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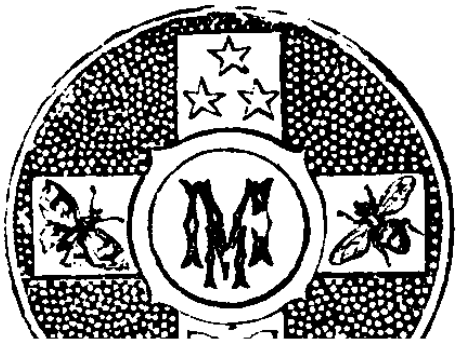

ON THE

GENESIS OF SPECIES.

BY
ST. GEORGE MIVART, F.R.S.

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TO

SIR HENRY HOLLAND, Bart., M.D.,

F.R.S., D.C.L., etc. etc.

My dear Sir Henry,

In giving myself the pleasure to dedicate, as I now do, this work to you, it is not my intention to identify you with any views of my own advocated in it.

I simply avail myself of an opportunity of paying a tribute of esteem and regard to my earliest scientific friend—the first to encourage me in pursuing the study of nature.

I remain,
My dear Sir Henry,
Ever faithfully yours,
ST. GEORGE MIVART.

7, North Bank, Regent's Park,
December 8, 1870.

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THE GENESIS OF SPECIES.

CHAPTER I.

INTRODUCTORY.

The problem of the genesis of species stated.—Nature of its probable solution.—Importance of the question.—Position here defended.—Statement of the DARWINIAN THEORY.—Its applicability to details of geographical distribution; to rudimentary structures; to homology; to mimicry, &c.—Consequent utility of the theory.—Its wide acceptance.—Reasons for this, other than, and in addition to, its scientific value.—Its simplicity.—Its bearing on religious questions.—*Odium theologicum* and *odium antitheologicum*.—The antagonism supposed by many to exist between it and theology neither necessary nor universal.—Christian authorities in favour of evolution.—Mr. Darwin's "Animals and Plants under Domestication."—Difficulties of the Darwinian theory enumerated.

The great problem which has so long exercised the minds of naturalists, namely, that concerning the origin of different kinds of animals and plants, seems at last to be fairly on the road to receive—perhaps at no very distant future—as satisfactory a solution as it can well have.

But the problem presents peculiar difficulties. The birth of a "species" has often been compared with that of an "individual." The origin, however, of even an individual animal or plant (that which determines an embryo to evolve itself,—as, *e.g.*, a spider rather than a beetle, a rose-plant rather than a pear) is shrouded in obscurity. *A fortiori* must this be the case with the origin of a "species." [2]

Moreover, the analogy between a "species" and an "individual" is a very incomplete one. The word "individual" denotes a concrete whole with a real, separate, and distinct existence. The word "species," on the other hand, denotes a peculiar congeries of characters, innate powers and qualities, and a certain nature realized indeed in individuals, but having no separate existence, except ideally as a thought in some mind.

Thus the birth of a "species" can only be compared metaphorically, and very imperfectly, with that of an "individual."

Individuals as *individuals*, actually and directly produce and bring forth other individuals; but no "congeries of characters" no "common nature" *as such*, can directly bring forth another "common nature," because, *per se*, it has no existence (other than ideal) apart from the individuals in which it is manifested.

The problem then is, "by what combination of natural laws does a new 'common nature' appear upon the scene of realized existence?" *i.e.* how is an individual embodying such new characters produced?

For the approximation we have of late made towards the solution of this problem, we are mainly indebted to the invaluable labours and active brains of Charles Darwin and Alfred Wallace.

Nevertheless, important as has been the impulse and direction given by those writers to both our observations and speculations, the solution will not (if the views here advocated are correct) ultimately present that aspect and character with which it has issued from the hands of those writers.

Neither, most certainly, will that solution agree in appearance or substance with the more or less crude conceptions which have been put forth by most of the opponents of Messrs. Darwin and Wallace. [3]

Rather, judging from the more recent manifestations of thought on opposite sides, we may expect the development of some *tertium quid*—the resultant of forces coming from different quarters, and not coinciding in direction with any one of them.

