PRESIDENTIAL ADDRESS

ON THE

PRESENT STATE OF THE DARWINIAN CONTROVERSY,

DELIVERED BY

JOSEPH JOHN MURPHY, Esq.,

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It is now seven years since the first time that you did me the honour of electing me as your president. My opening address on that occasion was chiefly on the subject of the origin of species and Darwin's theory; and to the same subjects I now design to return. I then, while avowing my agreement with Darwin to a considerable extent, stated where I thought his theory insufficient and unsatisfactory. During the seven years that have since elapsed, I have been conversing, reading, thinking, and writing on this subject, with the result of being now further than ever from agreement with Darwin. At that time, and when I wrote my book on "Habit and Intelligence," two years later, I went about three-quarters of the way with him. I cannot now go more than half. I cannot now agree with the distinctive parts of Darwin's theory at all. I agree with him only so far as he agrees with the great body of scientific men. The great body of scientific men are now believers in evolution. The doctrine of evolution, as applied to the science of life, means that all the species of living beings, both animal and vegetable, have not been originally created as we see them, but are derived from ancestors of lower and simpler organisation than themselves, by a process of descent with gradual modification:—that all species,

however different they may now be, are descended from the same or perfectly similar ancestors, which, like the simplest living beings now known to exist, were minute gelatinous masses without organisation or structure. I cannot admit that there is any presumption against this theory. It is, no doubt, unlike anything in our experience, but the same is true of any possible theory of the origin of species: and of all possible theories of the origin of species, the theory of evolution is the least out of harmony with the ordinary facts of experience. The origin of species is a matter of inference, but the origin of individual organisms is a matter of observation. Every living organism has been evolved out of a perfectly simple germ, in which the microscope shows no vestige of structure; and it is surely more consistent with this fact to believe that species also have been developed, by descent with modification, from perfectly simple ancestral forms, than to believe that they have been created all at once just as we see them. The collateral reasons in favour of this theory constitute what is in my opinion a mass of argument of perfectly overwhelming force. The limited time at my disposal, however, makes it impossible for me to do any sort of justice to this argument, and consequently I shall not attempt to give it in even the barest outline.

The objection to the theory of evolution, which still lingers in many minds, appears to proceed from a notion that it somehow tends to get rid of the necessity for an intelligent Creator; but I shall give reasons for thinking that this is not really nor even apparently the case.

The doctrine of evolution is older than Darwin. Taking the origin of species by evolution as proved, and taking the known laws of life as his data, Darwin's theory is an attempt to explain the process of evolution by purely physical causation. The theory, in its extremest outline, is simply this:—All organisms are more or less variable: no two leaves in a forest are exactly alike, and the differences are often great enough to be quite conspicuous, as in the familiar case of human faces. At the same time, these variations tend to become hereditary. Now, if any variation is such as to give its owner any advantage over other individuals of the same species, the owner of such a "favourable variation" will be more likely than

less favoured individuals to win a place in the struggle of life, to survive, and to leave offspring. These offspring will tend to inherit the "favourable variation" that caused their parent to survive, and the same competition will go on among them. Those which possess the "favourable variation" in the highest degree will again survive, and the improvement will go on progressing and accumulating through generations. This preservation of favourable variations is what Darwin calls natural selection. In answer to a possible objection it must be remarked that at Nature's feast there is not room for all; so many are born that only a fraction of the entire number can survive and leave offspring. There is, therefore, a "struggle for existence," and the race is on the whole to the swift, and the battle to the strong. This theory accounts not only for improvement, but also for divergence. Various kinds of "favourable variations" are possible, and it is improbable that they should be found together; thus, different variations will give rise to races having different characteristics. Either keen sight or keen scent, for instance, will be beneficial to beast of prey, and because the law of probabilities makes it unlikely that variation should occur in the direction of both at once, the race which is modified in the direction of improved sight, and that which is modified in the direction of improved scent, will be different and divergent races. Thus, no doubt, have arisen the varieties of dogs that hunt in different ways; only—let this difference be remarked—the formation of distinct races by means of the selection and preservation of those dogs which are endowed with the highest share of some useful character, has not been effected by means of natural selection, but mainly by the action of man. Darwin everywhere takes it as proved that natural selection acts with a degree of efficiency quite equal to the selection of domestic animals through human agency, but I shall further on have to offer reasons for believing that this is very far from the truth.

The whole of Darwin's theory, or rather the facts that constitute its basis, may be stated in the four following brief propositions:— 1. All species are constantly though slightly variable, and some of these variations, by the law of probabilities, must be advantageous to their owners. 2. Advantageous variations will give their owners the best chance of success in the struggle for existence, and will thus be

preserved by natural selection. 3. Any improvement, once begun, will be perpetuated by inheritance and accumulated through successive generations. 4. In general, many variations are possible, each of which is separately an improvement, and as it is very unlikely that two such variations shall occur together, improvement will go on in different and divergent lines.

