taste, pleasing colours. This faculty, then, appears to be distinctively human and to be dependent on a higher cerebral development than any infra-human; from which conclusion we may draw two inferences, first, that the faculty itself may safely be classed as a higher and more intellectual one than that which discriminates between what is sweet to the palate and

* This is certainly an obscure point, since, although Mr. Darwin has pointed out an apparent relation between sexual attraction and beauty among birds, there is still lacking any proof that the category of beauty exists in the mind of any being lower than man.

what is not so; secondly, we may with equal safety conclude that it will improve and develop with the progress of the race and become more refined and subtle in its discernment. It may be as well to remark in passing that this development could not go on had the world been filled with objects of equal beauty or even of objects all beautiful. We are now in a position to discern more clearly what the difference is which was acknowledged to exist between the two cases which were instanced as analogous. In the first place, it is, I think, clear that the special faculty to which appeal is made on the matter of beauty is higher, more intellectual and truly human than that of mere sense of taste; and secondly, we may conclude that the testimony of the more highly developed races and of the most cultured individuals in those races will be entitled to greater weight than that of inferior races and less cultured individuals. If, then, it should be for a moment disputed that such beauties and charms as I have claimed for the Fern tribe do really pertain to them, decision would not be made on a mere show of hands. It would be necessary to appraise the votes according to the advancement and culture of the voters. Thus to the verdict of civilized and intellectual

nations would be accorded a value many times greater than that allowed to races barbarous and unenlightened. And, among individuals, there would be decreed a vote-value to the artist and the poet outweighing that of many less sensitive souls. Proceeding in this manner there is no doubt the proposition would be carried by an overwhelming majority. That is to say, it would be established as a fact upon the same basis upon which alone science admits facts to be at all established, viz. upon that of human perception and experience. Of course it is not for a moment supposed that the process just roughly indicated could be carried out in detail. I have merely endeavoured in some sort to define the kind of testimony upon which facts of this order implicitly found themselves, and by which they are continually buttressed into additional security of acceptance.

The remark will not be out of place here, and indeed has in great measure been led up to, that the attack upon theological positions, which has been inaugurated and carried on from the basis of operations furnished by the recent discoveries of physical science, may be impugned on the grounds that the basis so obtained is not broad enough to justify the superstructure of negation and

atheism which is sought to be reared thereon; and what is more immediately relevant in the present reference, the kind of testimony, upon which the facts they appeal to rests, is, in a sense, of a low order. What is meant is, that however brilliant the intellect by which scientific generalizations are made, the witness to the facts is that of the physical senses employed in complete independence of the moral and æsthetic faculties, and this necessarily so, because for such faculties to interfere during a scientific research would be to colour and obscure that cold and colourless light in which the man of science desires to view his facts. There exist, therefore, other series of facts, which by their very nature must rest upon testimony involving the use of these higher faculties. These other facts lie beyond the sphere of the student of physical science, so long as he appears in that character only. But whenever he intrudes his conclusions into the sphere of theology—or as we may call it, in order to evade the difficulty the term involves, cosmology, the study of the universe in all its phases and relations—he must be prepared to find even his own facts viewed in new relations and taking very different aspects, while he will also be confronted by arrays of facts equal in

importance to his own, but which could not be established by the methods he had made use of. But it is too often the case that the votary of a special branch of science fails to perceive and acknowledge the force and validity of deductions drawn from investigations other than his own. Hence it is that we may behold the sorrowful spectacle of a learned professor launching out into positive invective against a study which in reality offers a necessary complement to his own, or the no less sorrowful one of an eminent scientist assaulting with iconoclast enthusiasm the inmost citadel of faith. Still we may congratulate ourselves that they are not men of the very first scientific rank who so conduct themselves. It is not a Sir William Thomson who emits tirades against metaphysics, nor does Darwin in person head the crusade of atheism.

I trust that in diverging into these considerations I have not caused you to lose sight of the point I am endeavouring to establish. My aim was to repel in anticipation the charge of sentimentality which might otherwise have been urged with seeming effect against such views as those here expressed. To this end I attempted to show that the statement that beauty belonged to the

genus to which I referred was really as much capable of proof and establishment in the rank of a fact as common-place propositions which no one ventures to controvert. Now by sentimentality in its bad sense is meant, or at least ought to be meant, that state or mood or habit of mind in which facts are disregarded or undervalued, and preconceptions and impulses permitted unrestrained predominance. It is sentimental to bestow charity indiscriminately and therefore mischievously, but it would be a gross profanity to stigmatize as sentimental an act of wise generosity and intelligent, timely benevolence. Sentiment, indeed, depends for its value on its relation to facts. If it disregard or misconceive them, it is misleading; if it respect and understand them, it is a sacred guide. But withal there is the fact, too frequently neglected or forgotten, that sentiment is itself a fact, a phenomenon as undoubted in its existence as the solidest matter, the best established law. Man is not man apart from sentiment, as an atom is not chemic apart from its affinity; *sentiments are the affinities of the soul.* We may then, I think, with all respect to the soberest and the sternest facts that science can lay before us, still permit ourselves, not only to reap delight, but also to rein-

force our highest and best hopes, from the beauty the Fern world presents to us. Undiscouraged may we re-measure in imagination those æons which we are told separate us from the era of the Acrogens, and re-picture to ourselves the splendours of those solitudes primæval, where moss and fern and lycopod seem entwined in silent struggle for empire and supremacy; where in glory unregarded the sunlight smote through tangled and glistering vistas of tropic frondage, while yet the dawn rose unsaluted of any song-bird and sundown built its brilliant cloud-dreams unbeheld of man. From a spectacle so impressive in its mighty repose, so tranquillizing in its mute imperceptible progress, we would gather not chilling inference of human littleness or Nature's impassivity; but we would the rather feel a solemn elevation in that so vast and imposing a prelude, an overture of such broad and stately movement should precede the drama of life, feeling thereby assured that preparation so leisurely and ample, an apparatus so elaborate and splendid, are the prophets and precursors of such action and event as shall prove themselves of equal and adequate grandeur. That colossal past we now contemplate is no cumbrous pyramid to fix our hopes for ever in the dust. It forms rather the

massive immovable piers and foundations whereon, without sound of hammer or any instrument, shall be upreared the temple of the future.

Nor here, although language metaphorical has been used, can the hue and cry of "sentiment" be permitted. To the expert in physical investigations we appeal, it may be, against himself. Have you not, we ask, with elaborate patience and study discovered for us, and pointed out to our delight and edification, the extraordinary economies of Nature? No extravagance is allowed in her household. The disused organ dwindles, the unnecessary defence is removed. Is Nature then only "penny wise and pound foolish"? A miser of the scraps of matter and force, and yet a spendthrift of centuries and of races? To us this is inconsistent, incredible; so, friend, is not our sentiment in harmony with your fact? Is not our faith in the future but the prolongation of the line you yourself have drawn for us?

It would be as undesirable as tedious to review the whole system of plant life with even that degree of detail with which those parts about which we have been hitherto concerned have been scrutinized and commented upon by us. It is our belief, or at least mine, that how-

ever great the range and orbit of Nature; however multifarious and multitudinous its phases, it remains a seamless web, woven on one loom, a single organism, as it were, with one spine of purpose and character running its whole length. Still it is desirable in an attempt to establish any case that a sufficiency of corroborative evidence be called; and therefore we shall not hesitate to throw up additional buttresses and supports to a thesis already advocated, wherever we find fit opportunity and material.

But before we finally leave the Cryptogams, *i.e.* those plants in which the leaf or frond represents the highest specialization of function, it may be well to devote some thought to this organ itself. Its importance cannot be exaggerated, it is the great typical and representative organ of plant life. If we could but understand how a leaf grows and why it thus grows, no other problem of botanical science would remain sealed to us. But we do not. To a certain extent we know how it grows, having discovered the materials of which it is built up, and some of the chemical changes which lifeless matter undergoes ere becoming part of the vitalized tissue. The conditions of growth are likewise ascertained. We are thus enabled to kill a plant and encourage its growth; but in other

respects Nature is equally mysterious and obstinate. No one can, nor indeed ever will, at least upon mechano-chemical grounds, explain the shaping of the simplest leaf, nor could all the *savans* of Christendom induce a daisy to grow a dandelion leaf, or an elm to produce a single acorn. From germs structurally similar, often chemically identical, plants of complete diversity spring not shaped by the apparently vast surrounding forces, but fashioned by an apparently feeble inner law. This secret, mysterious vital power, this invisible, undescried formative influence, which is to the plant exactly what original character—that human mystery which is all but the whole of human fate—is to man, is a force more subtle and no less compelling than the harder, larger, ruder forces of which this planet in its infancy was the play-ground and arena. Let it not be supposed that this is said in ignorance or disregard of the fact that all vital energy is conditioned by these physical forces. But let us not confuse relation and identity. One individual, say a child, may have his life conditioned by the action of others, and may perish or survive according to the treatment it receives. We do not, however, argue from that the identity of the child and the persons on whom it

is dependent. No more can we consent to identify that directive energy by which the form of an organism is determined with those forces by which its existence is conditioned and supported. This is a point not of small, but of the very last and highest importance. It indicates the Thermopylæ which must be held at all risks against materialism, whose thesis is that all sublunary existence can be accounted for by those properties with which matter in its unorganized condition was primarily endowed. If a stand is to be made, it must be made on the threshold of life; because if it once be established that any life is to be accounted for and has been caused by the original qualities of matter alone, there remains no point at which a stand can be made, at least until we come to the region of consciousness. On the other hand, if this position can be secured, materialism is held at bay and prevented for ever from threatening the domain of humanity. For if these supposed omnificent properties do not account for the formation of a frond, still less can we expect to find in them the promise and the potency of the mind and heart of man.

There requires no apology for the assertion that the shapes of leaves have never yet been accounted for, be-

cause it is a simple indisputable fact, easily proved so far as proof is required by a citation of an attempt made by the eminent De Candolle to explain leaf-formation. His theory is to the effect that "the shape of the leaf may be viewed as dependent on the distribution of the veins and the quantity of parenchyma* scattered through their interstices—the general outline being determined by the divisions and directions of the veins, by the greater or less abundance of parenchyma, through the midst of which the veins are distributed." The least amount of reflection makes it evident that this is no explanation of cause whatsoever; for, obviously, while the direction of the veins and the proportion of parenchyma constitute the elements of the leaf-form, they are not the cause of it.

What we want to know is what determines the direction of the veins and the quantity of parenchyma. The above explanation, if it can seriously be regarded as such by the author or any one else, is exactly as intelligent and intelligible as an explanation of the form of a statue would be, which consisted in saying that it depended on

* This somewhat uncouth term is meant to designate the main tissue of the leaf, which is in relation to the veins what the silk of an umbrella is to the steel or whalebone ribs.

the bulk of marble left in one part and chiselled off at another. Both statements would be true, but neither explanatory.

Of course it may be argued that although the required explanation is not forthcoming at present, it is sure to come to hand in course of time. To this it may be replied that such a belief implies a faith in the method employed which we do not possess, and we therefore decline in the interests of science to admit a proposition that still awaits proof. If then a breakdown occurs in this intended triumphal procession of matter so soon after setting out, it seems improbable that the goal will ever be safely reached.

There are two aspects or relations in which it will be convenient and instructive to regard the leaf, viz. its relation to man as an object which must meet his eye, and its economic functional relation to the plant of which it forms part. The latter is that chiefly regarded from the strictly scientific and especially from the Darwinist point of view, but the other clearly demands consideration. Not a little remarkable is it that the æsthetic and the functional importance of the leaf vary to a great extent together, and bear a sort of proportion. In the Ferns, for

example, the leaf is the all in all of the plant, both as regards functions and ornament. While performing the absorptive, assimilative and reproductive offices it never fails to exhibit at least a comely and often an exquisite form. Among flowering plants, however, the leaf, having lost its functional supremacy, seldom if ever asserts a decorative precedence. In the case of those plants popularly called "flowers" the leaf is almost always æsthetically subordinate to the flower, the flower being really the leaf in its highest phase of beauty; the aim of the plant, or its main effort, being apparently to blossom. But in the case of large trees, whose object is rather the upbuilding of trunk and the preservation of the whole, both the individual flowers and leaves as a rule are subordinate in decorative value, the form of the tree, and the effect of flowers and leaves as massed upon it, being the points to which attention seems directed. Thus the flowers of our forest-trees are usually green and inconspicuous, at most affording, before the expansion of the leaves, a graceful but scant embellishment; and one can well perceive how much more in accordance with the sober dignity of treehood is such chaste decoration than anything more brilliant and ornate. An oak pranked

with white blossoms or an elm garlanded with yellow florets would appear as inappropriate as a soldier with butter-cups in his hair or a sage with daisies round his hat. (It is quite possible that the soldier or the sage might please us so decorated, but not unless we understood that childish hands had set the flowers there in loving frolic.) But admitting this limitation, that the leaf is often subordinate and therefore shows no ostentatious elaboration of form, it still may confidently be maintained that the great majority of leaves have a tendency to beauty of design, most frequently amply fulfilled. Mr. Ruskin in his beautiful and interesting, if also erratic and immature, work on botany ("Proserpina"), to which both now and heretofore I am largely indebted, proclaims the laurel, or as he calls it, Apolline, leaf to be the noblest of leaf-forms. I have no intention to dispute his dictum on this point, but in reference to what has gone before, wish to say that, while as a tree-leaf, a citizen of a large commonwealth of leaves, in which it is intended that the individual shall not be missed but secretly replaced, it may be the king of leaves, I would still assert that as a piece of sheer beauty it cannot be compared with any of the more graceful fern-fronds.

There is one principle which I should like to enunciate clearly and to emphasize, seeing that it may save us much disappointment and gloom in our studies of Nature. It is this, that Nature, I use this term in its personal sense as being much more reverent and appropriate to the occasion than a continual reference to the Deity would be, does not aim always at doing many things at a time, or at least usually exhibits one aim as dominant over the rest. Thus in plant life, seeing that plants form the garment of the earth, and must be continually seen of men, the leading aim is often to all appearance beauty; while in the case of animals, which have the power of motion and ability to avoid man when there is hostility between them, the result aimed at is rather strength, activity, and self-defence, although often extreme grace or dignity of movement is likewise attained. Nor, on the other hand, can we often, if ever, find in Nature a one-ideaed action; other ends appear to be kept in view even though one seem largely to predominate. Thus, while, as we have observed, leaves tend to beauty of individual form and also of combined effect, they never fail in fulfilling their debt of utility to the plant to which they belong. They are no otherwise made than in

that mode best fitted, so far as we can judge, to the necessities of that plant. And because they are so admirably made in this respect, man must forsooth raise his heel against Nature, and cry, "There is here no wonder and no divine design! Plants are perfect in their place because the imperfect have been eliminated in a struggle for existence." It is somewhat hard on Nature to turn her perfection of utility against herself. For it is clear that, whether an organism comes into being by creation or evolution, the fact of its existing at all argues a harmony between it and its environment, involves a quality of utility in its structure; for to say that its structure and faculties are unfitted to its environment, is to pass sentence of death upon it. So that really no argument contrary to a creative hypothesis can be drawn from the often self-regarding economy of an organism, seeing it is a necessity inherent to the circumstances; but, on the other hand, an important inference may be drawn from the observation of the fact that while apparently so completely self-regarding in their economy they nevertheless are linked by relations of utility, and become adapted to perform services to parts of creation which cannot be looked upon as forming part of their

immediate environment. Thus, while it might be difficult to prove *seriatim* that all other beings are constructed with reference to man—for it often happens that by the very ill-adaptation, as it seems, of some creature to man and his comforts that creature plays an important part in the development of the higher human faculties—it remains and will remain an impossibility to prove that Nature is devoid of provisions for the eliciting of, not only lower energies and inferior faculties, but even the highest qualities and loftiest endowments of man. Certain is it that the student of Nature, whether he seek truth or pursue beauty, need never weep the tears of an Alexander for new worlds to conquer. If he do, they will be, like those of the Macedonian, tears also of ignorance. The only limits we have yet discovered are the limits of our own faculties. An improved telescope apprises us of a score of unknown systems; a higher power obtained in the microscope may multiply by thousands the population of a drop. Nor is the increase in mere quantity and number. Beauty behind beauty, and wonder behind wonder greet us as we advance. Nature is no piece of veneered and varnished elegance. Sawn through the centre, the graining is constant and undegenerate. No scamping is there in her

workshop, the smallest pollen-dust is bedight with delicate coatings, the most minute of diatoms has its tiny disc graven with a fair design. To me it is a mystery how any man can come from a contemplation of Nature with the weary soul and the dreary creed of an atheist. Man may find, indeed, much that humiliates him, bidding him reflect that he is not the cynosure of the universe, seeing that the existence of the meanest creature seems fenced with like care to his own, causing him to speculate that as there are unfathomed deeps of being beneath him, so there may be heights as immeasurable above, and yet leaving him a conviction of his own possible dignity and worth, a creature for whose production past æons have laboured, the crown of the visible creation, and a confidence that the pervading Power that has indued the meanest atom with indestructible existence, quickened dead matter with the wonder of vitality, and exalted it into the very home of feeling and palace of thought, cannot be such as to be careless of the souls of His children, callous to the destiny of Man.

IV.

OF BOTANY.

Beginnings of vegetation on this planet—The advent of the Grasses—Their two limiting forms, open and serried—Nature looks ahead—Economic importance of the order—Its beauty—The Pine order; Their food—Special adaptations to snow-bearing—Their forms and spirit—Nature's miracles—A catholic spirit in science—Of the stem—Darwin on twining stems—A confession of his—Alternative conclusions—Nature as a mechanician.

