Monday, 5th December 1864.

His Grace the Duke of Argyll, at the request of the Council, delivered the following Opening Address :—

In opening this Session of the Royal Society of Edinburgh, at the close of my tenure of the Presidency, I must express my sincere regret on account of the small amount of attendance which it has been in my power to give. I can only assure you that, if I had had the opportunity, my attendance would have been far more regular; and that nothing but the impossibility of reconciling this with other duties has prevented my occupying this chair as often as the honour you have done me, and not less my own inclination, would have led me to do.

During the years which have elapsed since I first had the honour of addressing you from this chair, science has been enriched by an accumulated store of facts in many branches of inquiry, and by not a few of those discussions which so often promote, quite as much as actual discovery, the advance of knowledge. Our own Society has not been idle. Valuable papers have been communicated on a great variety of subjects; and when we look, not merely at the number and variety of these, but at the detailed character of many of them, and remember the number of Societies which are specially devoted to special subjects, it is impossible not to be impressed with the immense scope, as well as with the laborious minuteness, of modern investigation. But, divided and subdivided as the natural sciences have come to be, they all touch each other at innumerable points; and there are some questions touching the shadowy line that connects rather than separates the physical and the metaphysical, on which almost all the sciences are found to have a common, and often an unexpected bearing. Such, for example, is the subject with which Geology, and Palæontology, and Comparative Anatomy, and Archæology, and the mental sciences, have all been of late years so busy, and on which different schools of thought are now disputing every inch of ground. That subject is the history of Organic Life; and the question, whether in that

history we can trace anything beyond a series of disconnected facts, —anything in the nature of a Law.

I propose in this paper to make some observations upon this subject, in two of its most general aspects—

1. Upon the idea of "Creation by Law," how we should define it, and in what light we should regard it.

2. On the bearing which existing theories on the "Origin of Species" have upon our knowledge and conception of Creation by Law.

The word "Law" is very often so loosely used that it is absolutely necessary to begin any discussion on this subject by defining the sense in which it is to be understood. Much dispute, in science as well as in other matters, may often be avoided by a simple definition. If Law be understood to mean nothing more than an "observed order of facts," there need be no discussion at all on "Creation by Law." There can be no doubt whatever that there is an "observed order" in the forms of organic life. They are all allied to each other after an order and gradation which is as certain as it is mysterious. But, assuredly, this is not the sense in which creation by law is so eagerly affirmed by some, and as jealously contested by others. "Law," however, generally means not merely the "observed order of facts," but some Force which is its compelling cause. Force is the root idea of Law in its scientific sense. The law of gravitation, which is the purest example, is not merely the "observed order" in which the heavenly bodies move, but it is the force which compels those movements, and (in a sense) explains them. The difference between "law" in the narrower, and "law" in the larger sense, may be roughly illustrated by the "Three special Laws" discovered by Kepler, as compared with the one universal Law discovered by Newton. The Three Laws of Kepler were simply and purely "an observed order of facts," in respect to the planetary orbits. They stood by themselves—disconnected —their cause unknown. But the higher law discovered by Newton revealed their connection and their cause. The "observed order" which Kepler had discovered was simply a necessary consequence of the law of gravitation. In its light, the three laws of Kepler have been merged and lost.

It is true, indeed, that Law, in the narrower sense, suggests

and implies the existence of Law in the wider sense. An observed order of facts—assuming, of course, that the order is constant under the same conditions—implies the action of some force of which that order is the index and the result. But the mere general idea that *some* force is at the bottom of all phenomena which are invariably consecutive, is a very different thing from knowing what that force is, in respect to the rule or measure of its operation. It is, indeed, the great object of pure science, to ascertain the measures of force. Mr Lewes, in the very curious and interesting work which he has lately published on the philosophy of Aristotle, has maintained that the knowledge of measure—or what he calls the "verifiable element" in our knowledge—is the element which determines whether any theory belongs to science, or to metaphysics; and that any theory may be transferred from metaphysics to science, or from science to metaphysics, simply by the addition or withdrawal of its "verifiable element." In illustration of this he says, that if we withdraw the formula "inversely as the square of the distance, and directly as the mass," from the law of universal attraction, "it becomes pure metaphysics."* If this means that, apart from ascertained numerical relations, our conception of law loses all reality and distinctness, I do not agree in the position. I think the idea of natural forces is quite separate from any ascertained measurement of their energy; that, for example, the knowledge that all the particles of matter exert an attractive force upon each other, is, so far as it goes, true physical knowledge, even though we did not know the farther truth that this force acts according to the numerical rule ascertained by Newton. That matter attracts matter is a definite idea,—although it is less definite, or less complete than the idea that the measure of that attraction is "directly as the mass, and inversely as the square of the distance." This is undoubtedly the highest, or perhaps I ought to say, the ultimate, conception of a scientific "law,"—force ascertained according to some method and measure of its operation.

But now we must go a step farther. What is force? What is our conception of it? What idea can we form, for example, of the real nature of that force, the measure of whose operation has been

* Aristotle. By G. H. Lewes. P. 84.

so exactly ascertained—the force of gravitation? It is invisible, —imponderable. All our words for it are but circumlocutions to express its phenomena or its effects. There are many kinds of force in nature—which we distinguish after the same fashion—according to their effects, or according to the forms of matter in which they become cognisable to us. But if we trace up our conceptions on the nature of force to their fountain-head, we shall probably find that they are connected, more or less directly, with our own consciousness of living effort,—of that force which has its seat in our own vitality, and especially with that kind of it which can be called forth at the bidding of the will. If we can ever know anything of the nature of any force, it ought to be of this one. And yet the fact is that we know nothing. The vital forces which work in our organisation, work, for the most part, entirely independent of our will, and even of our consciousness. Those of them which are at the bidding of will are subject to it only through an elaborate machinery; and if that machinery be damaged, we know too often, by sad experience, that their connection with the will is broken. If, then, we know nothing of that kind of force which is so near us, and with which our own intelligence is, so to speak, in such close alliance, much less can we know the ultimate nature of force in its other forms. I dwell on this because I think that both the aversion with which some men regard the idea of creation by Law, and the eagerness with which some others hail it, are founded on a notion, that when we have traced any given phenomena to what are called natural forces, we have traced them farther than we really have. We know nothing of the ultimate seat of force. Science, in the modern doctrine of the Conservation of Energy and Convertibility of Forces, is already getting something like a firm hold of the idea, that all kinds of force are but forms and manifestations of some one central force, issuing from some one fountain-head of power. Sir John Herschel has not hesitated to say, that "it is but reasonable to regard the force of gravitation as the direct or indirect result of a consciousness, and a Will existing somewhere."* And even if we cannot assume that force, in all its forms, is due to the direct working of the Creator, at least let us not

* Outlines of Astronomy. 3d ed. p. 265.

assume the contrary,—let us not speak or think as if the forces of nature were either independent of, or even separate from, His power. The idea of Creation by Law leaves these questions exactly where it found them. It has no adverse bearing on theology; and those who prize it under the notion that it has this bearing, as well as those who dread it on the same account, are equally forgetful of what "Law," in a scientific sense, must be defined to be.

But there is still another sense in which the word "Law" is habitually used in science; and this is perhaps the most common and the most important of all. It is used to designate not merely an observed order of facts—not the bare abstract idea of force—not mere individual forces, according to ascertained measures of operation—but forces as combined with each other, and fitted to each other for the attainment of special ends. The whole science of mechanics, for example, deals with Law in this sense—with natural forces as related to purpose and subservient to intention. And here we come upon "Law" in a sense which is more perfectly intelligible to us than in any other; because, although we know nothing of the nature of force, even of that force which is resident in ourselves, we do know for what ends we exert it, and what is the "law" governing our devices for its use. That law is—combination for the accomplishment of purpose. The universal prevalence of this idea in nature is indicated by the irresistible tendency which we observe in the language of science to personify the forces, and the combinations of force, to which all natural phenomena are in the first instance due. It is a great injustice, too often committed, to suspect scientific men of unwillingness to accept the idea of a personal Creator, merely because they try to keep separate the language of science from the language of theology. The separation may sometimes be due to such unwillingness, but quite as often—I hope much oftener—it is a separation which is maintained for other and better reasons. But it is curious to observe how the attempt breaks down,—that is, how impossible it is, in describing physical phenomena, to avoid the phraseology which identifies them with the phenomena of mind, and is moulded on our own conscious personality and will. It is impossible to avoid this language, simply because no other language conveys the impression which

innumerable structures leave upon the mind. Take, for example, the word "Contrivance." How could science do without it? How could the great subject of animal mechanics be dealt with scientifically without continual reference to Law as that by which, and through which, special organs are formed for the doing of special work. What is the very definition of a machine? Machines do not increase force, they only adjust it. The very idea and essence of a machine is that it is a contrivance for the distribution of force with a view to its bearing on special purposes. A man's arm is a machine in which the law of leverage is supplied by the vital force for the purposes of prehension. A bird's wing is a machine in which the same law is supplied, under most complicated conditions, for the purposes of flight. It is impossible to describe the facts we meet with in this or in any other branch of science, without investing the laws of nature with something of that personality which they do actually reflect, or without conceiving of them as partaking of those attributes of mind which we everywhere recognise in their working and results. If any one imagines that the idea of Creation by Law casts out the idea of creation under the supreme control of purpose, let him read one of the later works of Mr Darwin,—I refer to his most curious work on "The Fertilisation of the Orchids." In investigating the laws which determine the form and the propagation of this strange order of plants, Mr Darwin finds it impossible to describe them without exhausting all the forms of language in which we can express the workings of intention and of mind in the determination of physical results.