All these propositions are incontestable, and yet they appear to be a very insufficient basis for a theory which professes to account for the descent of the most highly organised animal and vegetable forms from those minute gelatinous masses without structure, which I have already mentioned as the simplest forms of life. It is not enough that a theory be founded on facts: the foundation of fact must be broad enough to bear the superstructure of theory. But further, the theory is utterly paradoxical. It is an attempt to account for the facts of vital organisation without the agency of an organising Intelligence; and no paradox can be greater than this. No greater paradox can be imagined than to maintain that all the wonderful adaptations of the animal frame—of the wing for flight, of the ear for hearing, and of the eye for seeing—are in no way due to intelligence, but only to the action of blind unintelligent forces. Yet Darwin's theory implies this. Paradoxes, however, have sometimes proved to be true. It is not so very long since the earth's motion was a startling paradox, and at an earlier period the spherical form of the earth was a paradox also; and when any theory, however paradoxical, comes to us with such authorities in its favour as Darwin, Wallace, and Huxley, it deserves at least a respectful consideration, with which no prejudices, religious or any other, ought to be permitted to interfere. I never can read Darwin's great work on the "Origin of Species" without a strong and admiring sense of the force of his facts and the ingenuity of his arguments. Nevertheless, I regard his theory as insufficient and unsatisfactory in every point. I believe, in the first place, that in the evolution of species, variations must have occurred which no theory of spontaneous and unguided variation is sufficient to account for; in the second place, that natural selection among small spontaneous variations is incapable of acting to the extent required; and, in the third place, that even if these causes were adequate, there are still large classes of facts which contradict the theory.

It must have been felt by every one who has bestowed even a little thought on the subject, that one of the greatest difficulties, and certainly by far the most obvious difficulty, of Darwin's theory, is that of accounting for the origin of a co-ordinated structure. I mean of a structure in which a number of parts are adapted to each other. The most remarkable of all instances of co-ordination of parts, or, in other words, of complex adaptation, are the organs of the higher senses, the eye and the ear; and it appears incredible these should be due to such a process as natural selection among spontaneous variations. Darwin shows that he has felt this difficulty, though he believes that it is capable of a satisfactory answer. I admit that I may have overstated this argument when I said, in my opening address seven years ago, that in order to improve such an organ as the eye at all, it must probably be improved in at least ten different ways at once. Of course, ten variations, all occurring together and co-operating with each other, would, on Darwin's principles, be improbable to a degree that could not be distinguished from impossibility. But it is at least conceivable, as Darwin has pointed out in reply to me,* that the various improvements needed in order to bring the eye to perfection, improvements in the lenses, the iris, the eyelids, the retina, the muscles that move the eyeball, &c., may be effected, not all at the same time, but one at a time; for a slight improvement in one of these may be useful when occurring alone, though a great improvement would be useless without other improvements co-operating with it; and thus such an organ as the eye, according to Darwin, may have been brought to perfection by innumerable slight improvements in each part separately. I do not deny that there is great force in this argument, but I think we can point to, at least, one case where improvements cannot possibly help each other unless they are absolutely simultaneous; I mean the two nervous connections of the iris of the eye. One of its nerves has its root in the brain, and contracts the pupil under the stimulus of light; the other has its root in the sympathetic ganglia, and opens the pupil again when the intensity of the light is diminished. It is obviously impossible that the efficiency of either of these two nerves could be increased

* See Darwin's Work "On the Variation of Animals and Plants under Domestication." Vol. II., p. 222.

separately; they will not be improved at all unless they are improved together; and this, on Darwin's principles, can only be done by means of accidental favourable variations occurring in both at once. But such coincidences are so improbable that they may be left out of account, as if they were impossible. I should think there must be many such instances in the anatomy of all the higher animals, though I cannot mention any other which is equally conclusive.

There is moreover this further flaw in Darwin's reasoning on the subject. It appears to take for granted that one variation, or the variation of one part of a structure, is as likely to occur as another; and that therefore the exact variation which is needed is certain to occur, if only time enough is allowed for the process of the evolution. It is obvious that this is all-important, for such an organ as the eye would be useless if it were left imperfect in a single important part; if, for instance, one of the lenses were considerably out of focus. Now, the assumption which Darwin thus tacitly makes appears inconsistent with fact. We do not find that one variation is as likely as an another; on the contrary, we find that different species are variable in different degrees; that one part of an organism is more variable than another, and that among variable parts there is a tendency to variations of a particular kind, and an equally remarkable steadfastness of character in other respects. I will mention one striking fact as to the constancy of a character which cannot be of first-rate importance to its possessors. Those lowly organised fishes, such as the lamprey, which have no jaws nor fins, have also only one nostril, but in all other vertebrates there are two nostrils. It is impossible to give any reason for the absence of variation in this comparatively unimportant character; but it is important as showing that indefinite and equal variability in all directions alike is not a law of nature.

In a remarkable passage of one of Darwin's works, he compares the action of natural selection in forming a co-ordinated structure to that of a builder who constructs a regular and harmonious work of architecture out of irregular masses of stone which have assumed their shape accidentally, by falling from a precipice. In such a case the form of no one stone has been purposely designed for its place, or designed at all, yet wedge-shape stones may be found for the