IT would be alike tiresome to you and laborious and unprofitable for me, in continuing our meditative review of the Plant-world, if we were to attempt to notice every class of plants with even the same amount of detail and deliberation which we bestowed on Ferns and Mosses. Nevertheless it will assist us in giving form to this treatment of the subject if we maintain the direction if not the velocity of our progress. If we consider that this planet must at one time—and this seems highly probable, if not absolutely certain—have been in a molten condition, it follows that, upon its first solidifying, the rock would be all of a voltaic character and perfectly naked of soil.

We have already observed, however, that there are forms of vegetation which can, under conditions of moisture and heat, attach themselves even to such naked rock and flourish thereon, and while doing so gradually deposit a thin layer of mould. This, as was previously pointed out, is the function of the lichen. And in this first stage of this soil-less globe it is evident that no plants save lichens and algæ could exist. We also observed how the moss succeeded the lichen and made provision for the fern. In alliance with these humble and silent agents some mightier, yet not more necessary, natural forces were at work. The adamantine tooth of frost gnawed into crumbs the hardest granite, and slowly the tempest and torrent swept the gathering spoil to swell the hoard of rude soil that was growing in hollow and valley. By such incessant, unresting processes was the earth accumulated and enriched, till it became capable of bearing what we call the higher forms of vegetation. But, if we consider the aspect our earth was then assuming and the soil-covered state to which most of its surface has attained, we easily divine that some new agent was now wanted to complete Nature's staff of labourers. It was not sufficient that the rocks should be crumbled, powdered and carried down to

the lowest ground, but it was evidently requisite that this denudation should be checked, so that not only the lower and level tracts but the higher places and slopes should become soil-clad. Had any intelligent human being contemplated the condition of the earth at this stage, he must necessarily have remarked that some agent was now required to give the soil coherence, to bind it together so that it should retain its own position, and even arrest the downward progress of the newly forming earth. Accordingly there does appear, when thus demanded, an agent which accomplishes this object in a most complete manner. It seems as though at such an epoch a creative fiat had gone forth, "Let there be grass!" And there was grass. And lo, the shifting restless sand was wonderfully laced and woven, and a task more difficult than Michael Scott gave the demon quietly accomplished, and the loose soil at the mercy of the flood was stitched and bound and tied, till it became solid immovable turf. And the green irresistible conqueror rose, like a gradual wave, up the slope and mounted the hill, till the tides met on the summit, and the rugged, once uncouth and naked, hulk of rock was clad in a smooth and seamless garment. Grass is not an individual, but an association; not a tribe like

the fern, nor a colony like the moss-plot; the grass is a republic, a community, which seems to have recognised, æons since, the modern maxim of liberty, equality, fraternity. Even in cultivated forms this principle is preserved. How scrupulously every ear of wheat seems to respect the rights of his neighbour ears, so long as prosperity and strength enable him to do so, unlike in this respect the forest-trees, that thrust out rival arms against each other. The two forms to which the flowering heads of grass tend, the limiting forms which are well and clearly represented by our common cereals—the Wheat and Barley representing one form and the Oat the other—are in this reference worthy of notice. In the former the glumes are arranged in close-fitting rows along the axis of the stalk, and thus form a clean, firm and compact ear, so free of encumbrance and well contrived that, until it is itself injured or its stalk bruised, not the wildest onsets of the wind can bring it into hurtful collision with its neighbours. It might seem that if this model were departed from a less happy result would be obtained, but on the contrary we find that by a different route the same goal is reached. The head of the oat, representing the second form we specified, is constructed on an opposite principle

from the first. The glumes of the oat, instead of being sessile and close laid to the axis, are hung out on fine flexile pedicles at some distance from it, thus forming a spreading and, when ripe, slightly pendent head. But these heads, from the slimness and smoothness of the glumes and the sensitive flexibility of the pedicles, do not tend to abrade or injure one another any more than the compact ears of wheat. If we wished to have single terms for each of these two opposite styles of formation, we might call the one the "serried" and the other the "open" order. And we might divide all grasses into three orders—the serried, the open, and the mixed or intermediate. Now the observations we have made on this subject suggest the reflection, or rather the deduction, which may be supported by hundreds of other natural facts, that Nature frequently accomplishes a similar end in diverse ways. This brings to our mind an objection which has been urged against the theory, that the forms we meet with in Nature are to be entirely accounted for by natural selection and survival of the fittest, or on what we may call a purely competitive system of evolution. We are bound to suppose that grass in its primitive form was intermediate between the serried and the open order.

It is difficult to suppose how it could prove to its advantage and contribute to its survival to be both a little closer *and* a little opener. We can conceive its proving advantageous to be either a little closer *or* a little opener, but it is not easy to see how it could be beneficial both ways. Indeed, we are here brought in mind of a great and standing difficulty in the way of accepting the Darwinian theory, viz. that of understanding the use and operation of that slight change which is supposed always to commence that divergence which results in the production of distinct species. The fact is that to a mind divested of the bias of a pet theory, there seems to reside in Nature a certain prophetic instinct, urging on development in those directions which produce remote and future advantages rather than near and immediate ones. No one bears in reality, if not verbally, more ample testimony in favour of this belief than Mr. Darwin himself, in his masterly and interesting series of researches on the subject of cross-fertilization. For, proving as he so completely does, that there is a transition, a progress from self-fertilization to cross-fertilization, he at the same time proves, whether he has observed it or no, that such a system could not arise blindly, at haphazard, but was actually aimed at by

Nature as though conscious of its immense advantages. So positively marvellous are the contrivances by which cross-fertilization is promoted, and such the nicety with which it is accomplished, that one is rather tempted to attribute to plants a faculty of "thinking for themselves" than to deny in such a matter the operation of mind. But we have not yet arrived at that portion of our subject where it will be most convenient to discuss this question in full, and must therefore relinquish it for the present, in its general form at least, in order to return for a little to the grasses. Before leaving this subject we cannot avoid the reflection that the presence of grass in any form, such as still exists, implies the possibility, not only of that vast portion of the animal kingdom which we call graminivorous, but also of man. The grasses are, indeed, the foundation, the basis, of the present animal economy, the sea upon which the ship of life is upborne. Without grass civilization, yea, humanity itself, were impossible. As it may be said to have civilized the savage primeval world in a physical sense, so it teaches civilization, and even, as we have seen, politics to man. All those animals which aid the food-raising operations of man are graminivorous; the horse, the ass, the ox, etc.

Until he has subjugated and utilized these, he cannot be said to have reached the first plateau of civilized existence. When he has, he obtains some breathing space; his purely physical labour is done for him, and hence arises leisure, thought, culture. It would be easy to expatiate at length upon the economic importance of this order of plants, but as our present aim is rather to condense than to elaborate, we must refrain from so doing. But there remains yet another aspect under which we may consider it, viz. the æsthetic or decorative.

Whether we regard the grass collectively, as forming that lovely natural carpet, so elastic and grateful to the foot of man or animal, or in the beauty of its individual forms, we find a fertile source of delight and admiration. There are in Nature few fairer sights than a meadow on a bright day of June or July, when the grasses are in flower. No web from Lyons loom ever wore a more sweet and silken lustre than those acres of rippling grasses, over which the breezes seem to pass a-tiptoe, and fleet beyond our furthest view, ever returning, so it would seem, to renew their joyous race, calling on the staid, slow-sailing cloud-shadows to join them in their unwearying play, while before them the broad grass-

billows flee, glancing and shimmering in the sunlight, as though they were happy mates and playfellows of old. Or again, what more pleasant than to lean one's head back in the deep grasses and indulge in the phantasy of dreaming one's-self to be one of those minute creatures that haunt that miniature jungle, or an invisible daylight fairy exploring those steep green-lit glades, or surveying that tiny forest from the top-gallants of one of its mimic masts. Here, though we may in some sort allow fancy to become the exponent of fact, it is nevertheless true that it is the inherent beauty in the aspect of these things that touches the heart with delight, and wakes pleasant fancies in the brain; or, if we look upon the various forms that grasses take, whether in the leaves themselves or in the flowering stems, we cannot fail to be struck by the exquisite beauty by which the majority are characterized. They, like the ferns, appear to employ form rather than colour as a decorative agent; they are the delicate draughtsmen and designers of natural chasing and fine tracery, the elvin armourers that prepare swords and lances and bayonets, standards, pennons and plumes. It is, indeed, impossible to decide whether they exceed in beauty or utility. Man thus served is

like the hungry Geraint waited on by Enid, when he must have doubted for which he was the more grateful, the good fare or the lovely face.

I am quite aware that much that has been said applies more to the grasses of temperate than to those of tropical countries, but the difference is rather in detail than in principle, and there is no doubt that while the latter may be coarser in appearance, they are likewise often more conspicuous and splendid in their attractions. It is not here contended that the whole of this immense order is equally perfect in design and entirely beneficial to man. There are some less sightly than others, and some either poisonous, as the darnel is suspected to be, or dangerous and annoying, as the New Zealand spear-grass certainly is. But such exceptions can hardly weigh, so exceedingly rare are they.

There is another order of great beauty, and likewise of immense usefulness to man, which, before passing on, it behoves us to notice—I mean the *Coniferæ*, the Pine order. They appear historically to have even preceded the grasses, and, following our plan of taking into account the gradual process of soil formation, it is easy to see that they would naturally be contemporaries of the ferns, etc.,

because we find it characteristic of them to be able to subsist on the merest modicum of soil, on the all-but-bare rock. All they really seem to require is a safe anchorage, and this is best secured on mountain-side, precipice, or cliff, where the roots can grapple themselves with more than iron grip about huge boulders, or to the cracks and friendly seams, fissures and angles of the living rock, herein performing a mechanical feat which would defy the appliances of man. It would be as impossible to secure a pine, once felled, to its former position, on the same principle that Nature does of merely tying it by the root, so as to resist the enormous leverage it affords to the wind, as it would to put together the Humpty-Dumpty of the nursery rhyme. The strength of those living clamps and cordage seems little short of miraculous. The pine cannot therefore draw its chief nutriment from the soil; dew, mist, rain and snow are its seeming ethereal food, and it is extremely interesting to note how admirably adapted for arresting and absorbing these forms of sustenance it is. The fine innumerable spines catch and secure all these as in a close, almost impermeable, web or net. In nearly all instances the most important agent in its nutriment is the snow, for as a

race the *Coniferæ* affect great altitudes, at which the snow lies through a great part of the year. Now when the earth is iron-bound with frost, it seems obvious that the tree must feed on the snow. Only this winter,* during the severe weather, I was struck by the admirable adaptation it exhibits for this purpose. At first one notices how heavily laden all the trees of this order become with snow, and it appears a disadvantage, as though they would be more injured than other plants. On looking closer and reflecting more deeply it becomes evident that this fact is of great service. Let us take four species of quite different habits, and see how they adapt themselves. Take first the common Scotch Fir that we sometimes see riding the tempest under almost bare poles. In this case it is evident the snow does tend to remove the lower branches, but mark how the summit spreads itself into broad palms, which will receive and retain the greatest amount of snow, almost as much as if it were feathered to the ground. Consider, secondly, the Cedar of Lebanon, which sends out its lusty limbs at a slight upward incline, and expands into broad trays and terraces, which only become horizontal under a consider-

* 1878-79.

able weight of snow. We may take as a third example the Deodar, and we find that in a quite different way it carries out the same purpose. Its branches leave the stem at right angles, or even with a slight downward incline, and they are, especially at the point, supple and pendent. The snow thus tends to slip off the upper and lither boughs and descend upon the lower branches, which are already resting on the ground or their lower fellows, and which thus become thickly "happed" about with mounded snow. A fourth and equally distinctive case may be found in the Araucaria, upon whose long bristling arms I have seen a deep ruff-like ridge of snow fully two inches and a half high, which did not seem calculated to injure or inconvenience the plant, so easily was it sustained. These facts taken together with that, that when the ground is hard frozen a tree which so far maintains its vigour as to remain ever-green, as all of these do, can draw little or no nutriment from the earth, absolutely convince me that the pine feeds upon the snow through its leaves. The method in which it does so, as I believe, I will endeavour to explain. Firstly, it is ascertained by careful and repeated experiment that plants in general develop a certain small amount of heat,

the result of which is that in summer the temperature of the plant is below, in winter above, that of the surrounding atmosphere. Secondly, this temperature, besides depending on a chemical process in the plant, varies also according to that of the ground where the roots are. Thus, for example, the heaping of the snow round the Deodar will tend to the increase of the temperature of the whole plant. My belief is that the temperature of the pine is from such causes sufficiently high to melt, as it were, but a film of the snow next its leaves, and thus absorb it. A confirmation of this theory will be found in the way that snow, which has lain on a pine for a short time, will thrust itself home along the lengthy spines till it rests against the branch itself. From all this we gather that these four species of *Coniferæ*, at least, are most excellently adapted, though in quite different ways, for receiving and retaining a share of fit winter provision. We imagine that a human being who had never seen a Cedar or a Deodar, and yet had conceived them and their special modes of adaptation to snow catching and bearing, would be thought a person of exceptional intelligence; and yet we are seriously asked to believe that these things have come into existence without thought,

guidance or design. Call the process of their production, evolution, growth, creation, what you will, but do not try to persuade sane men that the elements of evolution, the conditions of growth, do not as surely imply intelligence and foresight as would the fiats of a Creator.

To attempt duly to extol this noble race of trees would be indeed like trying

"To throw a perfume on the violet."

Their beauty is varied, and exceeding, from the less attractive, but solemn and impressive, Yews and Cypresses, and the picturesque ever-interesting Scotch Fir, to the more clothed and reverend Pine, the patriarchal Cedar, the haughty affluent Wellingtonia, and the refined and lovely Deodar. But the spirit of the order is that of aspiration. All its higher members send their shafts straight heavenward without division or divergence. I doubt not the human notions of spire and pagoda came from the Pine and the Larch respectively. The Pine is truly Nature's priest, worshipping literally in the high places, gathering its solemn choirs about her mighty hill-altars, and chanting an eternal psalm. (Though I am no philologist, I should be hard to persuade that the very word *psalm* did not arise from an attempt to reproduce

the grave and meditative murmur of wind in a pine-forest.) The motto of the tree is "Excelsior," and its forests sweep up the mountain flanks in huge green waves, in serried hosts, as of a gallant army flinging itself indomitably up the steep glacis and against the mighty outworks and bastions that defend the fortresses of the frost and the shining citadels of snow. Like a sane, yet aspiring soul, the Pine anchors itself to the solid fundamental rock, and straining upward, with constant purpose, is nourished by the pure skies to which it ever tends, fed with food from the heaven to which it points.

It is a true saying that truth is stranger than fiction, but it is no less true that Nature is more wonderful than what we call miracle and magic. You may search all mythologies and legends, you may ransack all fairy stories and magic tales, but you will not find anything more truly marvellous than a pine-tree. Consider the elements of which it is built up, the conditions of its growth. There is first of all the bare or nearly naked rock and a dry, apparently dead, chiplet, we call the seed. Add to these water, with a small amount of other chemical substances in solution, in the various forms of dew, mist, rain and snow, and these under the influence of solar heat

become a large and lofty, a strong, tough, firmly founded and solid, a green-clad, shapely, increasing, complex, organized, a spined and plumed, aspiring, wisely-planned, utile, solemn-sounding, soul-suggesting thing, we call a pine-tree. Everything in legerdemain, magic legend or mythology, however astonishing and supernatural it may seem, is but a poor and shabby wonder beside this one and a thousand others which Nature daily and continually accomplishes. Yet because these are gradual and common we pass them by unwondering, if not unadmiring. It is not that science rightly considered either has explained or ever can explain away that wonderfulness which man in the youth of the race found everywhere in Nature, and which gave zest and poetry to existence. Rather, on the other hand, has man, bearing the lamp of science in his hand, like the hero of some Eastern tale exploring a magic cavern, paved with emeralds and roofed with rubies and diamonds, found in exploring the arcana of natural phenomena, ever new galleries and halls, ever fresh and alluring vistas of research and discovery. Perhaps the present and growing tendency of science to arrange her spoils in graduated series has some effect in detracting from the sense of marvel we would otherwise feel. It is

natural that it should be so; yet we must see on reflection that it does not really detract from the power exhibited that the process should be gradual, any more than we ought to admire a picture or a statue less when we know it is the product of a multitude of individual touches or strokes. Nature will not, indeed, condescend to sudden effects and surprises, will not stoop to any *coups de théâtre* to startle us into admiration; she presents us with things wonderful, complete, beautiful. If we are blind and say "They are nought," she seems to reply in silent scorn, "Indeed they are, *to the blind*, as the diamond to the earthworm, as the light of noonday to the mole and the bat; they are for the eyes and the hearts that can see." One cannot fail to suspect, on noting the cold and sometimes even disgustful tone in which Nature is sometimes spoken of, that certain scientific pursuits, like certain mechanical arts, which by too close and continuous application injure the sight of the operative, superinduce, in the case of too exclusive a devotion to them, a species of mental, if not of moral, ophthalmia, so that one is inclined to adopt in the case of science the famous replies of Schiller when asked what religion he was of. "Of none," he said. "And wherefore of none?" "For

religion's sake!" He feared by adopting the tenets and promoting the objects of a particular sect to lose the larger and loftier emotions and ideas which he felt constituted the truly spiritual and essential part of religion. So we may say, "We will not be, in spirit at least, geologists, botanists, biologists, or any of the 'ists' at all, not because we do not respect and credit science, but just because we fear to narrow our conceptions and lose our sense of that wider and higher science, that true knowledge of things, in which are embraced and sublated all these partial studies and subaltern pursuits."

It will not be any longer possible for us to follow out what we may call the historic order of Plant-life, according to the hypothesis we had adopted that the various stages of soil-formation would give us a clue to this order; for, when we find that the soil has arrived at the point at which it can support the grasses and pines, we must see that it is or shortly will be in a condition to support also a great variety of plants of quite distinct orders. We shall, therefore, so far change our method of progress as to consider those various parts of the plant, such at least as have not been already touched upon, in something like a natural and convenient order. Having already devoted

some attention to the descending axis or root, we may now proceed to the, formerly deferred, consideration of the ascending axis or stem.