As error is almost always partial truth, and so consists in the exaggeration or distortion of one verity by the suppression of another which qualifies and modifies the former, we may hope, by the synthesis of the truths contended for by various advocates, to arrive at the one conciliating reality.

Signs of this conciliation are not wanting: opposite scientific views, opposite philosophical conceptions, and opposite religious beliefs, are rapidly tending by their vigorous conflict to evolve such a systematic and comprehensive view of the genesis of species as will completely harmonize with the teachings of science, philosophy, and religion.

To endeavour to add one stone to this temple of concord, to try and remove a few of the misconceptions and mutual misunderstandings which oppose harmonious action, is the aim and endeavour of the present work. This aim it is hoped to attain, not by shirking difficulties, but analysing them, and by endeavouring to dig down to the common root which supports and unites diverging stems of truth.

It cannot but be a gain when the labourers in the three fields above mentioned, namely, science, philosophy, and religion, shall fully recognize this harmony. Then the energy too often spent in futile controversy, or withheld through prejudice, may be profitably and reciprocally exercised for the mutual benefit of all.

Remarkable is the rapidity with which an interest in the question of specific origination has spread. But a few years ago it scarcely occupied the minds of any but naturalists. Then the crude theory put forth by Lamarck, and by his English interpreter the author of the "Vestiges of Creation," had rather discredited than helped on a belief in organic evolution—a belief, that is, [4] in new kinds being produced from older ones by the ordinary and constant operation of natural laws. Now, however, this belief is widely diffused. Indeed, there are few drawing-rooms where it is not the subject of occasional discussion, and artisans and schoolboys have their views as to the permanence of organic forms. Moreover, the reception of this doctrine tends actually, though by no means necessarily, to be accompanied by certain beliefs with regard to quite distinct and very momentous subject-matter. So that the question of the "Genesis of Species" is not only one of great interest, but also of much importance.

But though the calm and thorough consideration of this matter is at the present moment exceedingly desirable, yet the actual importance of the question itself as to its consequences in the domain of theology has been strangely exaggerated by many, both of its opponents and supporters. This is especially the case with that form of the evolution theory which is associated with the name of Mr. Darwin; and yet neither the refutation nor the demonstration of that doctrine would be necessarily accompanied by the results which are hoped for by one party and dreaded by another.

The general theory of evolution has indeed for some time past steadily gained ground, and it may be safely predicted that the number of facts which can be brought forward in its support will, in a few years, be vastly augmented. But the prevalence of this theory need alarm no one, for it is, without any doubt, perfectly consistent with strictest and most orthodox Christian theology. Moreover, it is not altogether without obscurities, and cannot yet be considered as fully demonstrated.

The special Darwinian hypothesis, however, is beset with certain scientific difficulties, which must by no means be ignored, and some of which, I venture to think, are absolutely insuperable. What Darwinism or "Natural Selection" is, will be shortly explained; but before doing so, I [5] think it well to state the object of this book, and the view taken up and defended in it. It is its object to maintain the position that "Natural Selection" acts, and indeed must act, but that still, in order that we may be able to account for the production of known kinds of animals and plants, it requires to be supplemented by the action of some other natural law or laws as yet undiscovered.[1] Also, that the consequences which have been drawn from Evolution, whether exclusively Darwinian or not, to the prejudice of religion, by no means follow from it, and are in fact illegitimate.

The Darwinian theory of "Natural Selection" may be shortly stated thus:[2]—

Every kind of animal and plant tends to increase in numbers in a geometrical progression.

Every kind of animal and plant transmits a general likeness, with individual differences, to its offspring.

Every individual may present minute variations of any kind and in any direction.

Past time has been practically infinite.

Every individual has to endure a very severe struggle for existence, owing to the tendency to geometrical increase of all kinds of animals and plants, while the total animal and vegetable population (man and his agency excepted) remains almost stationary.