arches, long flat stones for the lintels, and so on, which will serve the builder's purpose as if they were hewn to order. This comparison is ingenious, and illustrates Darwin's meaning well; but it may, I think, be shown that the facts of the organic world do not correspond with it. Suppose we were to examine such a building as Darwin has imagined, with the view of discovering whether the forms of the stones were such as to make possible for us to believe the assertion that they owed nothing whatever to the stone-cutter; and we were to find in one single instance a shape which could not possibly be due to any agency except human art, this would be enough to disprove the assertion that the builder had no stone-cutters in his employment. Now, I maintain that there are many instances in the organic world comparable to this:—instances of peculiarities in living beings which could not have originated in those slight random spontaneous varations which alone Darwin's theory admits. I will mention what occurs to me as one of the most conclusive instances of this kind. Some animals, of which the chameleon is the best known instance, have the power of changing colour. This power is of great value to its possessors, because they usually assume a colour resembling that of the surrounding objects, and thus at a little distance become comparatively invisible to the enemies that prey on them. This power must be invaluable to such an animal as the chameleon, which has neither strength nor swiftness nor any other ordinary means of attaining safety; and once a race of animals was formed with this power, there is not the least doubt that it would be preserved and perpetuated by natural selection. But how is it first to be formed? how many generations of animals without this power would have to live and die, before a single individual was born with the slightest tendency to change its colour in correspondence with the colour of surrounding objects? Another instance of the same kind is presented by those animals which change their colour with the seasons, turning white in winter, and putting on a dark colour in the summer. The ermine is perhaps the best known instance of this. The animals which put on a coat of white for the winter are benefitted by the comparative facility with which a white animal may elude its enemies among the snow; while their summer coat of brown or gray is safer during the seasons when the

ground is not covered with snow, because a white animal would be dangerously conspicuous on grass or rocks. This power of changing colour with the seasons, when it is once acquired, is thus certain to be preserved by natural selection. But how is it to be first acquired? how is the first beginning to be made? Colour is no doubt a very variable character, but it seems impossible that the peculiarity of the ermine, which changes colour periodically with the season of the year, could ever originate in mere random unguided variations.

I go on to mention other instances of structures which appear impossible for mere unguided variation to originate. If they are less conclusive than those instances which I have just taken from the facts of colour, this is because the circumstances are more complex and less within the grasp of our knowledge; but they open far wider questions. If Darwin is right, and if there is no other agency at work in organic formation than that of natural selection among spontaneous, or, as I prefer to say, unguided variations, it necessarily follows that no variation can be preserved unless it is useful to its possessor. Darwin regards this as one of the fundamental data of his theory. But it will be seen that it raises a multitude of difficulties: for there are many organs whereof the usefulness is evident in their mature state, while it is difficult to see of what use their first germs could have been to their possessors. The usefulness of a bird's wing is obvious in the mature state, but ungrown wings are almost proverbially useless; and I am not aware that Darwinians have made any attempt to show what may have been the first incipient state of the bird's wing. Granting the theory of evolution, birds must be descended from reptiles, and their wings must be modified fore-legs. But, on Darwin's theory, how are we to account for the transformation of a leg into a wing? How was the period of transition got over, during which the limb was ceasing to be either a foot or a hand without having yet become an organ of flight? Natural selection would have been more likely to destroy than to preserve a race of animals in such a state. A similar difficulty occurs respecting the fins of the fish. On any theory of evolution, fishes that have fins are descended from finless fishes like the lamprey. [Here Mr. Murphy exhibited the skeleton of a lamprey.] But how could the first fins be acquired at all, if it was necessary that they should from the very

beginning be of such service as to give their owners a perceptible advantage over fishes without fins? A fin in its first incipient state would be as useless as an ungrown wing. But these are cases where we do not know what the incipient state was, and the argument consequently can scarcely be thought conclusive. I go on to mention a remarkable case in which recent researches have brought to light what appears to be a structure in that incipient state wherein it is of no use to its possessor, and has been formed with the purpose of being useful, not at first, but after it has been perfected through countless generations. The great vertebrate class of animals—that is to say, the class of animals which have a back-bone to support the body and protect the chief nervous cord—has until very lately appeared to be quite isolated from all other classes. The affinities of the members of that class had been traced from warm-blooded vertebrates down to cold-blooded ones; from cold-blooded air-breathers like the frog down to fishes; from the higher fishes down to such fishes as the lamprey, which has neither jaws nor fins; and from this down to the amphioxus, a little creature which has no brain, no distinct heart, and no red blood, yet shows itself to be truly a vertebrate, though the lowest of vertebrates, by the possession of a true vertebral column; though this is only a membranous tube situated along the back and containing nervous matter. [Here Mr. Murphy exhibited an amphioxus preserved in a phial.] But here until lately the chain of affinities appeared to break off: nothing was known which appeared to connect the vertebrates with any invertebrate class. All vertebrates present fundamentally the same mode of development. If the developing embryo of a fish or a frog, for instance, is watched under the microscope, a deep groove is seen to form itself on that side of the original structureless germ which ultimately becomes the animal's back, and at the bottom of this groove a band of cartilaginous substance is laid down, which is afterwards developed into the vertebral column. This mode of development is common to all vertebrate animals from the amphioxus upwards, and is altogether unlike that of nearly all invertebrates. But a discovery has been made within the last few years which appears to supply the missing link between vertebrates and invertebrates, and to show from what lower forms vertebrate animals are most probably descended. The