I am afraid that to some this discussion may, at first sight, appear irrelevant. But I am sure this impression will be removed in those who recollect how powerfully ambiguity of language reacts upon the progress of knowledge. Words which should be the servants of thought are too often its masters; and I know of no word which has been used more ambiguously, and therefore more injuriously, than the word "Law." I do not mean that it may not be legitimately used in several different senses. It is in all cases, as applied in science, a metaphor, and one which has relation to many different kinds and degrees of likeness in the ideas which are compared. It matters little in which of these senses it is used,

provided the distinctions between them are kept clearly in view, and provided we watch against the fallacies which must arise when we pass, in its use, from one meaning to another. There are at least four different senses which must be carefully distinguished—

1. We have Law as applied simply to "an observed order of facts."
2. To that order as involving the action of some force or forces, of which nothing more may be known.
3. As applied to individual forces, the measure of whose operation has been more or less defined and ascertained.
4. As applied to those combinations of force which have reference to the fulfilment of purpose or to the discharge of function.

Now, in which of these senses does science justify us in entertaining the idea of "Creation by Law?"

First, it is certain that there is an "observed order of facts" both in the organic and in the inorganic world. I mean to speak in this paper of the organic world alone, and chiefly of those higher forms which are the seat of animal life. In these there is an observed order in the most rigid scientific sense, that is,—phenomena in uniform connection, and mutual relations which can be made, and are made, the basis of systematic classification. These classifications are imperfect, not because they are founded on ideal connections where none exist, but only because they fail in representing adequately the subtle and pervading order which binds together all living things. But the order which prevails in the existing world is not the only order which has been recognised by science. A like order has prevailed through all the past history of creation. Nay, more; it has, I think, been clearly ascertained, not only that relations similar to those which now exist have existed always among all the animals of each contemporary creation, but that order of a like kind has connected with each other all the different creations which were successively introduced. In almost all the leading types of life which have existed in the different geological ages, there is an orderly gradation connecting the forms which were becoming extinct with the forms which were for the first time appearing in the world. It is still disputed by some geologists, whether we have

certain evidence that this gradation has been the gradation of a rising scale—of progressive creations from lower to higher types. But this dispute is maintained only on the ground, that we cannot safely trust to negative evidence. It is an unquestionable fact, that so far as this kind of evidence can go, it does testify to the successive introduction of higher and higher forms of Life. Very recently, a discovery has been made, to which Mr Darwin only a few years ago referred, as "a discovery of which the chance is very small," viz., of fossil organisms in beds far beneath the lowest Silurian strata. This discovery has been made in Canada—in beds far down, near the bottom even, of the rocks hitherto termed "Azoic." But what are the forms of life which have been found here? They belong to the very lowest of living types,—to the "Rhizopods." So far as this discovery goes, therefore, it is in strict accordance with all the facts previously known,—that as we go back in time, we lose, one after another, the higher and more complex organisms,—first, the Mammalia; then, the Vertebrata; and now lastly, even the Mollusca. It is in accordance, too, with another fact which has been observed before, viz., that particular forms of life have attained, at particular epochs, a maximum development both in respect to size and distribution,—the favourites as it were, of Creation for a time. These earliest Rhizopods seem to have been of enormous size and developed on an enormous scale, since there is good reason to believe that beds of immense thickness are composed of their remains. All that is new in this discovery is the vast extension which it gives in time to the same rules which had been already traced through ages which we cannot number. The facts of creation, therefore, do range themselves in an observed order, and in this sense, at least, it may be said with truth that creation has been "by Law."

And now we advance one step farther. Every observed order in physical phenomena does suggest irresistibly to the mind the operation of some physical cause—the working of some force or forces, of which nothing more may be known than these their visible effects. This is the second of the four senses in which I have said that "Law" is frequently used. We say of an observed order of facts that it must be due to some "Law," meaning simply that all order involves the idea of some arranging cause, the work-

ing of some force, whether it be one which we can trace and define or not. In these two senses, then, both somewhat vague, it cannot be doubted that Creation has been by Law.

The next question, however, is the main one—Is the observed order which prevails in nature, and especially in the organic world, an order of which we can even guess the physical cause? Is it an order which contains within itself any indications of the force or forces which have been concerned in producing it?

In considering this question, there is one thing to be observed at the outset. It is certain that nothing is known or has been even guessed at, in respect to the history and origin of Life, which corresponds with Law in its strictest and most definite sense. We have no knowledge of any one or more forces—such as the force of gravitation, or of magnetic attraction and repulsion—to which any one of the phenomena of Life can be traced. Far less have we any knowledge of any such laws which can be connected with the successive creation or development of new organisms. Professor Huxley, in a recent work,* has indeed spoken of "that combination of natural forces which we term Life." But this language is purely rhetorical. I do not mean to say that Life may not be defined to be a kind of force, or a combination of forces. All I mean is, that we know nothing of any of these forces in the same sense in which we do know something of the force of gravity, or of magnetism, or of electricity, or of chemical affinity. These are all more or less known, not, indeed, in respect to their ultimate nature, but in respect to certain methods and measures of their operation. No such knowledge exists in respect to any of the forces which have been concerned in the development of Life. No man has ever pretended to get such a view of any of these as to enable him to apply to them the instruments of his analysis, or to trace in their working any of those definite relations to space, or time, or number, which are always the ultimate quest of science, and the discovery of which is her great reward.

Since, then, laws, in this most definite sense of the word, have not been discovered in the existing phenomena, or in the past history of organic life, let us look a little closer at the ideas which

* Elements of Comparative Anatomy, p. 2.

these phenomena have suggested to the mind of those who have speculated on the origin and development of species.

There is one idea which has been common to all theories of development, and that is the idea that ordinary generation has somehow been producing, from time to time, extraordinary effects, and that a new species is, in fact, simply an unusual birth. It is worthy of observation, that the earlier forms in which the theory of development appeared, did suggest something more nearly approaching to a law of creation than is contained in the later form which that theory has assumed in the hands of Mr Darwin. The essential idea of the theory of development, in its earlier forms, was, that modifications of structure arose somehow by way of natural consequence from the outward circumstances or physical conditions, which required them, and from the living effort of organisms sensible in some degree of that requirement. Now, inadequate and even grotesque though this idea may be as explaining the origin of new species, it cannot be denied, that it makes its appeal to a process which, at least to a limited extent, does operate in producing modifications of organic structure. For example, the same species of mollusc has often a shell comparatively weak and thin, or a shell comparatively robust and strong, according as it lies in tranquil or in stormy water. The shell which is much exposed needs to be stronger than the shell which is less exposed. But the mere fact of the need cannot supply the thing needed, unless by the adjustment of some machinery for the purpose. How the vital forces of the mollusc can thus be made to work to order, under a change of external conditions, we do not know. But we do know, as a matter of fact, that the shell is thickened and strengthened, according as it needs resisting power. This result does not appear to arise from any difference in the amount of lime held in solution in the water, but upon some power in the secreting organs of the animal to appropriate more or less of it, according to its own need. The effects of this power are seen where there is no difference of condition except difference of exposure. I have seen it stated, that they are observable in the shells which lie on the different sides of Plymouth breakwater,—the sheltered side and the exposed side. The same power of adaptation is seen in many other forms. Trees which are most exposed to the blast are the most