The more one reflects upon the phenomena of life, especially of vegetable life, the more is one convinced that they can only be caused and directed either by a consciousness existing in the organism itself and controlling its conduct, or some pervasive consciousness without the organism which ordains for it its actions, either of which hypotheses seems to imply some pre-existing intelligence; for Nature must be a power even more miraculous than we esteem her, if she be either herself wise without thought and prudent without knowledge, or capable of endowing her productions with a consciousness, wisdom, and foresight of which she herself is innocent. Thus, with regard to a seed, there resides in that organism a faculty of discerning between up and down, and that even when in darkness,—for I have not yet heard of a seed, although many must alight or get sown the wrong way up, sending its radicle upwards or its plumule * downwards. By a certain and infallible instinct the true

* The plumule is that part of the seed or vegetable embryo which goes to form the leaves and stem, the radicle that which becomes the root.

direction is always taken, the future root seeking the darkness, and the future stem the air and light. No doubt the sun may be regarded as supplying the physical energy for this action of the plant, as for all, but it cannot be said to have given direction to the movement, the direction being determined by certain qualities in the seed itself, even as in a humanly contrived machine the motive power, heat, supplies the energy, but the intellect of the inventor, as realized in the machine, conducts this energy in the desired course. This is a highly important principle, by losing sight of which men have fallen into the error of reckoning this universe to be the necessary outcome of the undirected action of the various forms of energy. Perhaps no more ludicrously insufficient reason for a fact was ever rendered than that which is seriously assigned as the cause of the upward direction taken by the plumule, viz. that it takes this direction in opposition to the force of gravitation. This is surely the first time that the movement of any body in one direction has been ascribed to a force pulling it in another. There is surely in the plumule no natural, one is tempted to say piggish, obstinacy which causes it to go one way because it is pulled another. All we know, and I believe

can know, on such a point is that the plumule is so constituted as to seek the air and light, indeed to take and, if strong enough, maintain that vertical direction through assuming which the plant may best avail itself of the action of air and light; for the natural aim taken by the young growing point is not toward the quarter from which the maximum of light comes, although the tendency of a plant when it loses rigidity is to lean toward the light. The advantage of this fact for that plant which may be said to have a perfect stem, that is, a permanent one, rigid enough to resist the downward attraction of the earth, is obvious, as it is thus enabled to balance itself and maintain its upward course in a way it could not do if starting with a sunward slant. In this, as in all instances, the plant seems to proceed as though possessed of a perfect consciousness of its future, and with a matured scheme of living and complete strategy for the campaign of existence ready to unfold itself. There are thus plants which seem aware from the first that they will not be able to reach the light, to exalt themselves unaided above the surface of the earth. They come, therefore, provided with properties and implements for attaching themselves to bodies more rigid, and thus climbing to the light

and upper air. Upon this point I should like to dwell a short time and to quote to you from Mr. Darwin's fascinating and instructive monograph on "Movements and Habits of Climbing Plants," sufficiently to show what truly astonishing powers and provisions exist in this class of plants. There are several ways in which these supple-stemmed creatures attach themselves to their stronger fellows or other means of support. They may either twine their stems round some object they meet with and thus rest a part at least of their weight on it, or they may attach themselves at various points by means of hooks and tendrils, or, like ivy, they may clasp with crampions. It is obvious, then, that the first aim of the plant must be to find something suitable to which to attach itself. With this view it executes a circular or elliptic revolution, so that it feels over a considerable circuit and continues this process till it meets with the object of its search. Then either the stem itself twists about the support or the various grappling apparatus lay hold of it. In the former case the whole plant above the first point of contact continues to revolve and wind itself round the stick or stem it has found. In the other the unattached tendrils or hooks remain voluble and

sensitive, and proceed to seek and clasp at fresh points. Especially remarkable is it that this sensibility remains just so long as there is hope of its being of use or need for its employment. The following from p. 79 of Mr. Darwin's work, referring to the *Gloriosa Plantii*, a plant climbing by its leaf-tendrils, will fully bear out this statement:—

"The hook when first formed, before the leaf has bent downwards, is but little sensitive. If it catches hold of nothing it remains open and sensitive for a long time. Ultimately the extremity spontaneously and slowly curls inwards and makes a button-like, flat, spiral coil at the end of the leaf. As soon as the tip has curled so much inwards that the hook is converted into a ring its sensibility is lost, but as long as it remains open some sensibility is retained.

"While the plant was only about six inches in height, the leaves, four or five in number, were broader than those subsequently produced; their soft and but little attenuated tips were not sensitive and did not form hooks, nor did the stem then revolve. At this early period of growth the plant can support itself; its climbing powers are not required, and consequently not developed; so, again, the leaves on the summit of a full-grown flower-

ing plant, which would not require to climb any higher, were not sensitive and could not clasp a stick. We thus see how perfect is the economy of Nature." This last exclamation is not mine, but Mr. Darwin's own, and no wonder. Dull must be the mind that is not attracted, charmed and exhilarated by contemplating so exquisite and accurate adjustment of means to end! As illustrating the versatility of Nature's contrivances note the following. Speaking of *Bignonia littoralis* Mr. Darwin says, "The species last described, *Bignonia Venusta*, ascended a vertical stick by twining spirally and seizing it alternately with its opposite tendrils, like a sailor pulling himself up a rope hand over hand. The present species pulls itself up like a sailor seizing with both hands together a rope above his head" (p. 92). Of *Bignonia speciosa* he says, "The whole terminal portion of the tendril exhibits a singular habit, which in an animal would be called an instinct, for it continually searches for any little crevice or hole into which to insert itself" (p. 95).

"Tendrils will not clasp each other, and if they have done so, unclasp again" (p. 131).

"A nice case of co-adaptation here comes into play; in all the other tendrils observed by me, the several branches

become sensitive at the same period. Had this been the case with the *Hanburya Mexicana*, the inwardly-directed, spur-like branch, from being pressed during the revolving movement against the projecting end of the shoot, would infallibly have seized it in a useless and injurious manner. But the main branch of the tendril, after revolving for a time in a vertical position, spontaneously bends downwards, and in doing so raises the spur-like branch, which itself also curves upwards, so that by these combined movements it rises above the projecting end of the shoot, and can now move freely without touching the shoot; and now *it first becomes sensitive*" (p. 134).

On p. 181 of the same work, Mr. Darwin, frankly and modestly, and with true scientific spirit, confesses, "Why a delicate touch should cause one side of a tendril to contract, we know as little as why, on the view held by Sachs, it should lead to extraordinary rapid growth of the opposite side."

This sentence shows that Mr. Darwin himself, if not possessing a truly philosophic mind, has at least sufficient philosophic sense to avoid confounding *cause* and *means* in the way some of his so-called followers frequently do. To certain of these it would appear a sufficient explana-

tion of *cause* to say that the tendril clasped the support because the outside part grew faster than the inner; but this is really only an explanation of *means*, for we want to know the cause of this different rate of growth, which evidently is some extraordinary faculty of the plant, not to be explained on either mechanical or chemical principles alone. For, if it rested on mechanical ones, how can we explain why one tendril either does not clasp another at all, or, having done so, unclasps again? It is not a little gratifying to me to find Mr. Darwin driven to use the same expression with regard to these tendrils which I ventured to apply to the conduct of rootlets, viz. instinct. There is, indeed, no other term, so scientifically precise, that can be applied; for instinct simply means *the faculty of performing necessary and beneficial actions without consciousness or ratiocination.* It is, therefore, as correct to say that the conduct of tendrils and rootlets is guided by a vegetable instinct, as to say that the action of young animals is guided by animal instinct. Instinct is, then, a characteristic of both kinds of living matter, and it may be traced very low, if not indeed to the very lowest forms of life; and it is a quality completely absent in dead unvitalized matter. This conclusion gives no little

support to our contention that vital action is as distinct from mechano-chemical action as mechanics and chemistry are themselves distinct. We are at any rate in this case shut up to one of two inferences from the facts Mr. Darwin has placed before us, either that these plants have both some consciousness of their surroundings and a capacity of acquiring the properties necessary to their wellbeing, or that some intelligent agent has constructed them so and endowed them with such faculties that they are specially and wonderfully adapted to the situation in which they are found. Which hypothesis is the more credible one may safely leave to the verdict of any sane mind. As an example how what we look upon as human inventions and contrivances have been anticipated by Nature the following may be quoted from the same work:—

"A tendril which has not become attached to any body does not contract spirally, and in the course of a week or two shrinks into the finest thread, withers and drops off. An attached tendril, on the other hand, contracts spirally, and thus becomes highly elastic, so when the main foot-stalk is pulled the strain is distributed equally between all the attached discs" (p. 147).

Whatever mortal first discovered and applied the prin-

ciple of the spiral spring doubtless considered himself, and was esteemed by others, a very clever person; but Nature had been quite as clever long before. And what art is there in Nature, what still unrivalled wealth of beauty! How we should miss the solid greenery of the ivy, that adorns alike the wrecks of Nature and the ruins of human works. How could we spare the sweet woodbine, that twines innocently about the rude trunk and breathes its honey-luscious fragrance through the evening woods? or could we afford to lose from Nature's bounty the purple-blooming clusters of the grape? Yet all these and hundreds of other plants—so dear to the sight, so grateful to other senses—are only enabled to exist by means of those extraordinary and beautiful provisions which we have been considering. Had this world been the result of a mere blind struggle for existence, unguided by purpose or prevision, it seems in the highest degree unlikely that these plants could have developed such powers in time to avail them in so intense a struggle. There may, indeed, be in Nature many problems which try the faith and defy the penetration of the actuest intellect, many sorrowful, apparently cruel, facts which sadden the heart, but the more deep and loving our study of Nature

becomes, the more, I thoroughly believe, will a faith be strengthened in us, that it is neither without intelligence, without foresight, or wisdom, nor yet without at least mercy and benevolence that the universe we contemplate has been constructed and is still controlled.

V.

OF BOTANY.

Of the stem—Its symmetry and attitudes—The poet and the flower—Evolution a doctrine of hope—The true notion of the leaf—A law of Nature and its justice—The floating apparatus of the Urticularia—The design, ingenuity, and knowledge involved in its contrivance and construction—Denial no refutation—Leaf-form and leaf-order—Law of proportion—The flower; not a degradation of the leaves—The evolution of colour and odour—The Nottingham catchfly—Rationale of plant-sleep—Practical joke in a flower—The moral edicts of Nature—The fruit of research.

THE concluding portion of the preceding chapter was occupied with the consideration of the wonderful and interesting phenomena exhibited by climbing plants; and the reason that the subject was treated of at that time was that, according to the order of progress I have endeavoured to observe, we had come to speak of the ascending axis or stem of the plant. No doubt a great deal more might be said on this plant-spine, which appears in so great a variety of forms, from the crown of the daisy to the column of the pine. One thing may be remarked, as

being an obvious generalization, viz. the symmetric manner in which plants of all kinds tend to grow about this axis. It is by no means hard to discern ample natural cause for this symmetric tendency, but still the immense effect of this simple fact on the appearance of the world must not be ignored, and cannot, indeed, be overrated. At the same time, every plant might have been symmetrical, and yet not exhibited a tithe of the grace and charm which we behold in Nature. The marvellous subtlety, complexity, and (what one can only call) air of unconcern with which natural forms are wrought into subjection or rather coincidence with this law of symmetry, give rise to that æsthetic power whose operation we so often feel. Take any wayside plant and make an accurate drawing of it in its natural posture, and, if the drawing only be accurate, you will find in it a charm which is best defined by saying that there is a certain symmetry in the distribution of the mass, in the modelling of the form into response and counterpoise of curve and angle, which is, at the same time, secret and subtle in the mode of its execution. Or look in winter at a line of leafless trees, as seen inlaid on the horizon, and you will perceive that, although no two are alike, they have all a certain poise, an air of being deli-

cately balanced, which forms no small part of the æsthetic pleasure they produce. (There are, of course, cases in which they are maimed or warped by injuries beyond complete repair or elemental forces too potent to be successfully resisted.) Plants have been well symbolized—I think by Mr. Ruskin—as vegetative fountains. They do, indeed, rise from the earth with a certain impulse like a spring of water; some like a little bubbling well, some with the aërial grace of a Roman fountain, some as with the strong rush of a geyser. And, as a matter of fact, branch-division, apparently so haphazard a proceeding, is governed by the same simple law as rules the division of a water-jet or pipe; viz. that the two branches at a fork have the sum of their transverse sections equal to that of the branch below the fork. But their symmetric development is not the only element in plant-form which goes to feed the spring of that beauty with which so many are endowed. While this symmetry with its air of unconsciousness produces an intense satisfaction in our beauty-perceiving faculties, there is also a pleasure even more subtile and moving created by that aspect of dumb volition and dim but delicate consciousness which so many of the higher plants possess. This is a more recondite charm than the other,

and there may be many who hardly notice or realize it, but it is, none the less, actually existent, even as those rays of light, to which our faculty of sight gives no response, and which are only made perceptible by passing through a certain medium, are as really existent as those which the least sharp-sighted can perceive and distinguish. Every plant, over and above that structure which science describes with such laboured detail, has an individuality, a certain mien and air of purpose about it, which is a more prompt and intuitive and yet no less reliable test than the items of a botanical description. And when this individuality is perceived by a man of poetic faculty and power of literary expression, he can hit off in a line that which seems ever eluding the most painstaking scientist. Burns' "Wee, modest, crimson-tippèd flower" is a more clear and readily recognised description, one as sharply individual and incapable of confusion as the most elaborate statement and catalogic definition of Babington or Hooker. It is a description, too, not only general but special, for the three adjectives would not apply to the daisy of the meadow and the wayside, which is rather frank and fearless than "modest," but yet exactly depict the "mountain daisy," found only where it has had some "scanty bield," and

therefore with a look of shyness and reserve, such as its congener of the fields never affects. And of this description the immense power arises from the poet's being able, unlike the scientist, to leave the plane of mere physical fact and travel into the moral and emotional; the reason that this is a power being, that there is in the plant just that individualism which we associate with character and therefore with moral qualities. Nor is such the mere fancy of poetic and imaginative minds, because while such characterization can only be made originally by an imaginative mind, it is, when made, recognisable to many, if not to all. No one, of course, believes that a plant is consciously "modest" in the sense that a human being is, but it is none the less a true symbol of that quality—an unbreathed word formed on the silent, beautiful lips of Nature. And without these symbols how poor and bare language and literature would be! The loss of half-a-dozen plants and their symbolism would, in Yankee parlance, "bankrupt" every ancient poet and many moderns. Deprive, for instance, Hebrew poetry of but four —the Rose, the Lily, the Cedar, and the Vine—and what is left? Literature so bereft would be like some glorious illuminated missal deprived of its gold and azure and scarlet.

Evolution, as I have here accepted it, is a doctrine of progress and of hope, and it would almost seem as though the intellectual current—which is to the world of life what the electric is to the electro-magnet—grew stronger as the ages ripen. The phenomena, for example, of Twining Stems, which we lately considered, are more fraught, it would seem, with accurate calculation and foresight than any we have before encountered. But this class of plants must have been of late development, seeing their powers would only be required among a highly developed vegetation. And we shall see further on that a tribe of plants, the Orchids—obviously also late-comers—show the most delicate system of adaptation that Nature presents. It would thus seem as though external Nature, as we know of it in this planet, were becoming more highly charged intellectually as we approach the period of man. Nor can there be any reasonable doubt that whatever were the strange splendours of primeval jungles and forests, the world of to-day is richer and more refined in its beauty. So that, although we have to abandon the conceited conviction, so long prevalent, that the earth, if not the world, was created solely for the delectation or edification of mankind, we may console ourselves with the

knowledge that we dwell in so ripe an age of the planet, and are so beset with beauty and instruction.

But we must cease marking time at our very starting point, and make an advance, which advance brings us to what is perhaps most significant of all plant-organs, the leaf. One cannot congratulate the botanist on the felicity of his definition of a leaf as "an expansion of the bark," a phrase conveying just as little information on the subject of the nature of a leaf as is well possible without its being an absolute contradiction of fact. It is, indeed, incorrect—as incorrect as to say that the hand is an expansion of the skin. A leaf is rather a subdivision and expansion of the stem, over which the bark is stretched—even as the skin over the human hand or over the webbed foot of a bird. The midrib, veins, and nerves of a leaf correspond to the bone, cartilage and muscle of an animal's limb. This alteration renders the definition much more consistent with the other doctrine of modern botany, that a plant consists of an axis, stem, and leaves —its primary divisions. For, as soon as we get beyond the very simplest organisms, where the organs are undifferentiated, and the functions—afterwards performed by the various plant-organs—only exercised by the general

surface of the vegetable mass, we come to the differentiation of leaf and stem, the one the central, the other the radial; the one representing generally the vertical impulse, the other the centrifugal. Structurally considered, then, the leaf might quite well be defined as an expansion of the stem—an expansion existing long before any bark, even in its broadest sense, is discoverable—but, functionally, it is better described as an aërial rootlet; for the stem itself, like the rootstock, the more distinctly it becomes a stem, the more completely discontinues any direct nutritive action, while the leaves always remain operative in that respect, although their function again becomes clearly differentiated from that of the rootlets. And, even in this reference, our analogy of a leaf to the hand is singularly appropriate. What are leaves but so many searching, suppliant palms, held out for the alms of the physical heaven, whereon its largess of rain, and dew, and sunshine is outpoured? But more instructively and accurately may we take the hand and arm as analogous to the leaf and its petiole—it is a vegetable limb in which we have all varieties of proportions between hand and arm—some all hand and no arm, some all arm and no hand.