Thus, every variation of a kind tending to save the life of the individual possessing it, or to enable it more surely to propagate its kind, will in the long run be preserved, and will transmit its favourable peculiarity to some of its offspring, which peculiarity will thus become intensified [6] till it reaches the maximum degree of utility. On the other hand, individuals presenting unfavourable peculiarities will be ruthlessly destroyed. The action of this law of Natural Selection may thus be well represented by the convenient expression "survival of the fittest."[3]

Now this conception of Mr. Darwin's is perhaps the most interesting theory, in relation to natural science, which has been promulgated during the present century. Remarkable, indeed, is the way in which it groups together such a vast and varied series of biological[4] facts, and even paradoxes, which it appears more or less clearly to explain, as the following instances will show. By this theory of "Natural Selection," light is thrown on the more singular facts relating to the geographical distribution of animals and plants; for example, on the resemblance between the past and present inhabitants of different parts of the earth's surface. Thus in Australia remains have been found of creatures closely allied to kangaroos and other kinds of pouched beasts, which in the present day exist nowhere but in the Australian region. Similarly in South America, and nowhere else, are found sloths and armadillos, and in that same part of the world have been discovered bones of animals different indeed from existing sloths and armadillos, but yet much more nearly related to them than to any other kinds whatever. Such coincidences between the existing and antecedent geographical distribution of forms are numerous. Again, "Natural Selection" serves to explain the circumstance that often in adjacent islands we find animals closely resembling, and appearing to represent, each other; while if certain of these islands show signs (by depth of surrounding sea or what not) of more ancient separation, the animals inhabiting them exhibit a corresponding divergence.[5] The explanation consists in [7]

representing the forms inhabiting the islands as being the modified descendants of a common stock, the modification being greatest where the separation has been the most prolonged.

"Rudimentary structures" also receive an explanation by means of this theory. These structures are parts which are apparently functionless and useless where they occur, but which represent similar parts of large size and functional importance in other animals. Examples of such "rudimentary structures" are the fœtal teeth of whales, and of the front part of the jaw of ruminating quadrupeds. These fœtal structures are minute in size, and never cut the gum, but are reabsorbed without ever coming into use, while no other teeth succeed them or represent them in the adult condition of those animals. The mammary glands of all male beasts constitute another example, as also does the wing of the apteryx—a New Zealand bird utterly incapable of flight, and with the wing in a quite rudimentary condition (whence the name of the animal). Yet this rudimentary wing contains bones which are miniature representatives of the ordinary wing-bones of birds of flight. Now, the presence of these useless bones and teeth is explained if they may be considered as actually being the inherited diminished representatives of parts of large size and functional importance in the remote ancestors of these various animals.

Again, the singular facts of "homology" are capable of a similar explanation. "Homology" is the name applied to the investigation of those profound resemblances which have so often been found to underlie superficial differences between animals of very different form and habit. Thus man, the horse, the whale, and the bat, all have the pectoral limb, whether it be the arm, or fore-leg, or paddle, or wing, formed on essentially the same type, though the number and proportion [8]
of parts may more or less differ. Again, the butterfly and the shrimp, different as they are in appearance and mode of life, are yet constructed on the same common plan, of which they constitute diverging manifestations. No *a priori* reason is conceivable why such similarities should be necessary, but they are readily explicable on the assumption of a genetic relationship and affinity between the animals in question, assuming, that is, that they are the modified descendants of some ancient form—their common ancestor.