strongly anchored in the soil. Limbs which are most used are the most developed. All these results arise by way of natural consequence. How shall we describe them? Shall we say that they are the result of Law? We may safely do so, remembering only that by Law, in this sense, we mean nothing but the co-operation of different natural forces, which, under certain conditions, work together for the fulfilment of an obvious intention. Of the nature of those forces we know nothing; nor is it easy to conceive how they have been so co-ordinated as to produce effects fitting with such exactness into the conditions requisite for the preservation of organic life. If there were any evidence that by the same means new forms of life could be developed from the old, I cannot see why there should be any reluctance to admit the fact. It would be different from anything that we see; but I do not know that it would be at all more wonderful, or that it would bring us much nearer than we now stand to the great mystery of creation. I look upon the adaptation and arrangement of natural forces, which can compass these modifications of animal structure, in exact proportion to the need of them, as an adaptation and arrangement which is in the nature of creation. It can only be due to the working of a power which is in the nature of creative power. We are so accustomed to these and other similar phenomena, and to hide our own ignorance of their cause, by describing them as the result of "Law," that we forget what a multitude of natural forces must be concerned in their production, and what complicated adjustments of these amongst each other for the accomplishment of purpose. It is purely, therefore, in my view, a question of evidence, whether this particular law of adaptation has or has not been the means of introducing new forms of life. There is no evidence that it has. So far as we know, this power of self-adaptation, wonderful as it is, has a comparatively limited application; when that limit is outrun by changes in outward conditions, which are too great or too rapid, whole species die and disappear. Nevertheless, the introduction of new species to take the place of those which have passed away, is a work which has been not only so often, but so continuously repeated, that it suggests the idea of having been brought about through the instrumentality of some natural process. But we may say with confidence, that it must have been

a process different from any that we yet know—a process not the same as that, obscure as this is, which produces the lesser modifications of organic forms.

It has not, I think, been sufficiently observed, that the theory of Mr Darwin does not address itself to the same question, and does not even profess to trace the origin of new forms to any definite law. His theory gives an explanation, not of the processes by which new forms first appear, but only of the processes by which, when they have appeared, they acquire a preference over others, and thus become established in the world. A new species is, indeed, according to his theory, as well as with the older theories of development, simply an unusual birth. The bond of connection between allied specific and generic forms, is in his view simply the bond of inheritance. But Mr Darwin does not pretend to have discovered any law or rule according to which new forms have been born from old forms. He does not hold that outward conditions, however changed, are sufficient to account for them. Still less does he connect them with the effort or aspirations of any organism after new faculties and powers. He frankly confesses that "our ignorance of the laws of variation is profound;" and says, that in speaking of them as due to chance, he means only "to acknowledge plainly our ignorance of the cause of each particular variation."* Again he says—"I believe in no law of necessary development."† This distinction between Mr Darwin's theory and other theories of development, has not, I think, been sufficiently observed. His theory seems to be far better than a mere theory—to be an established scientific truth—in so far as it accounts, in part at least, for the success and establishment and spread of new forms *when they have arisen.* But it does not even suggest the law under which, or by which, or according to which, such new forms are introduced. Natural selection can do nothing except with the materials presented to its hands. It cannot select except among the things open to selection. Natural selection can originate nothing; it can only pick out and choose among the things which are originated by some other law. Strictly speaking, therefore, Mr Darwin's theory is not a theory on the origin of species at all, but only a theory on the causes which lead to the

* Origin of Species, p. 131 (1st edition). † Ibid. p. 351.

relative success or failure of such new forms as may be born into the world. It is the more important to remember this distinction, because it seems to me that Mr Darwin himself frequently forgets it. Not only does he speak of natural selection "producing" this and that modification of structure, but he undertakes to affirm of one class of changes that they can be produced, and of another class of changes that they cannot be produced, by this process.* Now, what are the changes for the preservation of which his theory does, in some sense, account? They are such changes, and these only, as are of some direct use to the organism in the "struggle for existence." Any change which has not this direct value, is not provided for in the theory. All structures, therefore, are unaccounted for—not only as respects their origin, but even as respects their preservation—in which the variations have no other value than mere beauty or variety. Accordingly, Mr Darwin is tempted to deny that any such structures exist in nature. Now, I hold that any theory of which this denial is really a necessary part, is self-condemned. Yet a theory may be good as accounting for the preservation of some structures, although it fails to account in this respect for others. And so the fact that natural selection cannot have operated on structures of mere beauty and variety is no proof that the theory of natural selection is false, but only that it is incomplete. It does not account for the origin of any structure; and it accounts for the preservation of only a certain number. Surely, then, Mr Darwin assigns to his "law" of natural selection a range far wider than really belongs to it, when, on the strength of it, he denies that beauty for its own sake can be an end or object in organic forms. He says—"This doctrine, if true, would be absolutely fatal to my theory." Why should this be fatal to his theory, except on the supposition that Natural Selection gives a complete account both of the origin of new forms, of which, in reality, it gives no account at all, and of their preservation, of which it does give some account, but one which is only partial? I dwell on this, because it lies at the very root of the question how far Mr Darwin's theory can be said to suggest anything in the nature of a creative law of a kind to explain the

* Origin of Species, p. 200 (1st edition).

method which has been followed in the introduction of new forms. Let us test this question by bringing to bear upon it some particular example of specific variation. I select for this purpose one example to which my attention has been lately directed, which will illustrate what I mean better than any abstract discussion. It is the case of the Humming-birds.

This group of birds seems to me to exhibit, in the most striking form, not a few of those mysteries of creation which at once tempt us to speculate on the origin of species, and at the same time confound every endeavour to bring it into relation with any process which we know or can conceive. In the first place, they are sharply defined from all other forms in that class of the animal kingdom to which they belong. It is most difficult to say what is their nearest affinity, and the nearest, when it is found, is very distant. Secondly, they are absolutely confined to one continent of the globe. In the third place, the various species as amongst themselves are very closely united, ranging indeed over a great variety of forms, but for the most part connected with each other by very nice gradations. In the fourth place, there are, so to speak, some gaps in the scale, which suggest that some species have either been lost, or have not yet been discovered. In the fifth place, each of these species, however nearly allied to some other, appears to be absolutely fixed and constant, there being not the slightest indication of any mixture—of any hybrid forms. In the sixth place, there is the most wonderful adaptation of special organs for the performance of special functions, and for the relation of these organs to particular structures in the vegetable kingdom. In the seventh place, there is a development, for which in extent and variety there is no parallel in the world, of structures designed for mere ornament, and entirely separate from any other known or conceivable use.

A few words on some of these characters will show their separate and joint bearing on the idea of Creation by Law.

In the first place, then, the absolute distinctiveness from all others of this family of birds, coupled with its immense extent, gives the idea of some common bond, some physical cause, to which such an identity in physical characters must be due. This identity prevails not only in such essential matters as the structure of the bill and tongue, in the form of the feet and of the wings, in the habits

of flight, in the nature of the food, but runs also into some very curious details, as for example, in the number of feathers in the tail and in the wings, which are constant numbers—adhered to even when some of the feathers, not being used even for ornament, are reduced almost to rudiments. But under degrees of development which are very variable, the number is invariable. This identity of structure is the more remarkable from the immense extent of the group which it characterises. There are now known to science no less than 416 different species of humming-bird ; and it cannot be doubted that many more remain to be discovered among the immense forests and mountain ranges of Central America.

Now, what is the bond which unites so closely, in a common structure, all the forms of this great family of birds ? We think it a sufficient explanation sometimes of the likeness of things, that they are made for a common purpose. And so it is an explanation in one sense, but not in another. It gives the reason why likeness should be aimed at, but not the cause through which it has been brought about. Sameness in the purpose for which things are intended, is a reason why those things should be made alike; but it is no explanation of the process to which the common aspect is due. It is an explanation of the "why ;" but it is no explanation of the "how." Purpose is attained in nature through the instrumentality of means; and community of aspect in created things suggests the idea of some common process in the creative work. The likeness which is due to common parentage serves the most important purposes ; but it is not the less the result of a physical cause, out of which it arises by way of natural consequence. The likeness of the Humming-birds to each other suggests this kind of cause. It is true that the organs which it principally affects are specially adapted for a special habit of life. They are fitted to enable the bird to feed on the nectar, and the insects which frequent the nectar of flowers. But there are flowers in abundance in other quarters of the globe where there are no Humming-birds. And here we come on the curious facts of geographical distribution,—a class of facts which, as much as any other, suggest some specific methods as having been followed in the work of creation. Humming-birds are absolutely confined to the great continent of America with its adjacent islands. Within those limits there is every range

of climate, and there are particular species of Humming-bird adapted to every region where a flowering vegetation can subsist. It is therefore neither climate nor food which confines the Humming-birds to the New World. What is it, then? The idea of "centres of creation" is at once suggested to the mind. It seems as if the Humming-birds were introduced at one spot, and as if they had spread over the whole continent which was accessible to them from that spot. They are absent elsewhere, simply because from that spot the other continents of the world were inaccessible to them. But if these ideas are suggested to the mind by the general aspect of this family as a whole, they are strengthened by some of the facts which we discover when we examine and compare with each other the genera and species of which it is composed. There is a beautiful gradation between the different genera and the different species, so much so, that it has been found impossible to divide the Humming-birds into more than two sub-families, from the absence of sufficiently well-marked divisions. And yet, on the other hand, they cannot be arranged in anything like a continuous series, because some links appear to be missing in the chain.