There is certainly no theme in connection with our

subject more embarrassing, by reason of its extreme fertility, than this of the leaf. Whether we regard it in view of its function in plant economy, in respect of its utility to the plant itself, or consider its variety and beauty as a source of refined and ennobling pleasure to man, the theme is alike capable of indefinite expansion. Though, with regard to the former, it may justly be said that any signal failure in utility in a plant-organ would mean the certain and speedy extinction of the plant; for, while Nature often exhibits the dignity of repose, she has obviously no faith in the nobility of idleness, and adopts certain methods of exterminating the idler. Even when we find that portion of a plant, which we would botanically designate the leaf, failing to fulfil its usual offices, we will still find it told off to a specific duty, while its function is assumed by some other organ; for Nature's inevitable condition of ultimate continuance is utility—is the discharge of some essential office. No doubt, in the course of evolutionary progress, certain organs may become unnecessary and rudimentary without being obliterated, but they bear in themselves the sentence of death, and must eventually disappear, unless they can make themselves useful and necessary in some new manner.

Nothing can be more thoroughly just than such a law—one pervading creation, not excepting the moral and spiritual nature of mankind. Activity tends to strength and development, inaction to weakness and loss. The principle is so universal, and apparently self-demonstrative and automatic, that we give Nature no credit for this exact equity of hers, although the supposition that a world might have existed, in which a different law was operative, is by no means so wild a conception as is often seriously entertained by scientific men. But it is the fashion now to discount the virtues of Nature, as though they were something inevitable, while it is considered quite allowable to stigmatize her as cruel, merciless, and so on, because the earth will not get out of the way of a falling body, which happens to be human, or water declines to support an organism heavier than itself, because that organism has a wife and family to mourn his loss. Nature is sublimely impartial, and therefore intensely just. Any confusion between moral and physical condition, any deviation from the rectitude of law in the direction of that spurious form of justice which we call poetical, and which is merely sentimental, would involve an unreason, a chaos, and a complete loss of those charac-

teristics which convince us of the sanity and stability of the cosmos. We can, in this case at least, claim for Nature a justice which, if often terrible, is always majestic.

What most compels our astonishment and admiration, in regard to the utile aspect of leaves, is the infinite variety of form, and even method, they exhibit, along with a perfect equality in point of fitness. It would be, I think, impossible to make corrections on Nature, and say in any case that, from the plant's own point of view, its present form of leaf could be advantageously replaced by any other. This is doubtless accounted for by such a doctrine as the survival of the fittest, but it is certainly ortunate for us that the fittest should have included so great, so useful, and so delightful a variety. But the question is, how came the fitness? Whence this accommodating power of organisms? A haphazard variation it can hardly be, for the advantages of many forms can only have come into play when the change has been carried out to a pitch approaching perfection. Take such a case as the floating apparatus of the Urticularia.

"Small *ascidia* or sacs are connected with the leaves which, about the time of flowering, are filled with air, and buoy the plant to the surface. The opening of each sac is

surrounded by forked hairs composed of four cells, and is closed by a transverse cellular membrane, like the valve of a pump, capable of opening from without inwards, and which resists when it is pressed from within outwards. The physiological action of these ascidia is full of interest. At first they are filled with a somewhat gelatinous liquid, which by its weight assists in retaining the plant at the bottom of the water. Very soon the branching hairs already described, which project into the interior, secrete a gas, which accumulates as the gelatinous substance diminishes. By-and-by, when the vessels are full, the plant gets light and buoyant, and, disengaging its roots from the soil, rises to the surface of the water and flowers. The flowering over and the fruit mature, the air disappears from the ascidia, the valve allows the water to enter, and again the plant sinks to the bottom, to remain there until Spring stimulates its ascidia again into activity" (Brown's Manual of Botany, p. 158).

Unnecessary and almost irreverent does it seem to offer any comment or commendation of a system of contrivances so ingenious and so adequate. Had such a system been suspected to be of human origin, we could not praise too highly the inventive genius and scientific acquirements

therein displayed. But being only a piece of Nature's handicraft, we are now taught that there can be no ingenuity or wisdom or foresight involved in its construction, but that it has somehow been blindly sculptured into its present form, through the influence of its varying environment. That this interaction of organism and environment is and has been a most important creative factor, operative and potent to an extent which at one time would not have appeared credible, it is not my wish to deny. None the less distinctly do I maintain that, so far as my imagination and reason can carry me, I quite fail to see how this agent could, apart from some pervasive intelligence in Nature, give rise to an organism whose structure seems to involve, not only an accurate knowledge of hydrostatic and mechanical science, but the inventive and executive powers to bring that knowledge to practical effect. For this is what I fail to see, how a slight accidental variation in the direction of this system could be of the least use to the plant. Anything short of a perfect adjustment of the apparatus would be useless or worse. Of what use, for example, would the ascidia be, if the gas were not evolved in the necessary amount to buoy up the plant?—they would be mere ballast to keep it

down. Or if, on the other hand, the ascidia began as mere air-bags, the plant must be continuously at the surface and could not in this way acquire its extraordinary habit of leaving go with its roots. The only explanation, then, that we pretend to give of such an elaborate phenomenon is, that it is apparently the work of intelligence of a very high order, and that apart from such intelligence we fail to understand its origin. In employing this argument, we certainly rely somewhat on the analogy between the works of man and those of Nature. We know that the construction of a machine and the creation of a work of art involve certain pre-existent powers and qualities in the man who produces them. So, in like manner, we argue that we can infer the existence of an intelligent Power from the existence of intelligence-involving structures in Nature. There is only one method of escaping this conclusion, and this method is adopted by Professor Clifford and other anti-theistic writers, and is to deny point-blank the validity of the analogy, and to maintain that, although there may appear to be the same or greater amount of thought involved in the construction of some natural objects as there is in some human work, still the former is not necessarily the work of intelligence although the latter is. But there

is no attempt, so far as I know, to disprove the validity of the analogy; it is simply and brusquely denied. Yet it appears to me, being one at once so obvious and so conclusive to the majority of human minds, that it cannot be thus peremptorily dismissed without some reason given. For to deny it, is entirely to block the way of any progress in the philosophy of Nature, unless we are to dignify a purely materialist science, quite devoid of any intellectual, moral or spiritual significance, with that name. It is to land us in a complete ignorance of Nature, except from the strictly physical side; it is to abolish at once the religion, the philosophy and the poetry of Nature. That such denial hamstrings at once the argument in favour of the action of intelligence or any moral quality in Nature is no more proof, however, that there is truth in the denial, than the fact that it is open to any one to deny the postulates on which the whole of a science, such as Euclid's geometry, depends, disproves the truth of the postulate and the dependent science. One necessary geometric postulate is that two straight lines cannot enclose a space. Any one who chooses to deny this at once deprives you of the power of convincing him of the truth of the first book of Euclid. Or to take a still simpler instance, a man

might say he did not see why two and two always make four; and he would put it out of your power to prove to him the simplest proposition in arithmetic. Similarly to assert that the nice adaptation and ingenious contrivance observable in Nature, is no sign of intellectual design, renders it impossible to prove to the assertor anything whatever as to any moral or intellectual qualities otherwise deducible from the facts of the cosmos.

In the decoration of this our beauty-abounding planet, the leaf is certainly Nature's most effective instrument. Whether it be the pleasant verdure of field and lane, the soft reposeful masses of blending woods, or the solemn majesty of pathless forest that we regard, we cannot but attribute much of their beauty to the foliage in which they are clad. And if natural landscape owe so much to the leaf yet much more does each individual plant.

The green colour prevailing in leavage is an oft-acknowledged and a real source of satisfaction to the eye, and that although this same colour is the most difficult for a painter to reproduce successfully—that is to say, in such a manner as to cause a repetition of the same satisfaction. The older masters, whose colour is the wonder and despair of modern artists, banished it from their landscape-

distances, and the daring Turner constantly evaded its use. Nature seems to possess some still undiscovered art, some secret principle, which enables her to use that colour with an effect the ablest artist has not yet acquired. No one ever saw a complexion spoiled by the proximity of a green leaf, however many have fallen victims to a green ribbon.

Then in texture how various—coarse and homely in the Dock and Nettle, harsh though handsome in the Elm, silken in the Beech, lacquered in the Oak, and burnished in the Laurel; like leather, like paper, like velvet, like wax, like metal, like cloth, and unlike any of these things: and in form still more diverse, and nearly all beautiful, either by reason of individual design or by virtue of combined effect, and through the union of these. In beauty of individual form we must, as before, accord the first place to some of the more elaborate and lovely fern fronds, but of charm of combined effect almost any branch or plant will afford us illustration. No matter how simple the original form, Nature can elicit from it shapes of grandeur and of grace, as the Pine and the Larch may witness. Many a wayside weed, too, as we call them, displays when we study its form an elegance, a daintiness of outline, produced by leaves

of humble and simple shape. The sources of this charm are obedience—firstly, to the well-known law of phyllotaxis or leaf-order; and, secondly, to the less-known law of leaf-proportion; the former governing the position of leaves on the stem, the latter the variation in size and shape that they exhibit in their upward course. As to the former, not only is the general mode of growth spiral, but each plant, and frequently whole orders, adopt one particular pattern of leaf-order. If we liken a plant to an ascending jet of water, giving off drops from the central column, we must, to complete the resemblance, suppose this column to have had a rotatory motion about its axis, so that the drops, instead of being given off in rings, would be given off in a continuous spiral. In a pine-cone the scales come off in close succession, just as drops would from a revolving fountain, but in other plants a rhythmic pause is observed, so that the leaves stand at distinct and definite intervals along the stem. Some are like rhymed couplets, two and two at measured intervals, some, as the notes in a chime of bells or the endings in a stanza, respond after a longer space and in a more complex order. And, through this suggested simile, we can understand how a plant-form may give an ever fresh pleasure to the eyes, even as a

familiar verse or well-remembered cadence may give unpalling pleasure to the ear.

What I have called the law of leaf-proportion is clearly exemplified in the subtle, gradual diminution in size, accompanied often by even more subtly managed modification in shape, which leaves show in their ascent of the stem; that delicate fining off of the foliage preparatory for the final transition into flower. It is not difficult to understand that this is perfectly natural, that is in perfect accord with other mechanical forces and phenomena in Nature, but this only argues toward the praise and admiration of natural law, not toward a contempt for its fruit. The mechanical laws of Nature are never contravened, the apparent contravention being always obtained by a real obedience. Man, for instance, can produce the apparent contradiction of making water pump itself to a height greater than its original source, and that on the simple fact that two pounds of water falling one foot will raise one pound two feet. So can Nature make the lower mechanic force available in support of the higher vital action without any violation of the laws of the former. And the wonder is not how, being constructed as they are, plants ascend into the air and take such a course, but where

did they learn the art of so accommodating themselves to surrounding forces—forces which gave no promise or prophecy of such a development of Nature?

There must, doubtless, have been a time in the history of the planet, when foliage was even a more prevailing element in Nature's adornment than it is now; for we shall see, when we come to treat of the flower, that the more conspicuous and brightly-coloured blossoms have been evolved through the instrumentality of insect fertilization. Time was, ere Nature seems to have dreamed of the Violet or the Primrose, still less of the Rose, the Lily or the Orchid, when vast green-waving savannahs rolled for leagues without a star of blossom, and sombre, pathless forests stretched their stately aisles and solemn verdant vistas unlit by the sweet face of any floret—ere Snowdrop, on her pensive bells, rang in the Spring-tide, or Rose blushed in the summer, or the faint autumn Crocus lent its timid beauty to the fading autumn fields. Fair enough, then, doubtless—too fair for the rude sense of the behemoth and his huge companions, but not yet fair enough for that strange prodigy of the ages, Man—Nature had yet to deck herself as with bridal raiment for the coming of her first mate and conqueror and monarch.

"The flower," say the men of science, "is a modification of the leaves;" and this truth, though it be partial, is instructive. If it be held merely to mean that the original elements of the two are similar—that, in point of fact, in the earliest stages of their formation they are identical and indistinguishable, so that the embryos, as we may call them, have a possibility of becoming either the one or the other, it is true. But if it means, as it seems sometimes to be put, that the flower is made up of unsuccessful leaves, of leaves that have failed to become leaves, it is a misleading doctrine. Morphologically considered, as throwing light on the structure of the flower, it is valuable and illuminative, even as the anatomical doctrine that the skull is a mere folding-in and modification of the spinal cord, is a convenient and instructive hypothesis for the anatomist. But, looked at from a more central and philosophic stand-point, it is far more correct to say that the flower is the culmination of the plant, the apotheosis of the leaf, and the brain the culmination, the crown and capital, of the animal organism. That the flower is not simply the result of the failing of the growth-current, as the foam is the produce of the breaking wave, is proved by the fact of flowering frequently preceding foliation, and is corroborated

by the certain knowledge we have that flowering is a more exhaustive process—a process requiring greater energy than leafing. The assertion, then, that petals are degraded leaves is absolutely false—as false as to say a man is a degraded boy. The petal is rather a refined and sublimated leaf than one that is fallen from a higher estate. One might as well call a perfect lady a degraded peasant; what is persistently left out of sight being that what is lost in vigour and force is gained in delicacy and refinement. Even if we accept as flowers all that are scientifically so called from their functions, it may safely be asserted that they display a yet finer and more finished workmanship—a material more dainty, and pure, and rare than that of the foliage. Though it must be admitted that the decorative importance of the flower varies, so far as we estimate it by ordinary powers of vision, from a position of complete supremacy to one of comparative insignificance—from the splendid atonement of the bizarre Cactus to the unobtrusive florets of the majestic Oak. Yet many quite inconspicuous flowers contribute greatly, if not permanently, to the beauty of plant-form. The airy and tremulous catkins of the Birch, that seem to shake with the same conscious charm as the trembling pendants in the ear of a beauty at

her bath; the green rosettes of the Elm, that render rich the broidery of its branches against the soft cloud or tender twilight of May; or the carmine tufts that gem the greening branches of the Larch, may be brief in the cycle of their beauty, yet make no small part of Nature's spring-tide witchery.

Of the means through which flowers have been evolved from the less conspicuous and attractive forms to those of the highest beauty and splendour, a flood of light has of late years been thrown by the original and interesting researches of Darwin, Wallace and others. These have laid bare to us, at least in many places, what we may call the industrial system of Nature. We see, for the first time as it were, the very movement of those shuttles and spindles that are continuously weaving the web on Nature's unresting, unhastening loom. There is displayed to us that complex and efficient machinery, that blessèd conspiracy of minute and obscure causes, that elaborate and delicately-adjusted correlation of divers agencies, through which all that is delightsome or wondrous, strong, strange, or potent in Nature has been evolved, is sustained, cherished and perfected.

The aim of Nature is progress, and her method com-

petition—every organism is on its mettle to sustain itself and its successors against foes and rivals. But it is a competition, not blind and mechanical, but organized, complex and intelligent. The function of every organism is dual—to sustain, improve, and increase itself, and to provide for its successor. In the first it is purely self-seeking, in the second it is rather self-sacrificing; and it is instructive to note that it is to this latter and renunciative act that the energy, effort and contrivance of plants are the more intensely directed. No doubt many plants survive the act of reproduction, though by no means all; at the same time, the flowering and fruiting of a plant is the most exhaustive and perilous of its actions. To many the act is necessarily and invariably fatal. Through these two forms of activity, the productive and the reproductive, the energy of the organism is directed towards the development of its species. The power of advance in each individual is very limited, but the power of a long successive series is indefinitely great. Each organism has a certain latitude of change—a certain range of variation, through which it is at liberty to move; its successor has a latitude no greater, but measured from a new point, and that this new point may not tend to coincide with the old,

and so the organism relapse again to its old condition, the edict of intermarriage or cross-fertilization has been pronounced, and in the execution of this law no pains and no means are spared, from those comparatively primitive and simple to those most elaborate and exact.

At first sight the proximity in which the organs of sex are usually found to each other seems to point to self-fertilization as the object of this arrangement; but a closer and more intelligent examination has led to the establishment of the dogma that Nature abhors self-fertilization, or, if that be too strong a manner of expressing the fact, that Nature aims at and prefers cross-fertilization. It has further been established, through the unwearying and sagacious investigations of Dr. Darwin, that cross-fertilization contributes, not only to introduce variety, but also tends to the invigoration and what we may call improvement of the species by which it is practised. As a rule self-fertilization is but a last resort in the event of the stigma failing to receive or come in contact with pollen from another plant.

To enumerate and describe even the most striking instances of the means which Nature takes of carrying this —her edict of intermarriage—into execution would itself

be work enough for one evening, so that I must be content with a few illustrations. There are, as most of you know, three agencies through which this process is accomplished, viz. the wind, insects and birds. A very large class of plants, such as the grasses and many forest-trees, depend on the wind for the distribution of their pollen, and it might seem that with so comparatively rude an agent it would be difficult to secure crossing with any certitude. By several very simple expedients the desired end is aimed at and accomplished. In all the grasses, for example, the stamens when ripe dangle outside the floret, so that, when their light dry pollen is carried away by the breeze, little or none can reach its own stigma, which is sheltered by the glumes; and in many cases a yet more certain provision is made in the ripening of the stigma before the stamens, so that by the time its own pollen is matured the stigma is already preoccupied and fertilized by other pollen, or is effete and no longer capable of being affected by its own. Again in many plants, notably in the willow and other trees, crossing is rendered imperative by the individual plant producing flowers of one sex only. But this method of wind-distribution is rude and clumsy compared with the subtler and more refined methods that occur in Nature. In

the first place, it is extravagant, involving the production of an immense amount of pollen, the majority of which necessarily misses its mark; and secondly, while it obviously tends to produce and encourage that elegance and refinement of form which gives their charm to so many of the grasses, and the grace and shapeliness of catkin and cone, it does not tend to elicit and foster those so delightsome qualities which we all associate with the popular idea of what a flower is, viz. Colour and Odour. There may have been, and probably has been, a period of the earth's history in which the wind was the only go-between in the vegetable world, and if we can conceive of a human intelligence existing at that epoch and entering into the spirit of the creative method, and at the same time having discovered that the means of developing colour and odour lay latent in the plant-world, we can believe that such an intelligence with such data could have prognosticated that Nature would develop some new method by which these latent qualities would be elicited. What such method and agency was to be it might have been beyond his power to predict, but this much might have been foretold, that the new agency must be of a more discriminative character than the old. To fulfil this office, or at least with the

capacity for fulfilling this office, a great number of the insect world have come into existence.

