Transactions of the Pharmaceutical Society.

NORTH BRITISH BRANCH.

The sixth meeting of the present session was held in the Society's Rooms, 119A, George Street, Edinburgh, on the evening of Wednesday, March 14, Mr. Wm. Gilmour, President of the Branch, in the chair, when the following paper was read—

BOTANY, IN REFERENCE TO SOME MODERN SPECULATIONS.

BY HENRY B. BAILDON, B.A.

Mr. President and Gentlemen,—My paper, to-night, is in some sort a continuation of the previous one on chemistry, although neither mutually nor individually are they so logically arranged as I could wish. Before commencing, I would like to guard against misapprehension on the part of those who are now present, or who may read any report that may appear of what is said. In the first place, if I have occasion to refer to great and well-known scientific names, and, it may be, to endeavour to show their conclusions to be erroneous, let it not be thought that I would for one moment compare myself with them in point of knowledge of facts, but rather that I think myself, or any sane person, quite competent to combat their conclusions from mutually admitted facts. In the second, I do not wish it to be thought, that my arguments are intended to support any special religious view or scheme. That our view of nature must affect our religious belief there is no doubt, but to press conclusions home into the region of religious conviction would be here extremely out of place.

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 a universal it is not the only force. 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. But on this point we must not linger, seeing we are not yet over the threshold of our proper subject.

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 as to 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. This evening 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 chemical and mechanical science. 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 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 bared 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 somewhat 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 and 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 euthusiastic 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, because 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 that 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 external 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 phenonomena 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, moves, 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 earthworm 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 retain 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, if 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 functions 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 impassible 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 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 every-day 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 analyse 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 the 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 accumulates 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 woods, 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 embarass his opponents. It is like a man stepping out into the blaze of noon-day, and declaring there is no sun. What by-stander 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 stand-point. 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 in 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 vital 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. With this confession I will conclude.

On the motion of Mr. A. Noble, seconded by Mr. F. Schenck, a hearty vote of thanks was accorded to Mr. Baildon for his interesting paper.

The Honorary Secretary intimated the following donations to the Museum, viz., Seventeen specimens of Drugs, etc., chiefly from India, from the Society in London; Specimens illustrating the manufacture of Copper; Specimens of preparations of Lead used in the arts, from Mr. F. W. Pittuck, Hebburn.

Provincial Transactions.

GLASGOW CHEMISTS AND DRUGGISTS' ASSOCIATION.

The fifth meeting of the session of this Association was held on Wednesday evening, 14th February, in Anderson's College, George Street. Mr. D. Frazer, President, in the chair. The minutes of previous meeting having been read and approved of, donations were announced from Mr. John Henry, wholesale confectioner, Dr. A. M. Robertson, and the Secretary (Mr. J. M. Fairlie). Several new members were also proposed, after which, in the unavoidable absence of Dr. Machattie, F.C.S., the President delivered a popular lecture, entitled "Man and his Servants," in the course of which he gave a racy and entertaining sketch of the ancient "elements" fire, air, earth, and water, and their relation to man physically, socially and morally. At the close of the lecture, on the motion of Mr. Kinninmont, Vice-President, Mr. Frazer was awarded a hearty vote of thanks. At the opening and close of the evening's proceedings, Mr. John E. Fairlie exhibited a number of interesting objects by the aid of the microscope.

On the 14th inst. the sixth meeting of the session was held in the same place, Mr. Kinninmont, Vice-President, in the chair. The secretary (Mr. Fairlie), on behalf of Mr. Samual McCall Frazer, presented the Association with one of Messrs. Southall, Brothers and Barclay's "Students' Materia Medica' Cabinets." Mr. Kinninmont on behalf of the Association accepted the donation and moved that the best thanks of the Association be given to Mr. Frazer for his donation, which was agreed to by acclamation. Dr. A. T. Machattie, F.C.S., was then called upon, who delivered the last of his short series of lectures on "Modern Chemistry."

The following is an abstract of the lecture:—

The foundation of chemical science is obviously what is called chemical affinity, chemical attraction, or sometimes, *chemism*. This particular force, whatever it may be, seems to differ in some respects from all the other forces: gravitation, cohesion, adhesion, electricity, magnetism, etc. Notwithstanding the distinctions observable in these different forces, the opinion is growing among scientific men that all kinds of force are in some way connected, although we are at present ignorant of a principle common to all. In short, that the force which we call gravitation, acting throughout space and at immense distances, is not in essence different from the chemical force which unites atom to atom, and seemingly acts at distances almost infinitely small.

That substances combine with one another chemically is an elementary fact. That they always combine in definite proportions, when forming the same kind of compound, is a great advance in our knowledge, mainly due to Dalton, but foreshadowed to some extent by Wenzel and Richter, by experimenting on the double decomposition of salts.

Dalton's *atomic theory* assumes that the atoms of elementary, or so called elementary bodies, have a definite weight. The elements may not be simple substances; all we know is that they have not yet been decomposed. Indeed there is a possibility, even a probability, that there is only one kind of matter; and that the substances which we now regard as elements, may be special groups of atoms, which we have no means of decomposing. Speculations on the existence of an *ethereal medium* throughout space, conveying heat and light by undulation, but inappreciable by any other means yet discovered, favour the idea of the unity of matter, just as the correlation of the physical forces point to a unity in motion.

The question of deciding the atomic weights of the elements is one of vital importance in chemistry, and is by no means easy. Indeed lately several of the atomic weights have been altered, and the alteration has given rise to much confusion in text-books. Some chemists retain the old numbers as a matter of convenience merely; others use the new because they believe them to be correct; and others again, using both systems, introduce formulæ to illustrate the constitution of compounds, which still further increase the complication.

The atomic weights given for the elements are, of course, only relative. We do not know the weight of any atom. Hydrogen has at any rate the *lowest* atomic weight, or as we may more safely say, *combining proportion*. Hydrogen is accordingly taken as the standard, and its atomic weight regarded as one. In France, oxygen is the standard, and its atomic weight considered one hundred.

How are atomic weights determined? There are several means used to control the results.

Chemical considerations must necessarily be of most importance. Physical considerations are nevertheless of great value.

The expression *atom* is to be held to mean the smallest amount of any element which can exist in combination. This definition distinguishes the term atom from molecule; the latter term has two meanings: thus, a molecule of an element is the smallest amount which can exist in