But these general facts terminate in nothing more definite than a vague surmise. When we enter farther into details, we feel at once how little they agree with any physical law which is known or even conceivable by us. If the likeness which prevails in the whole group reminds us of the likeness which is due to community of blood, it is equally true that the differences between the species are totally distinct both in kind and degree from the variation which we ever see arising among the offspring of the same parents. Let us look at what these differences are. The generic and specific distinctions between the humming-birds are mainly of two kinds,—1*st*, Differences in the form of essential organs, such as the bill and the wings; 2*d*, Differences in those parts of the plumage which are purely ornamental. Now, of these two kinds of variation, the only one on which the law of natural selection has any bearing at all, is the first. And on that kind of variation, the only bearing which natural selection has is this—that if any Humming-bird were born with a new form of bill, or a new form of wing, which enabled it to feed better and to range farther, that

improved bill and wing would naturally tend to be perpetuated by ordinary generation. This is unquestionably true ; but it really does not touch the facts of the case. The bills and wings of the different genera do not differ from each other in respect of any comparative advantage of this kind, but simply in respect to variety corresponding with the variety of certain vegetable forms. One form of bill is as good as another, but some forms are adapted to some special class of flower. Some bills, for example, are formed of enormous length, specially adapted to obtain access to the nectar chambers of long tubular flowers, such as the Brugmansia. Some, on the other hand, as if to show that the same end may be attained by different means, obtain access to the same flowers by a shorter process, and pierce the bases of the corolla instead of seeking access by the mouth. Some have bills bent downwards like a sickle, adapted to searching the bark of palm-trees for the insects hid under the scaly covering; others have bills curved in the opposite direction, fitted, apparently, to the curious construction of some of the great family of Orchids so immensely developed in the forests of Central America. Some have bills equally well adapted for searching a vast variety of flowers and blossoms, and these, accordingly, migrate with the flowering season, and issuing from the great stronghold of the family in tropical America, spread like our own summer birds of passage, northwards to Canada, and southwards to Cape Horn, in the corresponding seasons of the year. In contrast with these species of extended range, there are many species whose habitat is confined, perhaps, to a single mountain, and there are some which never have been seen beyond the edges of some extinct volcano, whose crater is now filled with a special flora. Many of the great mountains of the Andes have each of them species peculiar to themselves. On Chimborazo and Cotopaxi, and other summits, special forms of Humming-birds are found in special zones of vegetation even close up to the limits of perpetual snow. Again, many of the islands have species peculiar to themselves. The little island of Juan Fernandez, 300 miles from the mainland, has three species peculiar to itself, of which two are so distinct from all others known, that they cannot for a moment be confounded with any of them. It is impossible not to see, in such complicated facts as these, that the creation of new species has followed

some plan in which mere variety has been in itself an object and an aim. The divergence of form is not a divergence which can have arisen by way of natural consequence, merely from comparative advantage and disadvantage in the struggle for existence. Bills highly specialised in form are certainly not those which would give the greatest advantage to birds which have equal access to the abundant flora of an immense continent. Some form of bill adapted to the probing or piercing of all flowers with almost equal ease, would be the form most favourable to the multiplication and spread of Humming-birds. Continued approximation to some common type would seem to be quite as natural, and a much more advantageous kind of change as regards advantage in the struggle for existence, than endless divergence and special adaptation to limited spheres of enjoyment. At all events, we may safely say that mere advantage, in Mr Darwin's sense, is not the rule which has chiefly guided creative power in the origin of these new species. It seems rather to have been a rule having for its object the mere multiplying of life, and the fitting of new forms for new spheres of enjoyment, according as these might arise out of corresponding changes in other departments of the organic world.

If, now, we turn to the other kind of specific distinction between Humming-birds, viz., that which consists in differences in the mere colouring and disposition of the plumage, we shall find the same phenomena still more remarkable. In the first place, it is to be observed of the whole group that there is no connection which can be traced or conceived between the splendour of the Humming-birds and any function essential to their life. If there were any such connection, that splendour could not be confined, as it almost exclusively is, to one sex. The female birds are of course not placed at any disadvantage in the struggle for existence by their more sombre colouring. Mere utility in this sense, therefore, can have had no share in determining one of the most remarkable of all the characteristics of this family of birds. Those who by special study have laid their mind alongside of the mind of Nature in any one of its departments, have generally imparted to them a true sense, so far as it goes, in the interpretation of her mysteries. Let us then hear what Mr Gould says on this point :—" The members of most of the genera have certain parts of their plumage fantastically

decorated; and in many instances most resplendent in colour. My own opinion is, that this gorgeous colouring of the humming-birds has been given for the mere purpose of ornament, and for no other purpose of special adaptation in their mode of life; in other words, that ornament and beauty, merely as such, was the end proposed."* Different parts of the plumage have been selected in different genera as the principal subject of ornament. In some, it is the feathers of the crown worked into different forms of crest; in some, it is the feathers of the throat, forming gorgets and beards of many shapes and hues; in some, it is a special development of neck plumes, elongated into frills and tippets of extraordinary form and beauty. In a great number of genera the feathers of the tail are the special subjects of decoration, and this on every variety of plan and principle of ornament. In some, the two central feathers are most elongated, the others decreasing in length on either side, so as to give the whole the wedge form. In others, the converse plan is pursued, the two lateral feathers being most developed, so that the whole is forked after the manner of the common swallow. In others, again, they are radiated, or pointed and sharpened like thorns. In some genera there is an extraordinary development of one or two feathers into plumes of enormous length, with flat or spatulose terminations. Mere ornament and variety of form, and these for their own sake, is the only principle or rule with reference to which Creative Power seems to have worked in these wonderful and beautiful birds. And if we cannot account for the differences in the general style and plan of ornament followed in the whole group, by referring them to any sort of use in the struggle for existence, still less is it possible to account, on this principle, for the kind of difference which separates from each other the different species in each of the genera. These differences are often little more than a mere difference of colour. The radiance of the ruby or topaz in one species, is replaced perhaps by the radiance of the emerald or the sapphire in another. In all other respects the different species are sometimes almost exact counterparts of each other. As an example, let me refer to the two species figured by Mr Gould as the Blue-tailed and the Green-tailed Sylphs; and also to two species

* Gould's "Trochilidæ," Introduction.

of the "Comets," in which two different kinds of luminous reds or crimsons are nearly all that serve to distinguish the species.

A similar principle of variation applies in other genera, where the amount of difference is greater. For example, one of the most singular and beautiful of all the tribe is comprised within the genus "Lophornis," or the "Coquettes." The principle of ornament in this genus is, that the different species are all provided both with brilliant crests, and with frills or tippets on the neck. The feathers of these parts are generally of one colour, ending in spots or spangles of another; the spangles being generally of metallic lustre. There seems to be a rule of inverse proportion between the two kinds of ornament. The species which have the neck plumes longest have the shortest crests, and *vice versâ*. In the shape and structure of all essential organs there is hardly any difference between the species. I need not multiply instances farther, since many others of the same kind will be observed in Mr Gould's splendid work. Now, what explanation does the law of natural selection give—I will not say of the origin, but even of the continuance and preservation—of such specific varieties as these? None whatever. A crest of topaz is no better in the struggle for existence than a crest of sapphire. A frill ending in spangles of the emerald is no better in the battle of life than a frill ending in spangles of the ruby. It is impossible to bring such varieties into relation with any physical law known to us. It has relation, however, to a purpose, which stands in close analogy with our own knowledge of purpose in the works of man. Mere beauty and mere variety, for their own sake, are objects which we ourselves seek when we can make the forces of nature subordinate to the attainment of them. There seems to be no conceivable reason why we should doubt or question, that these are ends and aims also in the forms given to living organisms, when the facts correspond with this view, and with no other. In this sense, we can trace a creative law,—that is, we can see that these forms of life do fulfil a purpose and intention, which we can appreciate and understand.