Now, while it is easy to understand the action of this system of insect-crossing and to note its necessary effects on the colour, odour and shape of flowers, *now that it is in full working order*, it is by no means easy to understand or imagine how it took its rise. How did the first dawnings of colour-sense in the insect operate to produce the faint beginnings of coloration in the flower? They seem to have grown up side by side. Whence came the initial impulse that started them on their mutually involved orbits of progress? From that same onward and upward tendency which characterizes Nature, and without which its progress is not to be accounted for.

It is surmised, not without strong probability of truth, that the first method adopted by plants to encourage the visits of insects was merely the production of an abundant supply of pollen upon which many insects—especially the Diptera—feed; but this comparatively rude and extravagant plan has been superseded in the more highly developed flowers by that of honey-secretion. That honey was ever a "waste product" of the vegetable world, I am certainly inclined to doubt, as being a fact inconsistent with the

economic reasonableness of Nature. Certain it is that in nearly, if not in all instances, in which this delicious product is found, it clearly performs a service to the plant that secretes it; and in most cases the nectaries and honey-hollows are so accurately and wisely placed that they seem absolutely to ensure the execution of that service for which they are meant, to attract and to reward its insect visitors. But that a plant should offer a *douceur* to its visitants is not enough, it must almost make its presence notable to them at some distance; and this is effected by two means, colour and odour. Brightness and purity of hue are, no doubt, the most advantageous qualities for a flower to possess; but diversity is also necessary that insects may recognise those plants to which they are specially adapted. That some insects, at least, have a decided sense of colour has been proved by Sir John Lubbock. This being so, there is no difficulty in seeing that the development of bright and pure colour is encouraged by this relation, and that certain flowers would have an advantage through being distinctive, in which reference it is worthy of remark that the Orchids and other highly specialized flowers have a tendency to extreme individuality of form and marking. Even those delicate pencillings of colour such as we find

so markedly in the Pelargoniums are not without their utility, and are believed to act as honey-guides in pointing the way to the nectaries; and perhaps nowhere is the union of utility and beauty more wonderfully instanced than here.

But Nature is too industrious to strike work with failing light, when colours are no longer easily perceived or distinguished, and in order to utilize the dusk and even the dark, she has gifted flowers with the power of manufacturing perfumes by which to communicate with and attract night-flying moths, which are absolutely necessary to the fertilization of some flowers. The following description by Sir John Lubbock of the behaviour of *Silene nutans* is an excellent example of the manner in which a flower utilizes the visits of moths:—

"The upper part of its flowering stem is viscid, from which it has derived its local name, the Nottingham Catchfly. This prevents the access of ants and other small creeping insects. Each flower lasts three days or rather three nights. The stamens are ten in number arranged in two sets, the one set standing in front of the sepals, the other in front of the petals. Like other night flowers, it is white, and open towards evening, when it also becomes extremely fragrant. The first evening, towards dusk, the

stamens in front of the sepals grow very rapidly for about two hours, so that they emerge from the flower; the pollen ripens and is exposed by the bursting of the anthers, so the flower remains through the night, very attractive to and much visited by moths. Towards three in the morning the scent ceases, the anthers begin to shrivel up and drop off, the filaments turn themselves outwards so as to be out of the way, while the petals, on the contrary, begin to roll themselves up, so that by daylight they close the aperture of the flower, and present only their brownish-green outsides to view, which, moreover, are thrown into numerous wrinkles. Thus, by the morning's light the flower has all the appearance of being faded. It has no smell, and the honey is covered over by the petals. So it remains all day. Towards evening, however, everything is changed. The petals unfold themselves, by eight o'clock the flower is as fragrant as before, the second set of stamens have rapidly grown, their anthers are open and the pollen again exposed. By morning the plant is again asleep, the anthers are shrivelled, the scent has ceased and the petals roll up as before. The third evening again the same process, but this time it is the pistil which grows, and the long spiral stigma on the third evening takes the position

which on the previous two has been occupied by the anthers, and can hardly fail to be dusted by the moths with pollen brought from another flower."

This one instance exemplifies, in addition to its beautiful correlation of plant and insect life exhibited in the arrangements for moth-fertilization, the defensive contrivances of Nature and the rationale of plant-sleep. While there are certain insects which it is beneficial for the plant to attract, there are others whose visits would, if not injurious, be at least unprofitable, and against these plants are protected in a variety of ways by hairs, hooks, prickles, viscidity, and other defences. This fact is very significant and extremely difficult to account for without assuming consciousness in the plant or an intelligent power directing its development. There is something, too, touching and poetic, while eminently reasonable and in harmony with cosmic custom, in the plant, like the animal, taking its diurnal or nocturnal period of repose; nor is there any doubt that the plant opens at the time most advantageous for itself, and closes when it would be unnecessary or injurious to remain open. Then the whole arrangement is so complex, as well as complete, that no series of tentative variations, however

numerous and extended over how-long-soever a period, seems capable of accounting for the perfect adjustment of the action and structure of the plant to an agency so diverse and independent. But I must be allowed to give an instance, if possible more startling in its ingenuity of contrivance. It refers to the fertilization of a tropical orchid, one of the Coryanthes, as observed by Dr. Crüger. He found that the labellum * of this orchid is hollowed into a great bucket, in which drops of almost pure water continually fall from two secreting horns which stand above it, and when the bucket is half full the water overflows by a spout on one side. The bare part of the labellum stands in the bucket, and is itself hollowed out into a sort of chamber with two lateral entrances; within this chamber are curious fleshy ridges. The most ingenious man, if he had not witnessed what takes place, could never have imagined what purpose all these parts serve. But Crüger saw crowds of large humble-bees visiting the gigantic flowers of this orchid, not in order to suck nectar, but to gnaw off the ridges within the chamber above the bucket. In doing this they frequently pushed each other

* The large under-lip of the flower, really formed by the back or upper petal twisted round, as is the manner of orchids.

into the bucket, and, their wings being thus wetted, they could not fly away, but were compelled to crawl through the passage formed by the spout or overflow. Dr. Crüger saw a "continual procession" of bees thus crawling out of their involuntary bath. The passage is narrow, and is roofed in by the column; so that a bee, in forcing its way out, first rubs its back against the viscid stigma, then against the viscid glands of the pollen-masses. The pollen-masses are thus glued to the back of the bees which first happen to crawl out through the passage of a lately-expanded flower, and are thus carried away. When the bee, thus provided, flies to another flower, or to the same flower a second time, and is pushed by his comrades into the bucket and then crawls out by the passage, the pollen-masses necessarily come first in contact with the viscid stigma and adhere to it, and so the flower is fertilized. Had any human being invented such an arrangement we could not fail to credit him, not only with an exquisite inventive faculty and power of precise adaptation of means to an end, but also that form of practical imagination that could foresee the "crush at the door," and the consequence of the ducking on the conduct of the bee. Almost a sense of humour seems to be involved in the

structure, since the whole proceeding is just an excellent and innocent practical joke at the expense, without the injury, of the insects, who seem in no wise deterred or offended, but ever ready to renew the fun. Now, the case of this orchid, if very striking, is by no means exceptional; it is rather the general rule, in such genera as the orchids, for the plant to possess some equally ingenious contrivance. But one more illustration on this topic, and I must desist. In Mr. Belt's "Naturalist in Nicaragua" he gives this account of the manner in which small birds, such as humming-birds, are employed in fertilization: "A climbing plant (*Marcgravia nepenthoides*) expands its flowers in a circle, and these hang down like an inverted candelabrum. From the centre of the floral circle and underneath the flowers there is suspended a number of pitchers, which are full of nectar when the flowers are ripe. The honey attracts insects and the latter attract birds, especially humming-birds. Before the latter can get at the honey-bearing pitchers, their backs must brush the open flowers out of which the pollen is ready to be shed, and in this manner they convey it from plant to plant and cross the flowers." Such a proceeding on the part of an animal would cause us to assign to it a rational mind, with the

power of correct inference; for the secretion of honey is not for the prior purpose of attracting insects, in themselves not useful, but for the ulterior purpose of securing the visits of the birds which are necessary to the crossing of the flowers.

If such things can be produced by the mere incessant jostling of atoms as in a lucky-bag, if the work of consciousness can be more perfectly accomplished by that which is unconscious, and the part of intelligence better played by the unintelligent, then must we admit that consciousness is but a cloud, and intelligence a thick veil, and thought a diseased and mistaken evolute of divine imperturbable matter! Not that I mean in any way to gainsay the fact that the creative process may be historically graduated, or, as it is named, evolutionary. That, I think, no enlightened and well-informed person can seriously doubt. What I do deny is, that this process is to be accounted for on any hypothesis which undertakes to dispense with the necessity for previsive and controlling intellect. To deny the existence of such intellect is like denying the fact of atmospheric pressure, because we do not feel it; for the reason that the working of creative intellect does not obtrude itself upon us, is just the same

as that which makes us unconscious of the miles of atmosphere piled on us, viz. that it acts equally in all directions and at every point successfully combats itself. Thus in Nature ingenuity of attack is met by ingenuity of defence, elaborate needs are responded to by equally elaborate machinery and contrivance. The impartial thoughtfulness of Nature puzzles us. We are offended to find the existence of a noxious weed, insect, or parasite cared for as tenderly as Man's. But everything in Nature, Man not excepted, is to be put on its mettle, the great meaning and moral of Nature is activity and progress, and one of her greatest functions is to stimulate Man, even by what seem hardships and cruelties, to yet intenser and more divine activity. Where Nature is lavish and indulgent, Man becomes indolent and often degraded. Nature pronounces thus for industry, but not for industry alone. She indorses, yea, rather, anticipates the dictum of Mr. Ruskin, "Life without industry is crime; industry without art is brutality." While no organism can survive without the full exertion of its powers, and even the effort after advancement, neither is there any that does not tend to some beauty, that does not obey, in measure however humble, the law of grace as well as that of gain. The

coarse and vagrant Colt's-foot that bastes together with straggling rootlets the loose soil of the embankment or the fallow, the slovenly and trampish Dock and its shrewish consort the Nettle, have their aspects and moments of fitness, and seem often, like Wordsworth's gipsy, "Weeds of glorious feature." Yet these are the mere idlers and runagates of the plant-world, outlawed from the civility of the park and lawn, where the Buttercup, and Daisy, and Cowslip are as invited guests.

But time presses, and however unfinished be my theme, it must now be left as it stands, and I must rather leave you to expand the line of thought for yourselves, and to draw from the significant facts I have mentioned their inevitable deductions. The researches and results of modern science, instead of in any wise detracting, to my mind, from the wonder and beauty of the Cosmos, and the reverence we feel for its imposing and still, in a great measure, mysterious order, rather increase the wonder, emphasize and illuminate the beauty, and deepen into awe that reverence. So let science go on unafraid to the darkest and furthest recesses of Nature, strong in the assurance, fearless in the faith, that nowhere can she miss the footprints of a supreme pervasive intelligence, nowhere

find herself in a region alien and unresponsive to reason, nowhere fail, though she alight on the furthest star, brood over the strife of primeval atoms, or read the riddle of life's beginning, to perceive and devoutly acknowledge, "Thou art there also!"

VI.

POETRY AND SCIENCE.

An incorrect antithesis—The kernel of the poetic idea—The prosaic air of scientific statements—No necessary hostility between Poetry and Science—Automatism—It must start from matter in a simple and uniform condition—The difficulties involved—The wonder and mystery of life—Contractility no equivalent—Sensitivity of living matter—Chemical evolution a baseless assumption—Affection towards a machine impossible—The sailor and his ship—Of Nature-poetry—Teaching of true science—Treatment of Nature by poets—True science enlarges the poetic domain.

THERE is a popular but inexact and misleading antithesis often stated between Science and Poetry; and, in consequence of this, it is often maintained that the increase of Science means the decrease, if not extinction, of Poetry. The premiss being defective it is not surprising to find the conclusion erroneous. The excuse and the reason for this false antithesis are to be found in the fact that, while the word Science is employed with some degree of definitude and exactness, the word Poetry is used in a vague and inexact manner. Science

undoubtedly is, in this case, employed to signify that organized, systematic and well-attested mass of knowledge of natural phenomena, to which—although the nucleus has so long existed—so large and important additions have been made in modern times. Poetry has been here used, however, not in its exact sense of an art in the same sense as painting, sculpture, and music are arts, but as meaning what should rather be called poeticalness, viz. that charming quality of beauty which is possessed by an idea, whether expressed in words or in any other medium. For an art and a science are not in antithesis to each other, seeing that every department of things has an at-any-rate-possible art, as well as a science: and, as a matter of fact, it would be easy to show that despite the prevalence of science, the present age has produced its full quota of poets and poetry. But it is easy to perceive that the facts of science may tend to divest Nature of the poetical aspect in which she had hitherto been regarded. Now the kernel of the poetic idea will be found to be personality and consciousness, and the staple form of poetic expression is personification. It is this that gives all early religions and languages their poetic air; for in them all powers are personal, and to all objects there is a certain ascription of

consciousness, and it is just because science tends to dispel belief in this personality and consciousness that it seems so inimical to poetic sentiment. But it may further be asked, Why is this idea of personality or consciousness so essential to poetry? It is simply because it is not possible apart from this to produce that emotional exaltation wherein arises that peculiar pleasure which a poetical expression or idea produces. We cannot by any device raise our emotions to what may be called the necessary *temperature* for poetic excitation over any mere thing, so long as we continue to regard it purely as inanimate, unconscious, impersonal. It is, in fact, absolutely impossible for us either to love or hate a *thing* pure and simple. Whenever for any reason our affections do get attached to any inanimate object, we find ourselves unconsciously endowing it in our minds with a species of personality, and when we come to inquire into the cause of our regard for it, we discover it is founded on some personal association, or that it arises from some real or imagined quality in the thing which either suggests consciousness in it or personality in its cause. Certain it is that the more our feelings are aroused the more eagerly do we seize upon that ready and ever effective form of

expression, personification, to enable us to give them adequate utterance. The orator that would excite or sustain moral enthusiasm in his audience does not speak of virtue, justice, religion as of abstractions. He clothes them with the splendid and touching personality of womanhood. Further, we not only invest with a sort of personality things that in reality may have none, but wherever our affections are engaged we tend to exalt the *degree* of consciousness and personality which the object of our feelings possesses. Thus the owners of pet animals address them almost as they would human beings, and seem to attribute to them all human faculties.

On the other hand, Science is eminently impersonal, and deals with the general rather than with the individual. Hence there is always a distinctly prosaic air about all scientific statements, and this it is that engenders the belief that Science is inimical to Poetry. Is not then, it may be asked, the thesis true that Science and Poetry are antithetic and in opposition the one to the other? We reply in the face of appearances, "No," for it is only in *method* that the two are necessarily opposed. The *results* of scientific research may yield a fertile soil for the seeds of poetic imagination—or, possibly, they may not. The

discoveries of Galileo and the laws enumerated by Kepler and Newton, for example, have not rendered the universe a whit less poetical than it was under the old cosmogony, and have rather added a new domain wherein the poetic imagination may range. They were, in fact, no more destructive of true poetry than they proved to be—as was so much feared—of true religion; the fact being that so long as Man is Man he can never be permanently deprived either of a poetry or of a religion. It is at the same time true that Science in some particular phase may appear to be hostile to one or both, and, if to one, usually, if not invariably, to both. So it may seem to be at the present, and indeed really is, if we were to accept all that is written by scientific men as being in itself scientific. And it is just because I do not think this to be the case that I would be prepared to maintain that the real discoveries and sure acquisitions of modern Science are not destructive either of poetry or of religion, meaning of course by each of these not what is accidental, fugatory, and adventitious, but whatever is really essential and characteristic in them. One is no more bound to reject religion because the earth goes round the sun, than one is to abandon poetry because the moon is no longer a goddess and the streams are no longer

nymphs. But it must at the same time be admitted that there are theses and theories promulgated and upheld in the name of Science which seem designed to withdraw much of their sustenance from both the poetic and the religious faculty. These theses and theories, although presenting some variety in detail, may all be comprised under the general term of Automatism. By the defenders of this philosophy an attempt is made to account for the whole of Nature and the universe as we now behold it, including man, by means of the original properties of matter. No doubt, if we were to postulate matter to have originally existed in a chemically differentiated condition, we could go some way in the construction of a universe without having to call in the aid of any new agent to account for the results witnessed. But this is a position—a postulate—which neither would nor, indeed, *consistently* could be admitted by the advocates of this system; for, were they to do so, they could at once be called upon to account for the complex, definite, exact, and beautiful laws governing chemical action, laws which seem to demand for their conception supreme intelligence and surpassing wisdom. It is, therefore, a logical necessity for the holders of the above doctrine to maintain that the chemical differences

of matter must have been evolved by some previous process from matter in some simpler, more primitive condition. There is only one simple condition of matter at which they can logically stop, viz. that of uniformity, homogeneity; and this uniformity, this homogeneity, this sameness of matter must extend not only to the quality, the kind, but also to its distribution of it—to the spacial quantification of it—as also to its temperature; for the only elements of variation in a—supposed—uniform matter are relative distance or spacial quantification, and relative movement or temperature; therefore it is by means of these elements that matter must become differentiated. Hence, unless matter was at some time uniform in these respects, it was not uniform at all—differentiation had already begun. We must, therefore, in order to get at the true starting-point of this automatism theory, go back to a point in the history of matter when it was uniform in kind, uniform in distribution, and uniform in temperature. (In regard to other conditions it requires merely to be noted that chemical affinity, electric and magnetic forces cannot be supposed to act or even exist in a uniform substance, and that gravitation, even granting its existence in such a case, could not, seeing it is a constant force varying only with