ascidians are molluscous animals of low organisation; but it has been shown that some ascidians, when first developing, present an almost perfect likeness to the first state of a vertebrate embryo, having the essential features of the dorsal groove and the band which is formed below it. In the case of the vertebrates, the embryo undergoes a forward development, attaining to a higher organization; in the case of the ascidians, the embryo undergoes a retrograde development, ending in a lower organisation than that with which it commenced. But, if the theory of evolution be true, we may infer that an animal having the characters common to the vertebrate and the ascidian embryos was the common parent of both vertebrates and ascidians; and here we have the first beginning of vertebrate organisation. But how will Darwinism account for this? As we have seen, Darwinism requires that every variation shall be from the first generation advantageous to its possessor, because otherwise natural selection would not preserve it. Now, of what use can the dorsal groove and the incipient cartilaginous band below it be to these ascidian larvæ? or of what use can they have been to the common ancestor of ascidians and vertebrates? The muscular system of an almost microscopic animal cannot need the support of a vertebral column, and the band which appears to foreshadow a vertebral column cannot be serviceable for the protection of the nervous centres, because it is situated below the rudiment of a nervous system, and does not attain, as it does in the developed vertebrate, to the form of a tube surrounding it. It seems to me that in these very curious facts we see two most important characters—the dorsal groove and the cartilaginous band below it—which no possible benefit to the animal itself will account for, and which were at first introduced by the guiding Intelligence that directs the work of evolution, not with a view to the benefit of the animals in which they first appeared, but with a view to the ultimate evolution of the vertebrate class of animals from this lowly beginning. Here, to quote the words of Schiller, we "find in our search the Creator at work in creating."*

I have now mentioned some instances of peculiarities of structure and function, for the origin of which mere spontaneous variation

* Beschleicht forschend den Schaffenden Geist."—*Der Spaziergang.*

appears unable to account. I now go on to show the difficulty of believing that even when favourable variations occur, they will be preserved by natural selection to the extent required by the theory. Darwin, in the earlier editions of his "Origin of Species," constantly took it for granted that the action of natural selection was altogether unerring—that it was absolutely certain to preserve those individuals which present favourable variations. There is here an important flaw in the argument, which so far as I am aware, was first pointed out by Professor Tait,* formerly of the Belfast Queen's College, but now of the University of Edinburgh; and this, I may remark, is a good instance of the service that an able man may do to a science which is not his own, and of which he does not know the details. Professor Tait has pointed out that no favourable variation can give to any single individual possessing it the certainty of surviving and leaving offspring; all it can give is an extra chance, and in many, perhaps in most cases, a very small extra chance. Among all organisms the chances are against any one individual that is born growing up to maturity: among many, and those not the lowest tribes, the chances are hundreds to one; and if, as Darwin maintains, all variations are singly but small, what will be the value of the extra chance which some favourable variation will give its possessor in the struggle for existence? If the chances are a hundred to one against any single individual of the unimproved species surviving, and the chance in favour of survival is doubled by some favourable variation, the effect will amount only to this, that the chances are not a hundred to one but only fifty to one against the favoured individual. This argument appears to be conclusive against the opinion that species have arisen in individual random variations. The case will be quite different if a considerable number of individuals present the same variation at once; for the law of probabilities, which shows that the chance of the preservation of one favoured individual among a thousand ordinary ones is almost imperceptibly small, shows also that if a thousand possess the same favourable variation among a million of ordinary ones, a considerable number of the favoured ones will survive and give origin to an improved race. Darwin, in the latest edition of his "Origin of Species," admits the force of this argument, and says it

* See the *North British Review* June, 1867.

shows that, in order to give origin to a new species, a favourable variation must occur in many individuals at once. But if variations take place at random and unguided, as Darwin maintains that they do, how is the same favourable variation to occur in a number of individuals at once? It seems to me that if Darwin only saw it, this admission amounts to giving up the entire case. I do not dispute that natural selection may give origin to races which possess in a higher degree some power or peculiarity of the unimproved stock; for where species are at all variable there will be many individuals that excel the rest in strength or swiftness or some other such favourable point, and these, especially if circumstances or their own instincts keep them apart, will give origin to a new race. But this process will account for only comparatively slight changes. It will not account for the origin of anything approaching to a new structure, for it appears impossible that this could originate in any other way than with single individual variations.

Let me illustrate by an instance the impossibility of a new structure arising out of small spontaneous unguided variations. The instance I shall take is in some respects favourable to the Darwinian theory, because it is a case of very simple adaptation. I mean the wing of the bat. This is very different from the wing of the bird. The bird's wing is nothing but an organ of flight; the bat's wing on the contrary has at least one of the functions of a hand, for it bears a claw by means of which the animal clings, and consequently the difficulty about the intermediate period of transformation of the leg or arm into a wing is much less in the case of the bat than in that of the bird. Moreover, it appears probable that birds flapped their wings from the first, but that the bat was originally a gliding animal like the so-called flying squirrel. In my work on "Habit and Intelligence," I agreed with Darwin, that natural selection among spontaneous variations was sufficient to account for the formation of the membrane which extends along the sides of the flying squirrel, and acts as a parachute, enabling it to take enormous gliding leaps; and that the same agency was further sufficient to develop a membrane like this into the wing of the bat. But further, thought, conversation, and reading on the subject have convinced me that it is not so, and that the advantage to the first squirrel or other animal which possessed the

beginning of such a membrane was far too slight for it to be preserved by natural selection. The difficulty is twofold. In the first place, the earliest beginning of almost any structure will be of scarcely sensible magnitude; and, in the second place, even though it were sensible, yet when an improvement begins with some single individual, the chances, as we have seen, will still be greatly against its leading to the survival of its possessor. Moreover, even when an individual possessing some favourable variation does survive, it will be prevented from becoming the ancestor of a new species or race by this fact, for which, obvious as it is, Darwin appears to have made no allowance, that among the higher animals, every one which is born has two parents, while, by the hypothesis, the favourable variation is found in only one; and as the offspring are, on the average, of intermediate character between the two parents, the favourable variation will be transmitted to the offspring in only half its original force; and to their offspring again, with only one-half of this, or one-fourth of its original force—and so on, constantly weakening. It is true that this action will be counteracted by the effect of fresh variations and fresh natural selection; but it can be only under very favourable circumstances, if ever, that the effect of natural selection, accumulating through successive generations, can overcome the weakening of the original tendency through the crossing of the breed.