But then it may be asked, has this purpose and intention been attained without the use of means? Have no physical laws been used, whereby these new forms of beauty have been evolved, the one from the other, in a series so wonderful for its variety in unity, and

its unity in variety? I am not now seeking to answer this question in the negative. All I say is, that the physical laws which are made subservient to this purpose are entirely unknown to us. That particular combination of a great many natural laws, which Mr Darwin groups under the name of Natural Selection, does not in the least answer the conditions which we seek in a law to account for either the origin or the spread of such creatures as the various kinds of Humming-birds. On the other hand, if I am asked whether I believe that every separate species has been a separate creation —not born, but separately made—I must answer, that I do not believe it. I think the facts do suggest to the mind the idea of the working of some creative law, almost as certainly as they convince us that we know nothing of its nature, or of the conditions under which it does its glorious work. Our experience of the existing order of nature is, that the young of each species repeat the form and the colours of their parent, and that even where variations occur, they are inconstant, and tend to disappear. We have no knowledge, for example, that from the eggs of the Blue-tailed Sylph a pair of Green-tailed Sylphs can ever be produced. We have no reason to believe that a species of "Lophornis," with a tippet of emerald spangles, can ever hatch out a pair of young adorned with spangles of some other gem. And yet we cannot assert that such phenomena are impossible, nor can it be denied that, as a matter of speculation, this process is natural and easy of conception, as compared with the idea of each species being separately called into existence, out of the inorganic elements of which its body is composed. Such new births—if they do take place—would perfectly fulfil, I think, the only idea we can ever form of new creations. For example, it would appear that every variety which is to take its place as a new species must be born male and female; because it is one of the facts of specific variation in the Humming-birds, that although the male and female plumage is generally entirely different, yet the female of each species is as distinct from the female of every other, as the male is from the male of every other. If therefore, each new variety were not born in couples, and if the divergence of form were not thus secured in the organisation of both the sexes, it would fail to be established, or would exhibit for a time the phenomena of mixture, and termi-

nate in reversion to the original type. Now here again we have the emphatic declaration of Mr Gould, that among the thousands of specimens which have passed through his hands, from all the genera of this great family, he has never seen one case of mixture or hybridism between any two species, however nearly allied. But this passage is so important, that I quote it entire. "It might be thought by some persons that four hundred species of birds so diminutive in size, and of one family, could scarcely be distinguished from each other; but any one who studies the subject, will soon perceive that such is not the case. Even the females, which assimilate more closely to each other than the males, can be separated with perfect certainty; nay, even a tail-feather will be sufficient for a person well versed in the subject to say to what genus and species the bird from which it has been taken belongs. I mention this fact to show that what we designate a species has really distinctive and constant characters; and in the whole of my experience, with many thousands of humming-birds passing through my hands, I have never observed an instance of any variation which would lead me to suppose that it was the result of a union of two species. I write this without bias, one way or the other, as to the question of the origin of species. I am desirous of representing Nature in her wonderful ways as she presents herself to my attention at the close of my work, after a period of twelve years of incessant labour, and not less than twenty years of interesting study."*

If, therefore, new species are born from the old, it is not by accidental mixture; it is not by the mere nursing of changes advantageous in the battle of life; it must be from the birth of some one couple, male and female, whose organisation is subjected to new conditions corresponding with each other, and having such force of self-continuance, as to secure it against reversion. It matters not how small the difference may be from the parent form; if that difference be constant, and if it be associated with some difference equally constant in the female form, it becomes at once a new species. There are some cases mentioned by Mr Gould which may possibly be examples of the first founding of a new species. In the beautiful genus "Cynanthus," he tells us that there are some

* Gould's "Trochilidæ," Introduction.

local varieties near Bogota, in which the ornament is partially changing from blue to green; and it is a curious fact, that this variation appears to be taking effect under the direction of some definite rule or "law,"—inasmuch as it is only the eight central feathers of the tail which are tipped with the new colour. Mr Gould expressly says of one such variety from Ecuador, that it possesses characters so distinctive as to entitle it, in his opinion, to the rank of a separate species. The very discussion of such a question shows the possibility of new births being the means of introducing new species. But my object here is simply to point out that Mr Darwin's theory offers no explanation of such births, either as respects their origin or their preservation, neither does it even approach to tracing these births to any physical law whatever. It fails also to recognise, even if it does not exclude, the relation which the birth of new species has to the mental purpose of producing mere beauty and mere variety. Nevertheless it may be true that ordinary generation has been the instrument employed; but if so, it must be employed under extraordinary conditions, and directed to extraordinary results.

The only senses, therefore, in which we get any glimpse of creation by law are these—1*st*, That the close physical connection between different specific forms is probably due to the operation of some force or forces common to them all; 2*d*, That these forces have been employed and worked with others equally unknown, for the attainment of such ends as the multiplication of life, in forms fitted for new spheres of employment, and for the display of new kinds of beauty.

Is there anything in this conclusion to conflict with such knowledge as we have from other sources of the nature and working of creative power? I do not know on what authority it is that we so often speak as if creation were not creation, unless it works from nothing as its material, and by nothing as its means. We know that out of the "dust of the ground," that is, out of the ordinary elements of nature, are our own bodies formed, and the bodies of all living things. Nor is there anything which should shock us in the idea that the creation of new forms, any more than their propagation, has been brought about by the use and instrumentality of means. In a theological point of view it matters

nothing what those means have been. I agree with Mons. Guizot when he says that "Those only would be serious adversaries of the doctrine of Creation who could affirm that the universe—the earth and man upon it—have been from all eternity, and in all respects just what they are now."* But this cannot be affirmed except in the teeth of facts which Science has clearly ascertained. There has been a continual coming-to-be of new forms of life.† This is Creation, no matter what have been the laws or forces employed by Creative Power. The truth is, that the theory which fixes upon inheritance as the cause of organic likeness, startles us only when it is applied to forms in which unlikeness is more prominent than resemblance. The idea, for example, that the different kinds of Pigeon, or of Humming-birds, have all descended through successive variation from some one ancestral pair, whether it be true or not, would not startle any one. Yet, if this be true, we must be prepared for the same surmise extending farther. The advocates of development urge that time is a powerful factor. They say that if small changes, but constant enough, and definite enough to constitute new species, can and do arise out of born varieties, it is impossible to fix the limits of divergence which may be reached in the course of ages. Yet it surely does not follow that there is no such limit because we cannot fix it. It does not necessarily follow that because we admit the idea of the Rock-dove, and the Turtle-dove, and the Ring-dove being all descended from one ancestral Pigeon, we are bound to accept the idea of the Whale, and the Antelope, and the Monkey being all descended from some one primeval mammal. Mr Darwin says, truly enough, that inheritance "is that cause which alone, as far as we positively know, produces organisms quite like, or nearly like, each other." But this is no reason why we should conclude that inheritance is the only cause which can produce organisms quite unlike, or only very partially like, each other. We are surely not entitled to assume that all degrees and kinds of likeness can only arise from this single cause. Yet until this extreme proposition be proved,

* Méditations sur l'Essence de la Religion Chrétienne, p. 49.

† "We discern no evidence of a pause or intermission in the creation or coming-to-be of new plants and animals."—*Instances of the Power of God as manifested in His Animal Creation*, by Professor Owen.

or rendered probable, we have a sound scientific basis for doubting the application of the theory precisely in proportion to the unlikeness of the animals to which it is applied. And this is the ground of reasoning, besides the ground of feeling, on which we revolt from the doctrine as applied to Man. We do so because we are conscious of an amount and of a kind of difference between ourselves and the lower animals, which is, in sober truth, immeasurable, in spite of the close affinities of bodily structure. But the closeness of these affinities is a fact. Man, as Archbishop Whately has said, besides being man, is also an animal. Science will ask, even if she never gets an answer, What is the common cause of this common structure? The fact which it has always appeared to me most difficult to disengage from the theory of development, is the existence of rudimentary or aborted organs; the existence of teeth, for example, in the jaws of the Whale—teeth which never cut the gum—and which are entirely useless to the animal. We have an inherent conviction that this must have some use in the future, or it must have had it in the past. Whether we look at it in the light of history, or prefer to regard it in the light of prophecy, it points to the existence of some derivative form in which these teeth have been, or are to be, turned to use. There is one suggestion on this subject which I cannot accept. When men were yet unwilling to admit the existence of life and death upon the globe so long before the creation of man, it used to be said that fossils were only "sports of nature." So in our own day, I have heard it said that rudimentary organs are merely intended to satisfy that condition of our finite minds, in virtue of which we are unable to conceive creation, except in connection with some history and method of growth. And so, as a condescension to this weakness, aborted members are given to suggest a history which was never true, and a method which was never followed! Now, of one thing I feel as sure as I can be of any truth, viz., that there are no fictions in nature, and no jokes. Whatever natural things really point to, they point to faithfully; and the conclusions really indicated are never false. Abortive organs mean something, and they mean it truly. Still, there is no proof that inheritance is the only cause from which such structures can arise. In the inorganic world we know that not mere similarity, but