distance, operate towards the differentiation of matter under such circumstances.) Having accompanied them so far we must leave our automatist friends to extricate their uniform matter from the plight they have reduced it to; for it is confessedly far beyond our powers of conception or imagination to conceive or imagine how this can be accomplished, without calling in the aid of some external force not yet contained in this—supposed—all-sufficient and all-efficient system. No doubt it has been deemed possible, although it certainly involves some important assumptions, that if the uniformity of matter were once broken in upon, its differentiation into its various chemical and molecular conditions might be started, and that these conditions would be gradually evolved. If, it is maintained by some, a vortical motion is once established in the heated and distended gaseous matter occupying primeval space, we can at once account for all astronomic phenomena, in fact planets, suns, and systems are its necessary results. Even this supposition rests in no small degree upon assumption; it assumes a gradual cooling of the total of matter—a process very difficult to conceive, for heat is avowedly as indestructible as any other form of force, and can only temporarily go

amissing by means of what is called Dissipation. Now we all know that it is of the nature of gaseous matter to expand indefinitely so long as it is not limited by some confining force, hence the primeval gaseous matter must have distended itself through all the space there was. If space, then, was filled with gaseous heated matter, how is it possible for this dissipation of heat to commence, seeing there would be no space left for it to dissipate to? Hence we must start by assuming that in some way unknown to us this dissipation began, with all its marvellous results, on the strength of which assumption we may proceed to imagine the gradual cooling of the universe of matter into liquid and solid forms. This is no doubt imaginable if we were to suppose that the differences thus produced in matter were merely molecular, and that matter remained one in *kind*. But we are also called upon to suppose that this process is capable of producing those permanent differences in matter which we call chemical; that by the operation of pressure and heat, matter has become differentiated into its various chemical elements. This is another assumption which, so far from being warranted by facts, is stoutly opposed by all known facts; for it forms the distinguishing characteristic of the chemical elements

to show themselves defiant of these very agents by obstinately retaining their chemical qualities against all efforts to change them by means of these forces. So that we are really asked to accept this theory on the strength of a mere possibility, if, indeed, it amounts to that. Can anything be actually less scientific than this? less in accordance with the careful and patient method of science, which resembles the slow ascent of a mountaineer up a wall of snow or ice where he must first cut a sure foothole before advancing a step? For the naked form of the argument is this; it is just possible that under circumstances we are not accurately acquainted with, and in a mode of which we have no clear idea, matter became, at some unknown point in its history, differentiated into various chemical elements. Such a statement does not belong to the domain of science—that is, of organized knowledge—it is speculation, and that not of the most probable order. Its only possible basis is an analogy which is of the loosest and weakest. The analogy, if analogy it can be called, is that between the evolution of organisms and some—supposed—evolution of chemical elements. Because, forsooth, organisms may have been evolved by the slow action of certain general laws, which are on all

hands admitted to exist (though there may be different opinions as to their power of producing the witnessed results), we are also called upon to believe that chemical elements which exhibit no such laws, whose laws, indeed, seem perfectly opposed to any gradual development, have been evolved in an analogous manner. This is a strain upon our faith, not to say our credulity, little less than that which a belief in the infallibility of the Pope or in a literal six days' creation would impose. So far we see that, even if we suppose the uniformity of matter to be self-disturbed and differentiation set about, there remains a great difficulty in conceiving how that differentiation could ever arrive at that precise and rigid phase to which matter, chemically regarded, has attained. While, therefore, I would not go so far as to assert that chemical evolution is impossible, which would be almost as unscientific as to assert that it is proved, I would claim permission to reject it from my scheme of the universe as being at present purely hypothetic. Or at least I may be permitted to indulge in that attitude, which, if my memory misleads me not, has been highly extolled by a distinguished scientist as particularly philosophical, "suspension of judgment."

But, if difficulty be experienced in accounting for or

even conceiving of the self-instituted evolution of matter from sameness to chemical unlikeness and diversity, there is an even greater difficulty felt in understanding how unorganized matter could elevate itself to organization and vitality. For marvellous and beautiful as are the properties and relations among the constituents of the inorganic world, all the marvel and beauty pale before the crowning wonder and mystery of Life. In the very lowest and meanest of its manifestations life exhibits a power completely novel, that of assimilation. It is an aggressive, conquering principle, capable of converting the not-self into self; it draws material from the outside inorganic world, and not only attaches and secures to but actually identifies with the organism what before was foreign and external to it. And this reflection naturally leads to the conclusion that there is surely something not only too cold and inexpressive, but even insufficient and incorrect about the term which some scientific men use as equivalent to life, viz. contractility. I must confess to an instinctive repugnance and a rooted dislike to this, and some few more terms now in common use. What does contractile mean? Why, simply, capable of contracting. Now it is obvious that the word applies to numerous things that do not

possess life. A penny balloon is contractile. But no one supposes that the word is used in its strict sense. Contractility, as used in modern treatises, means not only the power of contracting but the power of recovering from contraction. Hence obviously the word extensility would be just as appropriate, if we were free to add that it included the power of recovering from extension. Contractile is, then, clearly a term that does not bear its true meaning on its face, but rather, if such expression may be permitted, on its back. It is in reality rather a negative than a positive expression, and when one of these alone can be used it seems desirable to use the positive. Thus it would convey a better idea of the action of the lung to say that it expanded (to receive air), than to say that it could contract (to expel it); for the essential and characteristic action is the expansion, the contraction being but the necessary prelude to a second expansion. But it would be still better could a phrase be found to signify the double action, the systole and diastole, which characterizes all life. Yet, difficult and unattained as this is, there seems no excuse for introducing and attempting to pass as current coin so clumsy and misleading a term as contractility. Tissue when *in articulo mortis* may be

contractile, but not extensile, and this tissue should not be ranked as living, but much more accurately as *dying* tissue. This is not a mere carping at words, but an attempt to expose, in the interests of real science and accuracy, a false equation in meaning, an erroneous definition. Vital and contractile, vitality and contractility, are by no means equivalent terms. You may, indeed, proceed by comment to attach to contractile the same meaning as vital has; but what a useless, unnecessary process! Why not frankly and boldly use the term vital? The fact is, Life is one of those primary entities which defies definition, and is a term which cannot be equated to any other, or series of others. But, if we are to have a technical phrase to signify the scientific view of vitality, surely we should choose the positive and more expressive term extensile rather than the negative and less adequate contractile. Still it unfortunately remains that both these terms are applicable to dead or unvitalized as well as to living or vitalized tissue. It is not, however, otherwise than easy to understand how the term contractility is such a favourite with some writers. To say Life is but contractility is at once to deprive the idea of Life of all mystery, wonder and poetry, to degrade it to the level of

mechanism. It lessens the gulf between dead and living, in fact by a piece of subtle verbal chicanery it bridges it over by the use of a term applicable to both. Hence those who are fain to demolish such distinctions show a real and intelligible affection for the term. Life in its purely physical aspect may be most nearly described as a mode of motion, resembling in its self-recurrence the elliptic motion of the planets, and appearing to demand, as that does, some primal impulse to originate it, and still so distinct from that or any other mode of motion that its generation by any other mode is precisely as conceivable or inconceivable as the squaring of the circle or the meeting of parallel lines. But we are sensible how poor and partial a description or definition this is, although it is more comprehensive and accurate than the phrase contractility. For Life seems mysteriously to involve and germinally to possess in its very lowest forms qualities distinctive of its highest. All living matter is to some extent sensitized. Its surfaces seem to possess a discriminative power in virtue of which they receive a certain kind of matter and refuse or reject another. Its surfaces, we say advisedly, for the lower forms of life are mainly, if not solely, sensitive on their surfaces, and before the develop-

ment of the nervous system there seems no provision for the conduction of sensation into the interior of the organism. Thus, it is characteristic of plant-life to be superficially sensitive only, any traces of sensibility which we observe being always on the outward surfaces. In animal-life, on the other hand, some rudiments of a nerve system appear low down in the scale of organism, and a process of centralization seems to go on till it lands us in the phenomena of consciousness. And along with this centralization of sensation there go on a differentiation in sensibility and a specialization of function; for, while in some lower forms the whole surface may be sensitive in the same degree and manner, in the more developed forms certain portions of the surface become more highly sensitized and also become fitted to receive sensations of diverse kinds. This culminates in the formation of distinct organs of sense, of hearing, seeing, taste, smell and touch. Now, that these organs may have been gradually evolved is perfectly possible, and certainly cannot be disproved, but the assertion that such a marvellous development is the necessary and natural result of the primary qualities of matter is without either proof or warrant. For, as has been pointed out, the automatist, in order to be consistent,

must refer for the origin of the universe to a single, uniform mode of matter, and this, because to allow that matter first existed in a condition of chemical differentiation is to leave perfectly ample ground for the assumption of a creative intelligence, for the existence of the organized chemical world, with its exact and orderly arrangements, as much implies design and pre-existent reason, as does that of the more highly organized world of living beings. Again, if we go back to this original, uniform matter, what qualities does it possess? no chemical qualities, certainly, for all chemical action depends on difference of which there is none. Such matter can only possess molar and molecular forces, and that these are capable of producing chemical differences is a complete assumption made in the face of all known facts.

To you must probably have already occurred the question, What has all this to do with titular and supposed subject of this paper, the relation between Science and Poetry? This question I shall now endeavour to answer. My thesis is that Science and Poetry are not antithetic, nor mutually destructive. But while I instanced the discoveries of Galileo, Kepler, and Newton, as having increased rather than diminished, still less destroyed, the

poetry of the Cosmos, I took care to admit that it was possible, however improbable, that a scientific discovery might have an opposite tendency. And we are now bound to acknowledge that, if Modern Science justifies Automatism, it is truly destructive of Poetry; for there is no one so dull as not to perceive that the moment we regard the creatures to which we have been attached, or the persons for whom we have felt affection, as but so many elaborate automata, attachment and affection become at once impossible. For love can no more exist between a machine, regarded purely as such, and a person, than attraction can exist between a particle and something not a particle. Thus, if once we regard other beings as but self-acting machines, and still more if we regard the Universe as a huge machine-producing machine, that emotional exaltation which is necessary to poetic feeling becomes no longer possible. For a machine can only interest us (except in a utilitarian sense) by means of the mental qualities it implies in its inventor. This is at once evident if we recall the expletives we or others naturally use on viewing some excellent piece of mechanism. "How ingenious!" "how clever!" "how simple in plan!" "what an original idea!" It is hardly necessary to point out

that these exclamations show how naturally and inevitably we refer from the mechanism to the mechanist. The ingenuity, the cleverness, the simplicity of plan, the originality of idea do not pertain to the machine, but are qualities of the inventor's mind.

But, if it should turn out that the machine was not the direct production of any man but that of another machine, our astonishment and admiration would only be increased on thinking how great the ingenuity, etc., involved in the construction of a machine capable of producing such another machine; for no one can fail to see that to construct a machine able to produce another, without any fresh direction from intelligence, would require an indefinitely greater amount of skill than to construct the machine (No. 2) at first hand. If, further, we found that not only machine No. 1, but No. 2, and an indefinite number more had each been the product of some antecedent machine, we should be lost in astonishment and bewildered admiration of the ability required to construct what must have been the first of such a series. And this really, even granting for a moment the automatic nature of organisms, is exactly what we see in creation, viz. an infinite series of mechanisms capable, without any inter-

ference of intellect, of producing each other, the final one being inevitably involved in the initial. This elaborates and makes evident the admirable dictum of an American divine, "Whatever is evolved must have been previously involved."

Some may object, however, that it is not true that our emotions are never excited, our affections engaged by mere pieces of mechanism. Does not the sailor love his ship, the engine-driver his engine? Perfectly true, I would reply, but just because they have ceased to regard them as mere machines, and have invested them with a species of personality. Listen to these men for five minutes and you will find them ascribing all sorts of human qualities to them. To begin with they never apply to these objects the cold neuter pronoun "it," but invariably the warmer and more affectionate "she." The epithets "brave," "stanch," "trusty," "gallant," "clever," "game," etc., are all certainly applied to a ship, and that by seafaring men, and some of them to a engine by its driver, and yet they all imply the possession of moral or mental qualities which we know these things do not really possess. Evident, consequently, it is that we must impute a certain individuality and consciousness to a piece of mechanism

before we can feel affection for it, for its own sake. There is no wonder, then, that the automatic theory causes a chill to come to our hearts and the glow of poetry that illumined Nature to pale and fade. For not only does it represent the existing universe as a series of automata, automatically producing each other without design or guidance or will, but it denies that behind the first all-causing origin and initial member of the series lies the wisdom, knowledge, foresight and consciousness, still less the righteousness and love, which, if to powers so stupendous, so infinite, such poor human terms may apply, appear to us to be demanded by the primal involution of powers and properties capable of executing an evolution so marvellous, elaborate, exquisite and vast. Were this denial true it would give a deathblow to true Nature-poetry, for although that does not deal directly or necessarily with what is avowedly theistic, it rests upon the fact of a spiritual meaning and existence in Nature; it, in truth, consists in the recognition and expression of that beautiful spiritual significance which seems to the poet to shine through physical phenomena. This is the basis of all that is best in Wordsworth, but which is quite distinct from that unlucky and inveterate moralizing to which he is too apt to

descend. The following sonnet of his explicitly proclaims this principle, and confirms both practically and literally my previous statement to the effect that the departure of nymphs and naiads by no means put a period to the poetic treatment of Nature:—

> "Brook! whose society the Poet seeks
> Intent his wasted spirits to renew;
> And whom the curious Painter doth pursue
> Through rocky passes, among flowery creeks,
> And tracks thee dancing down thy water-breaks;
> If wish were mine some type of thee to view,
> Thee, and not thee thyself, I would not do
> Like Grecian artists, give thee human cheeks,
> Channels for tears; *no Naiad shouldst thou be,*—
> Have neither limbs, feet, feathers, joints nor hairs:
> *It seems the Eternal Soul is clothed in thee*
> *With purer robes than those of flesh and blood,*
> *And hath bestowed on thee a better good;*
> *Unwearied joy, and life, without its cares.*"

How thoroughly spiritual is this, how thoroughly true, if we be permitted to believe that the universe is instinct with soul, and that such sweet parables are not the creation of mere poetic fancy but true messages of the Eternal Soul to the Spirit of man! But, if there be no mind or soul behind this material universe, then 'tis a mere mocking echo of his own heart, an empty reverberation from hollow rocks, that answer to his spiritual cries.

This we believe not, this we are justified in disbelieving. And so long as we can do so, I hold, no scientific facts can jeopardize Poetry. On the contrary, that increase of intimacy with Nature, which we owe to the processes and appliances of Modern Science, only enlarges the sphere wherein imagination may range. As space deepened and expanded for us and the majestic immensity of the Universe was revealed to the telescope of the astronomer, so by the aid of microscope, spectroscope, and the other ministering genii of the laboratory, while Space exhibits a new inward immensity, the imposing perspective of Time is unrolled and its endless avenues and interminable vistas open on the awed and bewildered intellect. Yet, it would seem, lest the human mind should be oppressed by these superincumbent infinities, Science proclaims also the unity and simplicity of the whole. Nature seems to kneel to us as a camel to receive its rider, and in the simplicity of her processes to condescend to the limitations of Man. For with all the truly infinite variety and gradation that Nature exhibits, her types and methods are singularly few and simple. She reiterates to us our lesson as a nurse or mother to a child. And of all the intellectual lessons taught in reply to the interrogations of Science there is none more prominent

than the idea of unity; and this unity will be found to exist not in detail, not in material manifestation, but as pervading principle and universal law. Astronomy and Physical Science instruct us that it is in obedience to a single force, in accordance with a universal principle, expressible by a single mathematical equation, that every one of the heavenly bodies, whether taken singly or in systems and constellations, are reined in their calm elliptic orbits or spurred on their wild hyperbolic courses. The law of chemical affinity, like that of universal affinity or gravitation, is another complete example of unity of principle with diversity of detail or result; and one might easily multiply examples of this principle, which may be called that of *intellectual unity pervading physical diversity.* Thus there is no inference deducible from it in favour of the primal sameness of matter. But how any sane mind can recognise this principle without acknowledging the absolute necessity of mind to the construction of a universe so constituted must remain to us matter for astonishment. For if it be but granted that it is conceivable that Mind had to do with the production of this Universe, the question may fairly be asked, Could Mind have left any more indisputable traces of its operation

than it has done? we think not. So that the most central and certain of scientific propositions are the most clamant on the side of Creative Intellect. If such facts do not prove the existence of such an Intellect, let us ask, what would? Let those who answer, they do not, state to us what in their opinion a universe which had been intelligently constructed would be like, and we for our part undertake to show that the Universe they describe not only does not exhibit so great traces of intellect as that with which we have to do, but also, using their modes of argument, to prove that their hypothetic universe was not constructed by a Supreme Intelligence.