I have now endeavoured to show that spontaneous random variation does not occur to the extent, or in the manner, demanded by the theory; and that if it did, natural selection would be insufficient to fix and perpetuate these accidental varieties into permanent species. I have next to show how, in my opinion, even if the slight random variations of which alone Darwin admits the existence were sufficient to originate species, and if natural selection were sufficient to perpetuate them, there are still many of the most remarkable facts of the organic world which are demonstrably opposed to the Darwinian theory. One of the most conspicuous of all the facts of the organic world is the remarkable variety of characters as between different species and different groups, contrasted with their equally remarkable fixity within species and groups. It is on this fact that all classification depends, and it is the prominence of this fact which has until lately caused the belief to be almost universal

that species are not only comparatively permanent but absolutely unchangeable. I have shown that I do not agree with this opinion. But I think that if natural selection among small spontaneous variations were the only cause of change, the facts of classification would be very different from what they are, and much simpler. There are many characters whereby one class or order is distinguished from another, which natural selection appears not to have the slightest tendency to produce. Take, for instance, the scales of fishes. If it is difficult, as it certainly is, to see how natural selection could have transformed a naked fish into a scaly one, the difficulty is not merely doubled or multiplied four-fold, but almost indefinitely increased, by the fact that there are among fishes, besides those which have the skin naked, four distinct types of scales, each of which is characteristic of entire groups of fishes. It appears impossible that such a character as a minute comb-like fringe at the edges of the scales, which is characteristic of one of these types, should be formed by natural selection; or, if it were, that so unimportant a character should be continued unchanged throughout entire groups. If Darwin's theory were true, the form and structure of the scales should either be a comparatively unvarying character, and the covering of all fishes should be nearly alike, as is the case among flying birds; or it should be a variable character, and then there would not be the great similiarity which is found through entire groups of genera. The same difficulty occurs, and is perhaps even more conspicuous, among plants. There is great diversity in the form of leaves; and yet how can one form be more favourable than another to the life of the plant? A Darwinian may argue that the prickles which arm the leaves of the holly have been produced by natural selection, because they no doubt are, or may be, useful to the tree by preserving its leaves from being eaten by cattle. If Darwin's theory is true, there are few simpler or better instances of it than this. But no such theory as this will account for the various characteristic forms of the leaves of the lime-tree, the oak, the ash, and the sycamore. The same remarks apply to the forms of flowers. Darwin has, no doubt, shown that many apparently anomalous structures among the flowers of orchids have really a very important function in insuring the fertilisation of the seed by the pollen brought by insects from other

flowers; for the pollen of another flower of the same species is better for this purpose than that of the same flower. But these cases appear to be exceptional; the orchids are a very abnormal group, and no such explanation is possible of the characteristic differences that distinguish the orders and genera of normally formed flowers; such differences, I mean, as those between flowers with the seed-vessel below the calyx or above it; separate petals as in the rose, or petals united together as in the harebell; and stamens inserted below the seed-vessel, or in the calyx, or in the petals, or in the style. It is impossible to see how natural selection can have perpetuated such variations as these, because it appears impossible that any one of them can have given its possessor any extra chance of success in that unconscious struggle for existence which plants, as well as animals, are always waging. I believe that the only account we shall ever be able to give of the cause and significance of these endlessly beautiful varieties is, that variety is part of the Creator's purpose.

I go on to describe a still more remarkable instance than any yet mentioned of a structure which natural selection appears unable to account for. It has been mentioned in Mivart's able reply to Darwin, entitled "The Genesis of Species." It is admitted by all that the fins of fishes correspond to the legs of quadrupeds; and in some fishes the correspondence is nearly perfect in respect of position. If we accept the doctrine of evolution, we cannot doubt that the first fins which were developed on fishes were in positions nearly corresponding to the legs of quadrupeds, and that from such fishes all quadrupeds are descended, as well as all existing fishes with fins. But there are entire tribes of fishes which deviate very strangely from this arrangement, having the fins that correspond with the hinder legs of a quadruped as it were moved forward, and with them that part of the skeleton known as the pelvis, with which they are in immediate connexion; so that the skeleton presents the strange spectacle of both pairs of limbs, with their supporting bones, being situated almost close behind the head. Fancy how marvellous this would be thought if it were seen for the first time in a newly discovered fossil! [Here Mr. Murphy exhibited the skeletons of a garfish or sea pike, which has a pair of hinder fins in a position corresponding to that of the hinder legs of a quadruped; and of a sea bream, in which the second

pair of fins, as well as the first, are near the head.] Now, how can Darwinism explain such a change as this? Darwin denies the occurrence of changes which are at once great and sudden among organisms in the wild state. But is it conceivable that such a change should take place gradually? Did the pelvis with the hinder fins creep forward gradually through ten thousand generations? I do not ask the question in order to put the idea in a ridiculous light: I should not deserve to occupy this chair if I were capable of doing so; but I mean how could this possibly benefit the race, so that the individual fishes which presented this character in the highest degree should be preserved by natural selection? The difficulty of accounting for the endless variety in organic forms has, I think, scarcely been seen by Darwinians; at least, I have met with no argument of theirs which appears distinctly to recognise it with the view of meeting it.