absolute identity of form, as in crystals, is the result of laws which have nothing to do with inheritance, but of forces whose nature it is to aggregate the particles of matter in identic shapes. It is impossible to say how far a similar unity of effect may have been impressed on the forces through which vital organisms are first started on their way. There are some essential resemblances between all forms of life which it is impossible even in imagination to connect with community of blood by descent. For example, the bilateral arrangement is common to all organisms, down at least to the Radiata. Again, the general mechanism of the digestive organs by which food is in part assimilated and part rejected, is also common through a range of equal extent. These are fundamental similarities of plan, depending probably on the very nature of forces of which we know nothing, but which we have not the slightest reason to suppose are due to inheritance. Other similarities of plan may depend on the same laws, equally unconnected with inheritance by descent. Indeed, inheritance has been suggested as the cause, mainly because there is a difficulty in conceiving any other. But there is at least an equal difficulty in conceiving the applicability of this cause to Man. Mons. Guizot, in the work already quoted,* lays it down as a physical impossibility that Man—the human pair—can have been introduced into the world except in complete stature—in the full possession of all his faculties and powers. He holds it as certain that on no other condition could Man, on his first appearance, have been able to survive and to found the human family. Even those who distrust this argument as entitled to the rank of a self-evident physical truth, must admit that it is at least quite as good as the opposite assertion, that any origin except the origin of natural birth is inconceivable. Where our ignorance is so profound no reasoning of this kind is of much value; but there is much to be said in support of Mons. Guizot's position. Certainly, Man as a mere animal is the most helpless of all animals. His whole frame has relation to his mind, and apart from that relation, it is feebler than the frame of any of the brutes. Yet in its plan and structure it is homologically, that is ideally, the same as theirs—organ answering

* Méditations sur l'Essence de la Religion Chrétienne, p. 22.

to organ, and bone to bone. "Adherence to Type" are words expressive of an idea, of a purpose, which we see fulfilled in organic forms. But this purpose must have sought its own accomplishment by the use of means, and the question of science always is, what were these? Love of beauty is equally a purpose which we see fulfilled in nature, but in the case of the Humming-birds this has been accomplished by giving to their plumes the structure of "thin plates," which decomposes light and flings back its prismatic colours to the eye. Fitness and special adaptation is another of the purposes of creation, but this also is attained through the careful arrangement, and pliability to use, of physical laws. In like manner, "Adherence to Type" is the expression of a fact, or the statement of a purpose, which, like all the other purposes fulfilled in nature, invites to an investigation of the instrumentality employed. We see the purpose but we do not see the method. We see the purpose, for example, in the wonderful adaptability of the vertebrate type to the infinite varieties of life to which it serves as an organ and a home. There is at least one conclusion which I hold to be certain, namely, this—that no theory in respect to the means and method employed in the work of creation, can have the slightest effect in removing that work from the relation in which it stands to the attributes of creative Will.

We cannot too completely shake off the notion that things which happen by way of "natural consequence" are thereby removed from being the effect of purpose and the work of Will. We forget that all our own works are works done through the use and instrumentality of natural forces, and it is knowledge and intelligence alone which enable us to combine these forces for the accomplishment of our designs. All that we do, or can effect, is brought about by way of natural consequence. The steam-engine works by way of natural consequence; so does Mr Babbage's calculating machine,—so does the electric telegraph,—so does the solar system. Everything that is done in nature, as well as everything that is done in art, seems to be done—as it were—by knowing how to do it. Whatever may be the ultimate seat of the elementary forces of nature, they can only produce the effects which we desire to attain by being combined under the control of mind. They appear to be used in the works of nature precisely on the same principle on which they are used

by man. The fewer those elementary forces, the greater must be the mental power, and skill, and knowledge, under which they are yoked to such various use. And it is apparently out of a small number of elementary forces, having fixed rules too, limiting their combination, that all the infinite varieties of organic and inorganic matter are built up by means of nice adjustment. As all the faculties of a powerful mind can utter their voice in language whose elements are reducible to twenty-four letters, so all the forms of nature, with all the ideas they express, are worked out from a few simple forces, having a few simple properties.

And here I cannot help saying that I do not share in the impression which is felt by many, that the progress of modern investigation is in a direction tending to materialism. Of course I am not speaking of what may be the tone of individual minds. But I do speak, and with strong conviction, of the general bearing of scientific truth. I not only do not share in that impression, but I entertain an exactly opposite belief. Nothing is more remarkable in the present state of physical research than what may be called the transcendental character of its results. And what is transcendentalism but the tendency to trace up all things to the relation in which they stand to abstract ideas? And what is this but to bring all physical phenomena nearer and nearer into relation with the phenomena of mind? Is this materialism? Some of the ablest writers who have incurred reasonable suspicion as to the drift of their teaching, nevertheless give witness most emphatically to what I would call the purely mental quality of the ultimate results of physical inquiry. Mr Lewes, whose work on Aristotle I have already quoted, says, "The fundamental ideas of modern science are as transcendental as any of the axioms in ancient philosophy."* And this is true. Let us look for a moment on the light, small as it may be, which physiology has cast on the great mystery of Life. We never see Life separate from some material organisation. Yet what is the doctrine proclaimed, I believe, first, by the great John Hunter, and now emphatically repeated by men like Professor Huxley and Dr Carpenter? It is that organisation is not the cause of Life, but Life is the cause of organisation.

* Lewes' Aristotle, p. 66.

Material organs are merely the special forms built up and fashioned by the vital forces, whatever these may be, for the discharge of special functions. And it is well worthy of remark, that some of the most clear and striking illustrations of this truth are to be found in some of the lowest forms of life, revealed to us only by the microscope. Professor Huxley and Dr Carpenter both refer to the Foraminifera, in which the most beautiful and complicated forms of shell are evolved by the vital force working in creatures composed of simple jelly, without parts, without structure, without organs of any kind. Thus the deeper we go in science, the more certain it becomes that all the realities of nature are in the region of the Invisible; so that the saying is literally true, that the things which are seen are temporal, and that it is only the things which are not seen that are eternal. Surely if this is materialism, it is materialism spiritualised. These doctrines seem to me rather to bring into the strict domain of science, ideas which, in the earlier stages of human knowledge, lay wholly within the region of faith or of belief. For example, the writer of the Epistle to the Hebrews specially declares that it is by faith that we understand "that the things which are seen were not made of things which do appear."* Yet this is now one of the most assured doctrines of science, that invisible forces are behind and above all visible phenomena, moulding them in forms of infinite variety, of all which forms the only real knowledge we possess lies in our perception of their beauty and their fitness—in short of their being all the work of "Toil co-operant to an end." Creation by Law means nothing but Creative Force directed by Creative Knowledge, worked under the control of Creative Power, and in fulfilment of Creative Purpose.

During the past year there have been more deaths than usual among the members of the Society. Of Foreign Honorary Fellows we have lost one, Baron Plana of Turin. On our home list we have to lament the loss of 10 of our Ordinary Fellows, some of whom had attained the full term of human life, while others have been cut off in their prime. Their names are—Leonard Horner, Professor Miller, Robert Morrieson, Dr Newbigging, Professor

* Fide intelligimus aptata esse sæcula verbo Dei; ut ex invisibilibus visibilia fierent.— *Vulgate.*

Pillans, Dr Archibald Robertson, Dr Smyttan, Lieut.-General Swinburne, Dr R. D. Thomson, and Lord Wood.

To replace these we reckon 16 new Fellows,—viz., Dr A. Crum Brown, Prof. Robert Dyce, Dr John Foulerton, Rev. John Hannah, Robert Hutchison, Wm. Lindsay, Peter M'Lagan, J. D. Marwick, Rev. D. F. Sandford, Prof. Sellar, R. W. Thomson, Arthur Abney Walker, Dr William Wallace, Dr Alex. Wood, Robert S. Wyld.

Our roll, therefore, stands thus:—The number of Fellows in 1863 was 274 (omitting Dr William Somerville, born at Minto in Roxburghshire, 22d April 1771, and died at Florence, 24th June 1860, whose name by mistake had been continued in the last list). Of these 274 we have lost by death 10, and by resignation 1, making in all 11, thus leaving 263. To which add the new Fellows, 16, making the whole number of Fellows of the Society at the commencement of this session 279, a larger number than has been on our list for many years.