The relevancy of this argument to the subject in hand I can justify partly by appeal to the facts of my own consciousness and partly by instancing the modes in which poets have treated Nature. As to the former, of this I am conscious, that if the Universe be represented to me as the result of pure chance or a blind necessity, a necessity identical in kind with the necessity that causes a barrel-organ or a musical-box to play a certain range of tunes and no others, my heart sinks within me, the glory of Nature seems to suffer eclipse, and, as during a physical eclipse the birds fly to their nests and hush their songs,

so, before so iron and dark a presentment, those fleet delights and faithful joys that make the music of the mind, flee before that cold shadow and cease their minstrelsy. In a word, the world's poetry ceases for me. I cannot love a soulless, exanimate Nature or love it only as one loves the body that once had life and all life's charm. No one can love the dead, except as remembered in their past or imagined in their future, and thus it is that affection teaches man the doctrine of immortality. So much in brief for the effect of such a conception on my own feelings. In regard to the methods in which Nature has been treated by poets, they may be said, generally speaking, to resolve themselves into two, that is to say, either or both of two modes of poetically presenting Nature are adopted. These depend upon whether the poet belong to those who are avowedly theistic or no. The former, among whom may be specified Milton, Thomson, Coleridge, and Wordsworth, tend always in their highest and most rapturous passages to culminate in a psalm-like fervour of praise of that Deity whose power Nature proclaims to them. Of this no finer or more apposite illustration can be found than in these concluding lines of Coleridge's magnificent "Hymn before Sunrise in the Vale of Chamouni:"—

" Thou too, hoar Mount! with thy sky-pointing peaks,
Oft from whose feet the avalanche, unheard,
Shoots downward glittering through the pure serene
Into the depth of clouds that veil thy breast—
Thou too again, stupendous Mountain! thou
That as I raise my head, a while bowed low
In adoration, upward from thy base
Slow travelling with dim eyes suffused with tears,
Solemnly seemest like a vapoury cloud,
To rise before me—Rise, O ever rise,
Rise like a cloud of incense from the Earth!
Thou kingly spirit throned among the hills,
Thou dread ambassador from Earth to Heaven,
Great hierarch! tell thou the silent sky
And tell the stars and tell yon rising sun,
Earth, with her thousand voices, praises God."

The latter, among whom Shelley would fall to be classed, are forced into the adoption of what may not unfairly be called modern Isis-worship. They bow before a personification of Nature which has little to distinguish it from the Venus of Lucretius or the Isis of the Egyptian cultus, and they sing with all the fervour of genuine faith and passion. Witness this passage from "Alastor:"—

" Mother of this unfathomable World!
Favour my solemn song, for I have loved
Thee only and thee ever; I have watched
Thy shadow, and the darkness of thy steps,
And my heart ever gazes on the depths
Of thy great mysteries. . . .

I wait thy breath, Great Parent, that my strain
May modulate with murmurs of the air,
And motions of the forests and the sea
And voice of living beings and woven hymns
Of night and day, and the deep heart of man."

Hence it will be seen that the divergence of these two modes of poetically presenting Nature are not so great as might appear. For there lies at the root of these conceptions the same idea of unity, intelligence, and spirituality.

Throughout this essay I have necessarily limited my view both of Poetry and of Science. I have considered them both as comprising only that portion of the universe which is called in the narrow sense Nature, that which is classed as specially physical, and have referred but little to the phenomena of finite intellect or human conduct. But it may be mentioned in passing that the same principle in great measure applies in every sphere. The advent of a mechanical theory banishes poetry or poeticalness. But my argument has been that this mechanical theory is at the least unproved, if not contrary to true science, so that true science has not yet filched its domains from poetry. On the contrary, it is well seen that scientific discovery has opened new realms to the imagination, and that hope is

thus afforded us that it may continue to do so. For my own part I have no fear nor shadow of doubt that, rightly viewed and truly interpreted, no facts can ever disenchant the true lover of Nature, or unsoul this still mystic, this ever-miraculous universe.

VII.

THE CRUELTY OF NATURE.

Nature and her accusers—A holy alliance—Competition and predation—Pain, its necessity—Is it unjust?—Limitations of animal suffering—Sensations of prey—Wasp-and-spider fight—Nature's anæsthetics—Animal pleasure—Uses of pain—Heine's testimony.

NATURE is on the whole having a very bad time of it just now: so much so that unless something can be said in palliation, if not refutation, of the charges brought against her, respectable people will really have to treat her as society treats other persons of the sex who have lost the good opinion of their fellows, and give her the cut direct. There are two distinct and opposite classes who, exemplifying the old maxim of the meeting of extremes, combine to blacken her reputation. On the one hand, the atheist, who is desirous of proving that the universe cannot be the work of a wise and beneficent Being, eagerly points out her faults and blunders, as he in his wisdom esteems them, while, on the other, many Christian writers, anxious

to discount the claims of a natural theology and to drive their hearers back upon an imported or *revealed* theology, descant upon her shortcomings and her alleged crimes. I have already endeavoured to vindicate the character of Nature in certain particulars, and to claim for her not only intellectual but moral virtues, and trust that I have, at the lowest, shown her to be neither so regardless of beauty, so devoid of intelligence and even foresight, nor so wanting in benignity and justice as her traducers allege. But all along, both on account of the ground I was then traversing and the audience I was then addressing, I was unable to come face to face with the central difficulty and the most serious accusation. I have alluded to it, where I could hardly refrain, but have always been conscious that the subject requires a more direct and adequate treatment. That most serious accusation is cruelty; and in preferring and maintaining it the atheistic school is far more logical and consistent. It cannot be turned against them except by saying that it proves too much, and instead of arguing the absence of moral bias in the universe, tends to show that there is a moral bias of a negative or evil kind. On the other hand, the Christian calumniators of Nature, among whom we must number the present Laureate, lay

themselves open at once to serious attack, and involve themselves in manifold difficulties. They seem to forget —and betray this forgetting with a *naïveté* which in a less important matter would be amusing—that their whole scheme rests upon the hypothesis that a good Deity exists, so that in weakening the argument in favour of such existence, as they do in disparaging creation, they are just knocking away the supports of their own system. But, what is even more fatal to their position, they take a view quite in opposition to that held by the founder of their faith, according to whom the world is under a loving Providence that clothes in beauty the lilies of the field, marks the sparrow's fall, and feeds the young ravens when they cry. If the system of Nature be cruel, it cannot be under such kindly control! And should they retort that, on the authority of St. Paul, "the whole creation groaneth," etc., I have but to reply that they are bound to take Christ as their supreme authority, seeing "the disciple is not above his Master," and that, while the Master teaches with supreme self-confidence, the disciple distinctly throws doubt on the continuity of his own inspiration. But it is not my aim to point out the inconsistency of these men, but rather to disprove their thesis.

In the first place, the view such writers presents is grossly exaggerated. To believe them in their sentimental moments—for it is sentiment of the worst kind—one must consider the world as nothing else than a fearful and gloomy Inquisition in which there are no sounds but shrieks and groans, the creaking of screws and wracks, and the horrid snapping of sinews and hideous crunching of bones—not a land of Life, but a haunt and horrible avenue of Death. Over this they lament with the effusiveness of hired mourners, yet omit not to eat the cake and drink the wine that passes round at this funeral feast. How many of those, who thus turn up pious eyes at the iniquity of Nature in permitting one animal to prey on another, have stirred a finger to check the depredations and outrages of that supreme creature of prey—Man! But the picture they draw is partial, one-sided, taking into account Nature's severities, without reckoning her mercies; apprising the sufferings of creation, without calculating its joys; painting in strong colours the pain that is undergone, without endeavouring to arrive at a knowledge of its uses or results.

The main and most damaging accusation against Nature, as it is usually put, is that implied in the hackneyed lines:

> "Nature, red in tooth and claw,
> With ravin, shrieks against our creed,"

and is this, that the system of Nature is one of warfare and of predation. Now let it be at once acknowledged that the competitive system, which in plant-life is mere silent rivalry, becomes in the animal world active and even desperate strife, and that the ultimate appeal of the beast and the bird is, like that so long prevailing among men and still between nations, personal combat, often *à l'outrance*. I am not going to attempt to prove the extreme theorem that this is the best of all possible worlds, or even that the process of struggle and suffering that we see is inevitable, although I must confess to so little acquaintance either practically or imaginatively with any other world or process that I cannot contradict either theorem. The advantages of this struggle in keeping up, if not in actually evolving, the qualities and activities of all organisms is quite enough insisted on now, and, as thus moderately stated, does not admit of dispute. What we want to know is, whether—all this being admitted—a charge of cruelty can be established against Nature. Now a charge of cruelty requires something more than the bare circumstance that pain has been inflicted to establish it. If the infliction of suffering be

either necessary, just, or proportionately beneficial, it cannot be said to involve cruelty in the inflictor. In fact to be cruel means to be capable of inflicting suffering wantonly or without necessity, justification, or compensating benefit. So it comes to this, that, in order to prove Nature guilty of cruelty, we must show the pain occasioned by her processes to be unnecessary, unjust, or useless.

The necessity of pain as a general phenomenon of consciousness seems involved with that of its opposite, pleasure. Practically, pain is the sentinel that warns us of injury which must be repaired. That the warning is sometimes too late and in vain does not prove that there is no necessity for the sentry. Not only does it apprize us of menacing evil, but apprehension of it causes us to evade and protect ourselves against dangers. Unless, in fact, our bodies were of invulnerable, indestructible materials, pain is an indispensable condition of safety and continuity of existence. Physiologically speaking it is a result of over-stimulation of the nerves, over-intensity of sensation; thus moderate heat and cold are both pleasurable in alternation, while excess of either is painful. Taken together, then, with the other facts and condition of life, pain, as a general fact, appears an obvious necessity, a necessity so ingrained in the nature

of things that we can no more understand how it could be dispensed with in a sentient existence than we can that two and two should make any other sum than four; and we can no more charge, on this ground, cruelty against Nature than we can arraign her of monotony and lack of invention because this arithmetical relation never varies.

If the necessity of pain has been established, it becomes almost superfluous to discuss its justice, that is to say, to ask the question, Is it just that a sentient being should suffer? Now it cannot be maintained that any creature has a right to claim an unbroken round of enjoyment; all that justice could demand would be an equality—supposing the moral question of desert to be left out of account—and all, therefore, that remains to be proved is that there is no balance of pain left over, when the amount of pleasure is deducted from that of suffering. It is, of course, a question which does not admit of a mathematically exact answer or demonstration. I wish to confine the inquiry to sub-human Nature, as the question of human suffering is too much involved with moral and spiritual issues, so that certain data and common criteria are not to be had. Yet we have equal indications in both directions, so that there seems no reason why the estimate

should err in the one direction rather than the other. Let us at once grant that all animals must, in proportion to the development of their sentient faculties, encounter considerable suffering during their term of life. Having been born, they must die, and it is seldom that death is reached without encounter with considerable pain: in addition to which, ailments and injuries which do not result fatally may have to be endured. Let it be allowed that they are often wounded in combat or maimed without being killed by more powerful animals, that they suffer from cold and heat, hunger and thirst, but let us not run into the error of imagining that their sufferings are correctly estimated by our own; for, though the higher animals may be nearly as sensitive as we are, it is certain that the lower creatures are very much less so, and diminish in sensitivity as they descend to the very zero of feeling. It is very inaccurate to gauge the pain felt by a singed moth or mutilated fly by that *we* feel on being burnt or dismembered. We must judge from the *nonchalance* with which these insects treat their losses that their sufferings are by no means acute. Nor have sheep or cattle, so far as we can judge by their conduct, anything like the same sensibility to wet or cold that human beings have. So that very large deductions

may justly be made in what we are apt to imagine the degree and sum of animal suffering. Again, let us take the case of animals that are preyed upon, and consider what are, probably, their sensations when overtaken by their captors. In the first place, the execution is usually of the swiftest. The swoop of the hawk or eagle, the spring of the tiger or lion, are sudden, unforeseen, decisive. The victim must be speedily unconscious, if only by reason of the surprise and overwhelming force of the shock. No one can fail to have experienced the fact that there is a distinct perceptible interval between the receipt of a severe injury and the realization of the resultant pain and loss. There is a moment of confusion, a brief interregnum of doubt—sufficient, one would imagine, in the case of a fatal injury, to tide over the period of survival and land one in the safe unconsciousness of death. Thus it must very often happen that the agony of the hawk-struck bird, or the antelope clutched, crushed, and rent by the lion, is of the briefest. But there is yet another palliative cause to be credited to Nature. When once the quarry is within the grasp or even within certain range of the bird or beast of prey, a fascination seizes it and it seems to lose both faculty and desire of escape, a species of mesmeric anæs-

thesia is induced, as we know by human experience—and it is probably less complete in that case than in that of a lower animal. More than this, some animals actually narcotize their victims. That this is so is borne out by the following passage, which, founded on Darwin's "Naturalist's Voyage round the World," is yet written with that *animus* which distinguishes writers of the modern atheistic school:

"We read with deepest interest, wherewith something of horror lends a zest, of the weird, ghoul-like wasps that sting spiders or caterpillars, not to death, but half-way thereto, then store up their victims till such time as the wasp larvæ, emerging from their eggs, devour at their leisure the inert yet living bodies of their prey. We watch eagerly the fight between wasp and spider, the wounding of the latter, its temporary escape, the wondrous, systematic hunt for it by its unrelenting foe, the discovery, and finally, after much artful manœuvring, the deadly stab that narcotizes the unfortunate Arachnid." *

All this is horrible in its bare statement, but, when we carefully analyze these transactions, much of the horror is removed. The first instance is the more revolting when we imagine that the victims suffer during the whole time of their paralyzed captivity, and are actually devoured

* From the *Secular Review*.

while alive and sentient. But does not the whole circumstance point to the strong probability, if not certainty, that these captive creatures are, like the spider in the second account, narcotized, and therefore secured from painful sensations? Again, in order to understand what the combatants in this wasp-and-spider fight go through, we must allow for that anæsthesia of excitement which anger or the mere act of battle produces. Any boy or man that has had a fight well knows how, under the afflatus of passion, he becomes regardless and almost unconscious of the punishment his antagonist inflicts. We all know, too, how a man, once involved in the heat of battle, is rapt in a delirium of courage, fury, and ardour so strong that he may quite unconsciously receive some serious wounds. Nor do I doubt that the indifference that religious and political martyrs display to pain is partly to be accounted for by the fact that the strong enthusiasm they labour under actually renders them, in part at least, insensible to their physical torment. This too from my personal experience I will contribute, that, although naturally apprehensive, sensitive, and timid, when once my anger, indignation, or interest is sufficiently roused, I become for the time impervious to fear or pain. From these facts we

are quite entitled to infer that it is with animals in some measure as with ourselves, and that during an actual and active combat they do not feel to the full the wounds they receive. Thus in the case of the spider, it would suffer most when in hiding after its wound, but would eventually be relieved of its sufferings by the truly merciful narcotic *coup de grace* of the wasp. We see thus that the system of Nature is not one of cold-blooded torture, such as it is painted, but full of mitigations and evasions of pain.

Perhaps even more difficult is it to estimate the amount of pleasure which sentient beings, other than man, may experience during their life. When we reflect that mere life, when we are in health and free from care or sorrow, is to us a distinct pleasure, and that the more fortunate of us, with all the fatal human tendency

> "To look before and after
> And sigh for what is not,"

frequently taste this pleasure, we feel entitled to believe that animals, with their Horatian philosophy, must yet more often than we drink life's bright waters untroubled by a tear. Each animal seems to rejoice in its highest gift —the swift in their speed, the strong in their strength, the busy in their toil, the cunning in their skill, and the

brilliant in their beauty. If the victim suffers, the victor has his hour of triumph; if the pursued trembles, the escaped has its time of respite and satisfaction. How ecstatic is the carol of the lark, that "unbodied joy," how laden with overflowing sweetness the nightingale's rhapsody, whose melancholy has, indeed, been imparted to it by love-lorn watchers and pensive poets, and, withal, how bright the twittering of swallows, how cheerful the gossip of sparrows, and how contentful in its self-importance the grave remark of the rook! In the satisfaction of their appetites, too, there must be much scope for pleasure to animals, seeing they are untroubled with the moral anxieties and perplexities that harass mankind. In their affections, also, there lies a source of joy as well as solicitude, and we need not doubt that parent-birds in rearing a brood have many a moment of happiness and pride. And of young animals how glad and pleasant the frolics, from the gambols of lambkins and kids to the playful encounters of tiger-kittens and the rough fun of a lioness and her whelps! It will be hard, I think, in the face of these compensations to bring in against Nature a true bill of Injustice.

Is, then, the suffering inflicted by Nature useless, that is to say, purposeless and without result? We think that

from the analogy of man it may fairly be argued that suffering may be an educative factor also among what we call the brutes. Modern Science, although it may not, and indeed has not definitely proved the Doctrine of the Descent of Man, has in many ways lessened the gap supposed to exist between the nature of man and that of other living creatures. The wonderful polities of ants and bees, the passions and courtships of birds and insects, and the reasoning powers displayed by the dog, the horse, and other domestic animals, have shown a remarkable approach to human faculties; and it is not an unfair inference from these facts that the animal nature is acted on by such influences as joy and sorrow, pain and pleasure, in a manner similar to man's. But in regard to man it is matter of notoriety and an absolute commonplace that those who have been the noblest and the greatest, those who have won most vantage-ground for their fellows, are, as a rule, those who have suffered most. Those poets that humanity still holds nearest her heart have

> "Learned in suffering
> What they teach in song."

The greatest reformers in religion, morals, or politics have all graduated in the bitter school of sorrow, with

adversity, poverty, calumny, persecution, bereavement, neglect, and pain for their relentless instructors. Their very sufferings seemed to have ennobled and energized them, to have chiselled out their characters to higher nobility and beauty. Indeed greatness of soul can only be exhibited in the face, at least of the possibility and danger, if not in the actual presence, of physical or moral pain. Not that we would for a moment admit the unfair corollary attached to this proposition by the Ascetic school, that self-sought and self-inflicted suffering is healthful to the human spirit; for conscious mortification ministers to a morbid self-satisfaction which readily becomes a spiritual disease, a very cancer of the soul. The brave endurance of that, through which fate or duty compels us to pass, is the antithesis to this, both in spirit and spiritual results.