If Darwinism fails to account for organic variety, I am of opinion that it fails quite as conspicuously to account for organic progress. I know that Darwinians think this not a difficulty of their system, but one of its strong points. Their view is no doubt plausible at first sight; but it will cease to appear so when the bearings of the question are more clearly perceived. It appears certain that there has been a tendency to progress in the organic world. If the theory of evolution is true, there has been vast, though perhaps not constant, progress in living beings from those minute gelatinous masses, without structure or organisation, which were first endowed with the powers of life, up to the most highly organised animals. And, moreover, there appears to be geological evidence that when a more highly and a less highly organised class of animals come into competition with each other, the higher class tends to supersede the lower. Thus, the lamellibranchiates and the brachiopods are both of them bivalve mollusca, and adapted to the same kind of life; and the more highly organised lamellibranchiates appear to be at present superseding the more lowly organised brachiopods. In the same way pterodactyles, which were flying reptiles, have been superseded by birds; ichthyosauri, which were swimming reptiles, have been superseded by whales; and dinosaurians, which were grazing and browzing reptiles, have been superseded by the order of animals to which our cattle belong. Now, even if natural selection among random spon-

taneous variations were an agency that could account for the production of a highly organised being at all, we have still to account for what appears to be a general law, that the more highly organised classes, when produced, tend to supersede the less highly organised ones. It will be perceived that the questions are distinct. To Darwinians the answer to this latter question seems perfectly easy: they will say that the more highly organised any being is, the better it will in most cases be able to contend in the struggle for existence: it will have stronger muscles, acuter senses, and subtler instincts, and all or any of these will tend to give it an advantage, and so to increase the chance of transmitting its improved organisation to its offspring. This answer at first sight appears satisfactory, and it satisfied me for a long time. But it leaves two important factors out of consideration. In the first place, though it is quite true that the higher organisms have the advantage over the lower ones in respect of active power, it is equally true that the lower organisms have the advantage in respect of endurance. For instance, though a warm-blooded quadruped is a higher being than a crocodile or a lizard, and is, in general, though perhaps not in every case, superior in muscular, nervous, and mental power, and will so far have the advantage in the struggle for food; yet these advantages will be balanced by the greater power of the crocodile or the lizard to endure the want of food. It appears probable that these two advantages on the two opposite sides may be set off the one against the other, so that there will be no decided advantage in the contest on the part of either the higher or the lower organism. In the second place, the lowest organisms are well known to be the most prolific, and it is obvious that this must tend to multiply the chances in favour of a race surviving and spreading. I do not attach any great importance to this latter argument, because Darwin thinks, and on such a question I admit there is no higher authority, that the greater or less degree of prolificness is one of the least important of all factors in estimating the chances in favour of the survival or extinction of a race. Nevertheless, it must be a factor of sensible magnitude; and these two facts, that the lowest races are the most enduring and the most prolific, appear to be a perfect reply to the Darwinian argument, that the higher races are able to defeat and supersede the lower ones in the struggle for

existence, by virtue of the greater efficiency of a high organisation. I conclude, then, that no such agency as natural selection among spontaneous variations is capable of accounting for the tendency to organic progess; and that it must be ascribed to an innate tendency imparted to living beings at the beginning by the Creator.

I now go on to mention an argument against Darwinism, which was first stated, so far as I am aware, by Mr. Mivart, in his admirable reply to Darwin, to which I have already referred. It is derived from the facts of what Mr. Mivart calls "independent similarities of structure." The meaning of this expression must be explained. In many cases there are organs belonging to different animals which are adapted to the same function, but are in all other respects totally unlike. Such is the case with the wing of the bird and the wing of the insect. Both of these are organs of flight, but they differ in everything else: in form and structure, in position, and in mode of development. The same is to be said of the eyes of insects and those of vertebrate animals, which are as unlike in structure as it is possible for two highly elaborate organs of sight to be. All this is quite consistent with Darwin's theory, and seems to be required by it: for if all organic change and progress begins in spontaneous unguided variations, the law of probabilities appears to require that if two organs are separately produced for the same function, they shall be produced in distinct ways, as the bird's wing and the insect's wing have been. Any close resemblance between two independently produced structures should, on Darwin's principles, be so improbable as to be practically impossible. Yet we do find such "independent similarities" in sufficient numbers to be a most serious difficulty, not to say an absolute refutation, of Darwin's theory, regarded as a complete theory of the origin of species. Were I to say all that I might say on this subject, I should have to reproduce Mr. Mivart's chapter which treats of it. I will only briefly enumerate the most remarkable of the instances which he mentions. 1. The marsupial mammals, such as the kangaroo and the opossum, which possess a pouch in which the young are kept, are quite distinct from the ordinary or placental mammals, and it appears impossible that either can be derived from the other. Yet each of these two great orders contains genera which bear the most striking resemblance to genera