Baron Giovanni Plana was born about 1790. After studying at the Polytechnic School, he was made Professor of Mathematics in the Military School of Alexandria, and then Professor of Mathematics in the University of Turin. In 1820 the King of Sardinia directed him to erect the observatory at Turin, of which he was made Director in 1822. He became Director of the Military School, Member of the Academy of Sciences at Turin, of which he was afterwards president, Chevalier of the Iron Crown, and of the Civil Order of Savoy, and member of various foreign academies. He was elected a Corresponding Member of the French Institute, and in 1860 one of the eight foreign Associates of that body. In 1820 he received from the Academy of Sciences in Paris the great mathematical prize for his "Theory of the Lunar Motions." He was elected an Honorary Fellow of this Society on 19th January 1835.

He married the niece of the celebrated Lagrange. He died at Turin on 20th January 1864.

He is the author of many celebrated memoirs in the Transactions of the Turin Academy. The most important of them relate to the Constitution of the Atmosphere and Astronomical Refraction, the Theory of Distribution of Electricity, the Theory of the Moon's Motion, and the Perturbations of the Satellites of Jupiter and Saturn.

Leonard Horner was born in Edinburgh on the 17th January 1785. He was the third and youngest son of John Horner, a merchant and linen-manufacturer, who long resided in George Square, Edinburgh, and was a citizen of marked ability, possessing much information, and full of anecdotes of old times. Leonard's mother was Joanna Baillie of the family of Baillies of Dochfour, Inverness-shire. He was sent to school at the age of seven, and when he was nine years old he entered the High School. His brother Francis was also a pupil of the same school, which at that time was presided over by its celebrated rector Dr Adam. He was a lively, but rather careless boy, and did not display the diligence or perseverance of his brother. His amiable manners, however, made him a great favourite with all. He displayed at first a fancy for a sea-faring life, but the idea was afterwards abandoned. On leaving the High School he entered the University of Edinburgh. He attended the lectures on mathematics by Playfair, and those on moral philosophy by Dugald Stewart, and in 1802 he became a pupil in the chemistry class taught by Dr Hope. At this time mineralogy occupied a share of his attention, and he began to form a collection of minerals. This early taste was developed in his after life.

About the age of nineteen he went to London with his father, and there the family resided for many years. At the age of twenty-one he married Miss Lloyd, daughter of a landed proprietor in Yorkshire. He now entered with devotion into the study of science, and was received into eminent literary and scientific society in London. The intercourse which existed between his grandfather's family and Dr Hutton seems to have operated on the mind of young Horner in inspiring him with a taste for geology. He entered the Geological Society in 1808, the year after its formation. He was one of its earliest secretaries, and he continued to the last to take a warm and active interest in its proceedings. Circumstances connected with the linen-trade obliged him to return to Edinburgh in 1815 in order to attend to business. In 1816 he became a Fellow of the Royal Society of Edinburgh. He contributed a paper on the occurrence of *Megalichthys Hibberti* in a bed of cannel coal in Fifeshire. Soon after this the premature death of his brother Francis, who was rising into eminence as a

statesman, cast a gloom over his spirit. His brother died in the year 1817, at Pisa, where he had gone for the sake of his health. Leonard Horner left his family, and accompanied his brother to Pisa, and was with him at his death. A monument was erected to Francis Horner in Westminster Abbey.

Edinburgh at this time possessed many eminent Whig lawyers, who distinguished themselves in politics and literature. Horner warmly joined them from congeniality of opinions and sentiments, and by his active and methodical habits he became the chief organiser of their political meetings. In 1825 he acted as chairman at the dinner given to Joseph Hume. He had a deep sympathy for those who had been exiled from their country on account of liberal opinions. Several of the Italian emigrants, Ugoni, Demarchi, Arrivabene, Castiglione, and others, shared his hospitality. To this is perhaps due that love for Italy which the family of Leonard Horner have always maintained. One of his daughters has translated the history of Colletta, has written a short history of Naples, and a few days before her father's death published a book on the poet Giusti, all which are works of much value.

He also espoused with earnestness the cause of the working men, whose education he considered as having been neglected on all hands. In 1821 he founded the School of Arts in Edinburgh, for the instruction of mechanics, and he never ceased to contribute to its welfare. This school has gone on prosperously. The average attendance for the last four years has been 700 annually. No similar institution in the empire has been so successful. This success is owing to the soundness of its constitution, which was entirely the work of Mr Horner. The students have no connection with its management. The Directors have the sole superintendence, and they are elected by the subscribers out of their own body, and are always men of good position and of education. Females are not allowed to attend. There are a given number of subjects, each taught by able and permanent lecturers. No casual or itinerant lecturers are employed. Mr Horner acted as honorary secretary till he went to London in 1828. He founded a permanent prize of three guineas, to be awarded by competitive examination in the classes of mathematics, natural philosophy, and chemistry, in succession.

Desiring to promote classical education among the middle classes

in Edinburgh, he, along with Lord Cockburn, set about the establishment of the Edinburgh Academy, which has continued to flourish since its foundation. Mr Horner visited the Academy on many occasions even after he left Edinburgh, and the last time he did so was in July 1863. On the same occasion he visited the High School, in which he had been a pupil, and he was present at the distribution of prizes, and gave an excellent address.

In 1827 he became Warden of the London University. This office he resigned after four years, and retired to Bonn, where he remained for six years with his family. In 1833 he accepted the office of Inspector of Factories, and did his duty most faithfully and philanthropically. By his labours great improvements took place in the mills and mines, more especially in regard to the employment of women and children. He earned the respect and the goodwill of the operatives, and this is evinced by the memorial presented to the Misses Horner after his death by the operative cotton-spinners of Lancashire, in which they express their feelings of heartfelt sorrow and regret, as well as of profound sympathy, on the death of Mr Horner, their father. They speak with grateful recollections of his unremitting labours in the cause of justice and humanity, his impartiality in the administration of the laws made for the protection of their wives and children, and his firmness in their vindication.

He was assiduous in his attendance at the Royal and Geological Societies of London. He entered the former on 11th November 1813, and he was subsequently one of the Vice-Presidents of the Society; of the latter he was twice chosen President. His efforts were directed to the better organising of these Societies, and he was successful in adding materially to the efficiency of the Royal Society as regards the election of members and the conduct of business. In 1861 he delivered his last address as President of the Geological Society. He had likewise published a memoir of his brother Francis, in two large volumes, and had translated a work by Cousin on education in Germany.

In 1851 Mr Horner suggested a series of investigations as to the deposits of the Nile. These were conducted by an Armenian officer of engineers, Hekekyan Bey. These researches seemed to support the view then propounded as to the great antiquity of man

and his works. The results were given to the Royal Society in 1855. The experiments thus instituted in the hope of obtaining an accurate chronometric scale for testing the age of a given thickness of Nile sediment, are not considered by experienced Egyptologists to be satisfactory.

After acting for thirty years as Inspector of Factories, he resigned his office, and devoted his attention principally to geology, classifying and arranging with great patience, perseverance, and skill, the foreign collection of the Geological Society in Somerset House. In 1861 he visited Italy, and resided for eight months at Florence. There he met with a sad bereavement in the death of Mrs Horner, his companion for fifty-six years. She was a most attractive lady, with a highly cultivated mind. From the shock of this event Horner never recovered completely, and it threw a shade over his declining years. When at Florence he translated with happy fidelity Villari's "Life of Savonarola," which he afterwards published with notes. He continued to work to the end, and he died on 5th March 1864, at 60 Montagu Square, London, at the age of seventy-nine.

A correspondent in America says of Horner—"Among us in the United States not a few knew and valued him as the biographer of his brother, Francis Horner, a statesman whose early death is still to be counted among the misfortunes of his country, and whose life, republished here in 1853, has served to join and strengthen the principle of many an aspiring young jurist in the United States, as it has in England, from its first appearance there. Others on our side of the Atlantic have known Mr Horner as a naturalist, who was at one time President of the Geological Society, and who contributed many valuable papers to its 'Transactions.' Others again have known him personally as the father of Lady Lyell, to whom and her eminent husband so many Americans became attached during their visit to the United States, and who were always proud to present to their distinguished father the friends from abroad who visited them in London." It has been well remarked, that Mr Horner was one of the living links which bound the present race of geologists to the fathers and founders of British geology. His recollections went back to the latter part of last century, and he used to tell anecdotes of the days of Hutton, and Playfair,

and Hall—names to which we now-a-days look through such a long vista of years, crowded with discovery, that they seem to stand far away amid the halo of an early heroic life.

James Miller was born at the Manse of Eassie in Forfarshire, on the 22d of April 1812. He was the third son of the Rev. James Miller, minister of the parish, and his wife Elizabeth Martin, daughter of the Rev. Dr Martin, minister of Kirkcaldy, in Fife.