When we thus find pain so important a factor in what we may call, in scientific parlance, the evolution of human virtue, may we not fairly argue that it may possess some kindred function in relation to animal character? One writer, himself a victim of suffering, almost without equal, Heinrich Heine, thus testifies to its elevating effect on animal nature: "It is only the suffering man that is

truly human; every limb has its history of pain, they are all *be-souled.* I even believe that, through the agony of suffering, dumb animals may become human; for once I saw a dying dog that gazed at me in his death-struggle with quite a human look." *

Something of the history of organisms, of physical evolution, we are beginning to know, but spiritual evolution is still a mystery. This one thing seems certain, that suffering is by some strange necessity bound up with that development and is the means and the price of progress.

Cause sufficient has now been shown, if not finally to rebut and disprove the charge of cruelty, so freely made against Nature, at least to throw grave doubts on its truth, and to establish important limitations. If my plea that the pain inflicted under the system of Nature is neither unnecessary, unjust, nor useless be established, then must the charge of cruelty be definitely abandoned, for one of these qualities is essential to cruelty. This much any reader of this will be convinced of, that those who glibly bring forward the accusation have not given the subject that wide and impartial survey which it demands and deserves.

* Heine's Wit, Wisdom, and Pathos. Translated by J. Snodgrass. Trübner & Co., London.

EPILOGUE.

It will not, I trust, be condemned as an affectation that, finding no other terms so convenient to my purpose, I have employed the words Prologue and Epilogue in their primitive and simple sense of fore-speech and after-speech, disregarding their conventional usage as applying to poetic forms. In a work of this kind, formed of a series of detached addresses, there seems to arise a demand for the speaker to "come before the curtain" both before its raising and after its fall; to utter both his *Ave* and his *Vale* to the reader. And if in the present case there appeared to be a call for a few explanatory and introductory sentences, much more does it seem desirable that the writer should attempt to look the (hypothetical) personage aforesaid once more in the face. For no one in the latter's position can be more thoroughly aware of the partial, incomplete manner in which our survey has been conducted than is the said writer. As he has had the misfortune to peruse the matter now finally resigned to the printer's hands some ten or, may be, twenty times more than is expected of the most well-affected reader, it were strange if it were otherwise. But to

point out defects is fortunately not *his* province. What he feels is that now or never, if his craft is to prove seaworthy at all, must the more threatening seams be recalked.

There is one fallacy, perhaps the most vulgar, as it is certainly the most stupid, of all propagated as slanders on Nature. It consists in maintaining that because the physical and physiological properties of natural objects are constant and do not vary according to the character or circumstance of the person coming under their influence, Nature cannot be the product of a moral or benevolent Will. Because, for example, a certain writer finds that some berries are poisonous to innocent children he bluntly announces that the Author of Nature cannot be good. Well, either natural qualities must be rigid and persistent or elastic and variable. If the former, it is quite impossible for the goodness and wickedness, knowledge or innocence, of the person to affect them; if the latter, the natural quality must depend entirely on the character of the person. No common criteria under so imbecile a scheme could exist. What was sour to me would be sweet to you; what was poisonous, wholesome; what was ugly, fair. The schoolboy that, in his innocence, left the leaves green and the fruit pleasant in the morning, would come home, after telling a lie or cheating his comrade at marbles, to black leaves and bitter fruit. How the tea would turn to vitriol and the cake to cinders in the mouth of the fair dame airing her maiden

slander! "A mad world, my masters!" it certainly would be, or rather a no-world. Each person would be his own universe, for his whole environment would change with his mood. Such a scheme would mean the blank non-existence of externality, which would be but a white sheet for the soul to cast images on. Under such conditions consciousness itself is inconceivable.

The only possible justice, the only sanity, lies in physical and physiological properties being absolutely independent of moral conditions. It is just that even the most wicked should profit by industry and knowledge; just that the most righteous should suffer for indolence or ignorance. Yet such crude, thoughtless criticism of the creation is allowed to pass current as valid. Certainly, unless the present citizens of heaven are totally lacking in sense of humour, they cannot fail of food for laughter, inextinguishable as that of the Olympians. Indeed we tremble as we cut the pages of a review, lest, after a gravity of twenty centuries, the Divine laughter should once more break forth and convulse the solid frame of things.

Of the relation of Man and Nature a word yet remains to be said. It must be always remembered that this relation is dual. Nature is at once the Protagonist and Antagonist of Man, at once his *Alma Mater*, his kindly mother, and the "strong angel" against whom he must for ever wrestle. Without such antagonism it seems

impossible that the powers and faculties of man could have been developed. For no power can be exhibited, still less elicited and exercised, except by a corresponding resistance. It is alike inconceivable in things physical and psychical that action and reaction should be otherwise than equal and opposite. Only against the massive inertia of Nature can be displayed the Protean activities of Man. Hence, from the purely human standpoint, every natural fact has a double aspect, adjuvant and resistant, friendly and hostile. To dream or to desire it otherwise is to be intellectually or morally imbecile.

To the reader who has come so far it is not necessary to say that this book is no systematic philosophy of Nature or of Life. Rather is it an attempt to induce in the reader that intellectual condition and moral mood in which alone the highest communion may be enjoyed with the spirit of Nature. Thus I prefer to leave it in a condition whose incompleteness may prove stimulative, than in one whose completeness might satiate. Its aim will, then, be accomplished if after its perusal you turn to the study and contemplation of Nature with keener zest for Beauty, a deeper reverence for Law, a firmer faith in Order; with that quickened spiritual pulse which clears and reinforces the Intellect, while it strengthens and purges the vision of the Soul.

WORKS BY THE SAME AUTHOR.

EXTRACTS FROM REVIEWS

OF

"MORNING CLOUDS;

BEING DIVERS POEMS,"

BY

HENRY BELLYSE BAILDON, B.A.

From "The Athenæum."

"Mr. Baildon possesses originality—a rare gift in these days—as well as abundant, if not superabundant, fancy, and even imagination."

From "The Guardian."

"A somewhat marked exception to this rule (want of originality) is found in the 'Morning Clouds' of Mr. Baildon, who, by the way, has been before now a dramatist. Mr. Baildon is in a laudable sense a reactionary writer. Unlike many of his contemporaries, he is content to express his meaning with a direct and somewhat old-fashioned simplicity which lays no extraordinary strain on the capacities of language. When he draws from nature it is in his own manner, and not in that of some more celebrated artist. . . . Mr. Baildon is not happier in such studies as these from the outer world than in his treatment of human emotion and sentiment."

From "The Graphic."

"The 'Child of Shame' and 'Two Friends' are worthy of Browning at his best."

From "The Literary World."

"Genuine sympathy with nature, and rare power of interpreting her moods, as well as a true perception of those aspects of human life which admit of poetic treatment, find expression in these poems. Their tremulous beauty, delicate fancies, and wealth of language recall the poetry of Shelley."

From "The Edinburgh Daily Review."

"The author of 'Rosamund' is a true poet. The wealth of thought, and freshness of feeling, and beauty of diction which marked his earlier efforts, appear in 'Morning Clouds' in a richer form and with a more mellowed splendour. Mr. Baildon is attaining to a more perfect mastery over his own

powers, and he speaks now with a more chastened strength and from a wider breadth of artistic experience. He describes vividly, he feels deeply, and to lyrical intensity he adds now and then the power of dramatic representation. The opening poem, 'Alone in London,' is the only modern poem we know that fairly rivals the most pathetic pieces of the elder Hood. The loneliness and weariness of her who is alone in a crowd; the rush of human life which sways and eddies and moves onward regardless of her misery and pain; the mystic call of the dark river, which in its inscrutable mystery seems to promise rest, are set forth by Mr. Baildon in fit music of perfect words, and form a poem of marvellous artistic beauty. We have not space to dwell as we would wish on these beautiful poems. From grave to gay, from feeling almost too deep for words to the light laughing mood of careless gladness, Mr. Baildo passes in his poems. Everywhere there is the touch of a master hand, in full artistic form is given to the airy nothings of the poet's dream."

From "The Edinburgh Courant."

"Mr. Baildon has made a distinct advance upon his previous productions, and lovers of true poetry will welcome the present volume with its many charming pieces, so full of profound thought and keen appreciation of the beauties of nature. Mr. Baildon may be said to belong to the Wordsworthian school of poetry, as while he portrays nature in a reverential spirit. Some of his descriptive poems are beautiful specimens of finished work, displaying true sympathy with animate and inanimate nature. He can enter into the sorrows of the poor and erring, and he is not without a certain amount of dramatic power, which may be seen in the scene between 'Edward I. and Sir William Wallace.' Mr. Baildon has a melodious richness and delicacy of touch which mark a true poet.

From "The Scotsman."

"Mr. Baildon's verses are enriched with such choice and subtly-coloured phrases as—

'The sea,
Palely blue-lucent, one great undulent gem;'

or,

'The blue hills
Sleep, *wan with splendour of the patient light.*'

Lines which prove the author to be a loving watcher of nature, and not a mere resetter of conventional diction."

From "The Aberdeen Free Press."

"We are glad to recognise in Mr. Baildon a true poet whose aim is pure and noble, if his flight be still rather the promise of what shall hereafter come than the full measure of his powers. He possesses the delicate fancy, the keen insight, and the responsive sympathy that enable him to carry off vivid and true impressions of life and nature in varying moods and under varying circumstances, and to depict them with the touch of a real artist.

EDINBURGH: DAVID DOUGLAS.

EXTRACTS FROM REVIEWS

OF

"ROSAMUND: A TRAGIC DRAMA,"

BY

HENRY BELLYSE BAILDON, B.A. CANTAB.

AUTHOR OF "FIRST FRUITS AND SHED LEAVES."

From "The British Quarterly Review."

"'Rosamund' is a drama of really considerable merit. Two at least of the personages breathe and act—the two women, Rosamund and Alma. This is not the Gothic Rosamund we know from Gibbon, who is a woman more like Froude's Mary Stuart, or the Lucretia Borgia of tradition. Mr. Baildon's Rosamund belongs to a much purer, more crystalline type of her sex. But she is truly dignified, interesting, and consistent throughout. She is well contrasted with Alma, her only intimate friend, and her handmaiden. The love scenes between Alma and Peredeo, a chieftain under King Alboin, are fresh and natural; and there is a very graceful lyric sung by Alma after her undoing by her lover."

From "The Scotsman."

"What we notice chiefly, however, here, as elsewhere, is the pure and unmistakable dramatic tone, and the thoroughly dramatic manner in which the flux and reflux of emotion is sustained. For really what is palmed off upon us under the guise of dramatic poetry is often quite the reverse of dramatic, having neither proper beginning, middle, nor end, in any of the speeches; and the ordinary business of the piece seems to be gone into for the purpose simply of giving talkative ladies and gentlemen an opportunity of airing fine sentiment and striking representative attitudes, after which they retire one by one like the singers at a public concert. The performers, in fine, are meant to speak only, not to act. But here we have flesh and blood humanity,—full-fleshed and full-blooded, it is true,—but speaking always naturally, though with sufficient poetic feeling and dramatic emphasis to give warmth and dignity to the representation. The allusions all tell more or less directly on the significance of the plot, and the incidents on the development of the individual characters. Then, over and above the directness of the address, there is

wonderful heartiness and energy in the give and take of the dialogue, and the colouring and illustration are always to the point. With regard to these individual images, we may quote a passage to show that Mr. Baildon has not lost the felicity of expression which we noted in his previous volume."

From "The Graphic."

"'Rosamund: a Tragic Drama,' by Henry Bellyse Baildon, B.A. (Longmans), is one of those plays which make one regret the present state of the stage. A century ago it would have been performed, and some noted actress would very likely have made her mark in the principal character; for whenever the Lombard queen comes on the stage the poet seems to receive inspiration from her presence, and the language rises at once—sometimes even to the verge of sublimity. Take, for example, these speeches: 'Now must I steel myself to play my part,' ending Act II.; the speech in Act III., Scene 2, after Alboin's exit; and Rosamund's final lines. Indeed, it is a good play, and not wanting in poetry—there is one delicious bit, spoken by Peredeo, which begins

> 'The gentle, low monotonous complaints
> Of wood-doves—loving in the quiet firs.'"

From "The Glasgow News."

"Mr. Baildon writes clearly and effectively, and has produced a most readable and interesting drama. It is short, and throughout graphic. The scenes are also short, each one contributing to the progress of the story, and each leaving behind a distinct and vivid impression. Many of the positions are very dramatically conceived, and a uniform pitch of sustained power is kept up from the beginning to the end. The story is simple, but gives scope for the delineation of the working of many passions. The manner in which it is treated shows that Mr. Baildon possesses many of those characteristics that make a dramatic writer, and that his imagination is rich, yet always finely tempered and subdued. . . . We hope to hear more of Mr. Baildon; for he who is capable of producing 'Rosamund' is capable of doing a really great and lasting work."

From "The Edinburgh Daily Review."

"In 'Rosamund: a Tragic Drama,' we are carried back to the spacious days of great Elizabeth. It might have been produced by some of the second-rate men whose activity distinguished that fertile epoch; and it would have done them no discredit. The plot is wild in its character, but it is regularly contrived; its parts stand in due relation, the characters are well discriminated, and are each fitted with appropriate parts in the dialogue, and through all there glows a noble fire of passion, there throbs a great rush of energy. No one can turn over the pages of the book without coming upon evidences of a capacious imagination, great freshness of feeling, remarkable wealth of ideas, and an equally remarkable command of language."

From "The Aberdeen Journal."

"We have read this drama with interest and admiration. The author is evidently a man of great ability, fine taste, and high culture. More than that, we venture to say that he is also a poet. Our readers know that we do not make such an assertion lightly; we think we shall be able to justify it. Mr. Baildon has chosen his subject, if we are not mistaken, from Gibbon. The story is a painful one, and we shall not attempt to tell it: he has told it himself with grace, reserve, pathos, and power."

From "The Dundee Advertiser."

"We hail this volume, although it has its faults, as a return to a better and more Shaksperian style of writing dramatic poetry than has prevailed for some time."

LONDON: LONGMANS, GREEN, & CO.

EXTRACTS FROM REVIEWS

OF

"FIRST FRUITS AND SHED LEAVES."

From "The Scotsman."

"In his preface, which is a brief essay on poetry, the author points to the cultivation of the beautiful as the great work of poets, as of all other artists. We are inclined to think that he is in this wanting somewhat in breadth, not so much in describing the beautiful as the true aim of good poetry as in limiting the scope of the beautiful. And when his poetry is turned to, there is found just that extension of his principle for which we would be inclined to contend. The author has, plainly, wide sympathies,—he could never be a poet if he had not,—and he has a keen appreciation of the sweet and true. There is no metaphysical mystery-making in what he writes, no catering for base passions, no forgetfulness of the dignity of the art for which he is illustrating. There is a strong individualism which might become a defect, but in its present development serves to lend a high tone of earnestness to the poems. There is infinite tenderness and delicacy too, and there is a simplicity in most of the pieces, which adds greatly to their charm. Take, as an instance of this, the short poem 'Ferns:'—

'Ye dwellers on the moorlands,
In woods, by joyous streams,
Curling to kiss the water
That flowing silver seems;

'In shady glens ye gather,
With plumage tapering tall;
With graceful-drooping tresses
Ye deck the ruined wall.

'Ye raise no odorous blossoms,
No flowers of sprightly hue
Of azure, gold, or purple,
To shrine the diamond dew.

'But with a magic shaping
No colours could enhance,
Ye grow in constant beauty,
And matchless elegance.

'Grace guideth every fibre
That creepeth through the green,
The work of Beauty's fingers
In every curve is seen.'

It will occur to everybody that but for one line that piece would be perfect in the simple beauty of its description. In other of the poems of a more ambitious character, there is manifested a power of riveting the attention and of inspiring the reader with much of the writer's passion. He touches the solemn and the tragic as he touches the tender and the true, with a fine vigour, in which strength and gentleness are fitly joined."

From "The Graphic."

"[The author] seems to possess many of the qualities which go to make a poet. He has much lyrical power, and one uncommon property—that is, a full appreciation of the true value of syllables, in accordance with the rules of English prosody, so well laid down by Dr. Guest and Mr. Skeet. . . . 'In Memoriam' is a good portrait, and 'David's Victory' has also pleased us. . . . The author's prose essay is one of the best parts of the book if it were not for that horrible word *unreliable*."

From "The Inverness Courier."

"The work possesses the merit of freshness and purity of style, and may claim kindred with the older and more catholic models. In the midst of poetry, much of it really beautiful, that tends to mere refinement of expression, it is encouraging to meet with a writer who combines definite thought with a manly, clear, and practical utterance. The spirit of many of the poems may be illustrated from these first stanzas of 'Hope-Song:'—

'Clear-singing lark that dost arise,
Undaunted under raining skies,
As though the sun with glad surprise
Did thee awaken.

'Though falls the rain on flat and slope,
The season's sunny horoscope
Thou singest with a deathless hope
And faith unshaken.

'Rain-chilled upon her lowly nest,
Thy mate is sitting care-oppprest
So thou dost sing, and mayst not rest
For any sorrow.

'Sing on, brave bird, and soar on high,
Shed down thy dew-bright minstrelsy,
Thy loving mate shall make reply
On sunny morrow.'

There is here simplicity and directness of thought, with colour, melody, and artistic finish. . . . The author can also strike another key, showing a delicate spiritual perception—understanding by that an element in which the moral and intellectual are happily blended—as well as artistic skill in delineation."

From "The Fifeshire Journal."

"In conclusion, though we should have been glad to observe equal merit and power sustained all through the volume, and we cannot anticipate a demand for a second edition, these 'First Fruits and Shed Leaves' being too metaphysical, and requiring too much study for soon becoming 'household words,' we are satisfied that they will be loved by men of thought, and even welcome and precious to the fortunately many souls whose discontent with things as they are is, like that of our author, born of a sincere belief that

'Somehow good
Will be the final goal of ill,'

and whose purpose is to do and be all that may help the world to that

'Far-off, divine event
To which the whole creation moves.'"

EDINBURGH: DAVID DOUGLAS.