in the other. A species of mouse, which is placental, is figured beside a marsupial named antechinus, and the two can scarcely be distinguished at a little distance. In other cases the teeth are remarkably alike. 2. There are remarkable resemblances between the skeletons, and also the brains, of birds and pterodactyles; and yet it appears certain that these resemblances are not due to a common descent. 3. The organs of sight and hearing in the cuttle-fish have a great general similarity to those of vertebrate animals; and this cannot be due to community of descent: for, if these two classes had a common ancestor at all, it must have probably resembled the ascidian larvæ which I have already mentioned, and was certainly far too lowly organised to have any special organs of sense. 4. There are resemblances between the skull-bones of the ichthyosaurus and the whale, which cannot be due to community of descent, and apparently not even to the similarity of the conditions of their life. 5. There are some of the crustacea, that is to say animals of the same class with crabs and shrimps, which are protected by a bivalve shell like that of the true molluscan bivalves, and have a muscle for closing it like theirs, and yet there is no more true affinity between these two structures than there is between the shells of the crab and the tortoise. 6. The "bird's-head processes" of the polyzoa and the "pedicellariæ" of the echinus or sea-urchin are very similar, and yet cannot be inherited from a common ancestor.

The same argument against Darwinism, from the fact of independent yet parallel modifications, has been advanced in a much more elaborate form by Professor Cope of America, in a pamphlet entitled "The origin of Genera," which is in my opinion the most important contribution to the subject that any one has made since the first publication of Darwin's "Origin of Species," though it appears to be little known, and Mr. Mivart has made no reference to it. I will state his argument in my own words. Darwin's theory, that all variations are fortuitous and unguided, accounts perfectly for the divergence of one species, or genus, or order, or class from another. According to him, species, by their variations, have branched out into genera, genera into orders, and orders into classes; so that the form of all true classification is that of a tree, with branches which diverge and rediverge in all directions without ever re-uniting. This

view of classification is, no doubt, mainly true; but, as Mr. Mivart has shown, there are cases of independent similarities for which Darwinism will not account; and Professor Cope has shown further that these are not only found here and there throughout the organic world, but exist systematically; so that in many parts of the system the true form of the classification is not that of divergent groups, but of parallel series, as in the classifications of chemistry. Thus there are what Professor Cope calls transverse affinities; one set of affinities being between different members of the same series, and another set, transverse to these, between the corresponding members of different but parallel series.

The following, for instance, is a possible case :—Let us call three genera A, B, and C, and their species 1, 2, 3, and 4. The affinities of the species will then be thus represented :—

A^1, A^2, A^3, A^4.
B^1, B^2, B^3, B^4.
C^1, C^2, C^3, C^4.

The species of the same genus, as A^1, A^2, &c., have thus one set of affinities with each other, while the corresponding species of the different genera, as A^1, B^1, and C^1, have another set of affinities, transverse to these. This class of facts appears fatal to Darwinism, which, being based on the hypothesis of random unguided variations, is inconsistent with any systematic parallelism in classification. I do not say that instances so complete as that which I have expressed in symbols often occur, but there are a great number of cases where two species of different genera almost exactly resemble each other in everything except the generic peculiarity. I will mention two very singular instances of these transverse affinities. The first is that of two species of silurid fishes which resemble each other very closely in everything but a single character of generic importance; but in this they differ :—one of them belongs to a genus which has the distinguishing character of being without eyes. The other instance is that of two species of the order to which the frog belongs, agreeing in the extraordinary habit of carrying about their eggs, until they are hatched, on the back, which forms depressions in the skin to receive them; and yet these species belong to different genera. In such a case, shall we conclude that these two species have assumed this peculiarity separately?

This appears improbable in the case of so strange a habit as that of carrying the eggs on the back. Or shall we conclude that a species in one genus may be descended from a species in another genus, and that all the species of a genus have not necessarily the same origin? Professor Cope adopts the latter conclusion. He maintains that in a great number of instances the same species belongs or has belonged to different genera—that is to say, that the same specific form may put on the characters of various genera without ceasing to be the same species and to wear the same specific characters. This conclusion is supported by a statement made on the high authority of Agassiz, that in many cases the characters of the species appear earlier in the course of development than the characters of the genus. From these facts, for such they appear to be, of species retaining their characters as such, while, at the same time, they put on the characters of various genera. Professor Cope infers that organic evolution is guided by no such agency as natural selection among spontaneous variations, but by an innate and inscrutable law of development, impressed on living beings at the beginning by the Creator.

The theory that the variations in which new species arise are not fortuitous but take place according to predetermined laws, is strongly supported by a fact which Darwin, with his accustomed candour, calls a very important one, though he must be aware that it tells against his theory. The black-shouldered peacock, a variety which has all the appearance of a distinct species, has been hatched, not once only, but on five distinct occasions, from the eggs of the common peacock. This shows that the same variation may occur several times, though Darwin's theory would lead us to believe that this is impossible.