At Eassie Mr Miller received his early training, and till he went to College at St Andrews he was constantly under the parental eye; for his father, aided by teachers and tutors, conducted the education of his own family, along with the sons of several neighbouring proprietors. Surrounded by home influences, Mr Miller received the early training which fitted him, when a lad of only twelve, for the Literary and Arts classes of the University of St Andrews. Here it was he first began to show his great intellectual facility, taking bursaries, and distinguishing himself, more particularly as a scholar in classics and metaphysics, in competition with lads considerably older than himself.

After three years spent at St Andrews, he repaired to Edinburgh in 1827, and commenced his medical studies, not only under the distinguished professors of medicine who then adorned our University, but also under the late Mr Liston, who, as a private lecturer unconnected with the University, had at that time taken the whole country by surprise as a teacher and practitioner of surgery.

In 1828 Mr Miller became a pupil of Liston's, and under that tutelage there grew up between the master and student an affection and mutual regard, which, though interrupted, so far as daily personal intercourse was concerned, by Liston's removal to London, and finally eclipsed by the premature death of that illustrious man, remained throughout life as one of the tenderest and warmest emotions of Mr Miller's inmost feelings. It was about this time that Mr Miller's anatomical skill led to his selection by Professor Munro *tertius* as his demonstrator of anatomy; and in the discharge of the duties of that responsible office, he acquired both that familiarity with normal texture and diseased structure, as well as that facility of description and easy diction, which were eminently characteristic of him throughout his after life.

It was during this period that his first essays in writing for the press commenced, Dr Munro having largely made use of his ready pen in preparing for publication his famous work upon the Gullet.

In 1832, having taken his diploma as surgeon, he commenced practice as Liston's resident assistant; and during the two succeeding years immediately preceding Liston's removal to London, Mr Miller not only acted in his absence, but largely relieved him in the daily press of business, while his evenings were occupied in re-writing and preparing Mr Liston's Practical Surgery for publication.

When Liston went to London, Mr Miller commenced practice on his own account, and during the succeeding eight years continued to make a growing reputation, and to acquire a large circle of attached friends—a reputation not only as a practitioner and teacher of surgery in the extra-academical school, but as a graceful public speaker, and as an attractive lecturer to art students upon pictorial anatomy.

In 1840 he became a Fellow of the Royal College of Surgeons, and was shortly afterwards elected surgeon to the Royal Infirmary. In 1842, when the Chair of Surgery in the University of Edinburgh became vacant, by the death of Sir Charles Bell, Mr Miller was unanimously elected to the Professorship by the Town Council, who then exercised the patronage over all, except the Crown appointments. At this period he was only thirty years of age. From that time to this, for twenty-two sessions, Mr Miller uninterruptedly lectured to overflowing classes of attentive and admiring students.

It was during the first year of his University course that a duodecimo edition of his Principles and Practice of Surgery was published by the Messrs Black—a work which, passing through four editions in octavo, acquired a world-wide reputation, and of which the fifth edition, under the title of "A System of Surgery," had only been completed a few months before his last fatal illness manifested itself.

It was in 1842, shortly after becoming Professor of Systematic Surgery, that Mr Miller was elected a Fellow of the Royal Society of Edinburgh.

His printed works and papers amount to upwards of thirty, and

are by no means confined to purely professional matters, his warm interest and zeal in social and religious questions leading him to spend much time in giving his support to whatever views his convictions espoused. The same conscientious love for the success of truth stole away many an hour from the but limited leisure which his professional avocations afforded him, and induced him to appear in public and advocate from the platform, to eagerly attentive audiences, the same views to which his pen lent so ready and powerful a support.

On the 17th of June, after an illness of only three weeks' duration, which at first created no serious anxiety in the minds of his medical attendants, James Miller passed away from amongst us, in the fifty-second year of his age, and the twenty-second of his Professorship.

Robert Morrieson was born in Edinburgh on the 18th January 1787, and was educated at the High School and University there. He studied medicine, and obtained a surgeon's diploma at the early age of nineteen. His intentions were to proceed to India at once in a medical capacity, but he was prevented from doing so by a regulation of the Court of Directors requiring medical officers to be of the age of twenty-two. Mr Morrieson, however, received from his uncle, Sir Hugh Inglis, a direct civil appointment, and he proceeded to India in 1806 as a civil servant, although very reluctant to give up the profession he had early chosen, with the benevolent purpose of doing good to his fellow-creatures. He found, however, afterwards many opportunities of gratifying this desire, and employed his medical skill among the poor natives of India. He remained a considerable time at Beerbhoom under his own brother, and rose to be Judge and Magistrate there. Afterwards he became one of the Judges of the Circuit Court at Moorshedabad, in which office he continued till, owing to the state of his health, he returned to Scotland in 1829; and till his death on the 10th November 1864, he has chiefly resided at his house No. 6 Heriot Row, Edinburgh, and at Harvieston in Mid-Lothian. He became a Fellow of the Royal Society in 1822.

Mr Morrieson was certainly one of those who, while they exercise no small influence among the men and movements of their day, are, by reason of their retiring modesty, comparatively unknown

to almost all beyond the circle of admiring and attached friends whom they invariably attract to themselves. That he had not merely a large heart, inclining him to consider, sympathise with, and assist whatever justly claimed his sympathy, but also a ready and liberal, though discriminating hand, is attested not only by his cordial support of the institutions and schemes of the Church with which he was connected, but by the spirit and manner in which he aided other enterprises of benevolence and usefulness. From his extensive connection with the management of trusts, which as a friend he had undertaken, he was brought largely into contact with young people. To their instruction and enjoyment few could give themselves with greater geniality and success. He took a lively and active interest in the great questions and movements of his times, especially those involving or in any way affecting the principles of Divine Revelation or the cause of Protestantism. It might well have been supposed that when nearly sixty years of age, Mr Morrieson's days of active study were over; yet twenty years ago he was among the most regular attenders upon the prelections of Drs Chalmers and Cunningham in the New College. His power and habits of regular study, early formed and matured by long practice, continued with him to the last. He devoted a fair portion of time to the consideration of scientific subjects, on which he possessed a large and varied fund of information, and to historical and general literature. His latter end was peace. He rests from his labours, and his works do follow him.

Patrick Small Keir Newbigging was born at Edinburgh on 2d November 1813. He was the fifth son of Sir William Newbigging, who for many years practised medicine in Edinburgh with great success. Three of his brothers, William, Robert, and George, studied medicine; but all of them, as well as John, who was a writer to the Signet, died at comparatively early ages. Dr Patrick Newbigging prosecuted his studies at Edinburgh, and graduated there in 1834; his thesis being on the Causes of the Impulse and Sounds of the Heart. He became a Fellow of the Royal College of Surgeons in the same year. During his student life he was elected a President of the Royal Medical Society. Before settling in practice he spent some time abroad in acquiring additional pro-

fessional knowledge at foreign schools. On his return he became associated with his father in practice, and he joined the New Town Dispensary as one of its medical officers. The subject of Auscultation occupied a considerable share of his attention, and in 1842 he published a translation of Barth and Roger's Practical Treatise on that subject. He communicated a paper to the Royal Society of Edinburgh on certain circumstances affecting the colour of blood during coagulation.

Dr Newbigging filled many important situations in Edinburgh, such as Surgeon to John Watson's Institution, and to Cauvin's Hospital; Medical Referee of the Life Association Insurance Company of Scotland; Physician to the Sick Children's Hospital, an institution in the foundation of which he took a lively interest; Examiner in the College of Surgeons, and President of that body, 1861–63, as well as President of the Royal Scottish Society of Arts. He became a Fellow of the Royal Society in 1848. For several years he suffered from valvular disease of the heart and aneurism of the aorta. The symptoms were long very obscure, and the existence of the disease was only known to a very few intimate friends. In spite of it he continued to perform efficiently his responsible duties to the last. Long before his death he found that any exertion, especially in walking up a rising ground, caused breathlessness and exhaustion. He did not make this known, and rather endeavoured to conceal it; so that few who saw his cheerful and active demeanour could have suspected that he was labouring under a fatal disease which was gradually undermining his constitution. The autumn before his death he resided for some time at Callander, where, by quiet and relaxation, he hoped to recruit his strength. On his return to Edinburgh, however, in October, the symptoms became aggravated, although he was able to visit his patients till within three days of his death, which took place on the morning of Saturday 10th January 1864. Those who knew him intimately perceived a softening influence coming over him, and an occasional solemnity of expression which betokened Christian preparation for a life beyond the present. He was a sound, judicious, and successful practitioner, and was much beloved by his patients. He exhibited on all occasions a courteous, cheerful, and gentlemanly demeanour, and his amiability gained him many friends.