Finally, if all other objections to Darwin's theory were satisfactorily answered, this one remains, that geological time is not long enough for the production of the highest forms out of the lowest by the gradual accumulation of slight variations. It may be a little startling to many to hear it said that geological time is not practically infinite. But the most elementary principles of physical science show that the world must have had a beginning at a time which was not infinitely remote; and Sir William Thomson, than whom there is

no higher authority, has calculated, from the mathematical laws of the cooling of heated masses, that the time which has elapsed since the earth was sufficiently cooled to be the abode of living beings, is certainly not more than five hundred millions of years, and probably not more than one hundred millions of years. Either of these periods so transcends the powers of the imagination that it may at first seem ample for any process whatever. But let us compare it with the periods demanded by Darwin's theory. Mr. Mivart says, and Darwin probably would not dispute this, that we cannot believe a distinct species to have been formed and established as such by any process of natural selection in less time than a thousand years. If, then, it takes this period to form a species, it ought to take something like ten-times as long to form a genus, a hundred times as long to form a tribe, and so on, the periods increasing in geometrical ratio as we go on to wider and wider groups, separated by greater and greater differences. Suppose, for instance, that it took a thousand years to develop the lion out of the original stock of the cat genus, it should then take ten thousand years to develop the cats out of the original stock of the tribe to which cats and dogs alike belong, and one hundred thousand years to devolop this out of the original stock of the carnivorous order, which was, I should think, more like a badger than either a cat or a dog. To develop this out of the original stock of the placental mammals would take a million of years, and ten millions to develop this out of the original stock of all the mammalia, which was probably more like the ornithorhyncus than any other known animal. To develop the first mammal out of a newt must have required probably a hundred times this, or a thousand million years; and to develop the first newt out of a fish a thousand millions more; and it must have taken at least as long a period for a fish with fins and jaws to be developed out of a fish like the lamprey, which has neither. It is, perhaps, not too much to guess ten thousand million years as the time needed to develop a fish like the lamprey out of such a fish as the amphioxus, which has white blood and no distinct heart; a hundred thousand million years to develop this out of an animal resembling the ascidian larvæ already mentioned, and at least as much more to develop this from one of those minute gelatinous masses without

structure, which are the simplest of all living beings. We thus conclude that the time needed for the evolution of the highest forms of life out of the lowest would probably require, on the Darwinian theory, more than two hundred thousand million years, while the utmost possible duration of geological time, according to Sir William Thomson, is not more than one four-hundredth of this. Of course I do not offer this estimate as making the slightest approach to accuracy. It is only a rough attempt to show how the order of the magnitude may possibly be estimated, and the ever multiplying length of the periods of time needed for greater and greater evolutionary changes. But if it is wrong, it errs on the side of not making the periods too long but too short, and this for two reasons. In the first place, I have greatly understated the number of gradations in the classification of groups subordinate to groups; and in the second place, I made no allowance for what we have good reason to believe to be the fact, that variation of sufficient magnitude to give origin to new species is not going on always, but takes place only at intervals.

The limit which is necessarily placed to the length of such an address as this compels me to omit three of the most interesting of the special subjects opened up by Darwin's theory—I mean mimicry, sexual selection, and the origin of man. But with these exceptions—important exceptions no doubt—I hope that I have given a clear outline of the present state of this most interesting controversy. If I am told I have dwelt almost exclusively on the arguments against Darwinism, I reply that I trust this is not in consequence of any unfair controversial bias, but because all the arguments on Darwin's side are to be found in his work on "The Origin of Species," while many of the opposing ones are new, or, at least, little known. It may perhaps have excited some surprise that I have not referred to the writings of Herbert Spencer; but, though he is by far the ablest exponent of the general theory of evolution, he has added little to the specially Darwinian form of the theory. I began by stating myself to be a believer in evolution, but I have given arguments which to me appear conclusive against that special form of the theory of evolution which we call the Darwinian theory. I may now be asked whether I have any better theory to offer instead. It is not necessary to give any reply to such a question as this. We are not fit to engage in the

search after truth unless we can endure to rest in negative conclusions, and remain without any theory at all;—in other words, unless we are able to renounce what proves untrue, while admitting that we have no true theory to substitute. The positive conclusions which I think we may accept are somewhat indefinite, but nevertheless they are valuable if true. They are the following:—1. The rapidity of the process by which new species and new classes are formed has been much greater than Darwin allows; and great changes have sometimes occurred quite suddenly. The most conclusive instance with which I am acquainted of a change which must have taken place suddenly is perhaps that of those fishes which have the pelvic bones and what corresponds with the hinder fins of other fishes as it were moved forward and situated close behind the head. 2. The variations by which new species and new classes are formed, are not fortuitous or at random, but take place according to a predetermined plan; and the evolution of living beings is guided by Intelligence.

This latter conclusion is not advanced as a discovery; on the contrary, it is the general belief of thoughtful men, and probably has been so from a period long before the dawn of conscious philosophy and science; but I believe the truest science confirms it, and that its denial by the Darwinian school will prove to be but a temporary aberration from those principles of common sense which cannot be safely disregarded in science any more than in the affairs of life. And if the existence of a guiding Intelligence, which cannot be resolved into any law of physical causation, is established as a scientific truth, we have a basis whereon to establish a science of natural theology. There are fashions in intellect as well as in everything else, and it is the fashion of the present day to decry natural theology as an impossible science; but I am convinced that this is only a passing phase of thought, and that philosophers, as well as men who make no pretensions to that name, will yet acknowledge God as manifested in His works.

Mr. Murphy in conclusion expressed his thanks to Professor Cunningham for lending him out of the Museum of the Belfast Queen's College the specimens exhibited during the address.