That remarkable series of changes which animals undergo before they attain their adult condition, which is called their process of development, and during which they more or less closely resemble other animals during the early stages of the same process, has also great light thrown on it from the same source. The question as to the singularly complex resemblances borne by every adult animal and plant to a certain number of other animals and plants—resemblances by means of which the adopted zoological and botanical systems of classification have been possible—finds its solution in a similar manner, classification becoming the expression of a genealogical relationship. Finally, by this theory—and as yet by this alone—can any explanation be given of that extraordinary phenomenon which is metaphorically termed *mimicry*. Mimicry is a close and striking, yet superficial resemblance borne by some animal or plant to some other, perhaps very different, animal or plant. The "walking leaf" (an insect belonging to the grasshopper and cricket order) is a well-known and conspicuous instance of the assumption by an animal of the appearance of a vegetable structure (see illustration on p. 35); and the bee, fly, and spider orchids are familiar examples of a converse resemblance. Birds, butterflies, reptiles, and even fish, seem to bear in certain instances a similarly striking resemblance to other birds, butterflies, reptiles, and fish, of altogether distinct kinds. The explanation of this matter which "Natural Selection" offers, as to animals, is that certain [9]
varieties of one kind have found exemption from persecution in consequence of an accidental resemblance which such varieties have exhibited to animals of another kind, or to plants; and that they were thus preserved, and the degree of resemblance was continually augmented in their descendants. As to plants, the explanation offered by this theory might perhaps be that varieties of plants which presented a certain superficial resemblance in their flowers to insects, have thereby been helped to propagate their kind, the visit of certain insects being useful or indispensable to the fertilization of many flowers.

We have thus a whole series of important facts which "Natural Selection" helps us to understand and co-ordinate. And not only are all these diverse facts strung together, as it were, by the theory in question; not only does it explain the development of the complex instincts of the beaver, the cuckoo, the bee, and the ant, as also the dazzling brilliancy of the humming-bird, the

glowing tail and neck of the peacock, and the melody of the nightingale; the perfume of the rose and the violet, the brilliancy of the tulip and the sweetness of the nectar of flowers; not only does it help us to understand all these, but serves as a basis of future research and of inference from the known to the unknown, and it guides the investigator to the discovery of new facts which, when ascertained, it seems also able to co-ordinate.[6] Nay, "Natural Selection" seems capable of application not only to the building up of the smallest and most insignificant organisms, but even of extension beyond the biological domain altogether, so as possibly to have relation to the stable equilibrium of the solar system itself, and even of the whole sidereal [10] universe. Thus, whether this theory be true or false, all lovers of natural science should acknowledge a deep debt of gratitude to Messrs. Darwin and Wallace, on account of its practical utility. But the utility of a theory by no means implies its truth. What do we not owe, for example, to the labours of the Alchemists? The emission theory of light, again, has been pregnant with valuable results, as still is the Atomic theory, and others which will readily suggest themselves.

With regard to Mr. Darwin (with whose name, on account of the noble self-abnegation of Mr. Wallace, the theory is in general exclusively associated), his friends may heartily congratulate him on the fact that he is one of the few exceptions to the rule respecting the non-appreciation of a prophet in his own country. It would be difficult to name another living labourer in the field of physical science who has excited an interest so widespread, and given rise to so much praise, gathering round him, as he has done, a chorus of more or less completely acquiescing disciples, themselves masters in science, and each the representative of a crowd of enthusiastic followers.

Such is the Darwinian theory of "Natural Selection," such are the more remarkable facts which it is potent to explain, and such is the reception it has met with in the world. A few words now as to the reasons for the very widespread interest it has awakened, and the keenness with which the theory has been both advocated and combated.

The important bearing it has on such an extensive range of scientific facts, its utility, and the vast knowledge and great ingenuity of its promulgator, are enough to account for the heartiness of its reception by those learned in natural history. But quite other causes have concurred to produce the general and higher degree of interest felt in the theory beside the readiness with which it harmonizes with biological facts. These latter could only be appreciated by physiologists, zoologists, and botanists; whereas the Darwinian theory, so novel and so startling, [11] has found a cloud of advocates and opponents beyond and outside the world of physical science.

In the first place, it was inevitable that a great crowd of half-educated men and shallow thinkers should accept with eagerness the theory of "Natural Selection," or rather what they think to be such (for few things are more remarkable than the way in which it has been misunderstood), on account of a certain characteristic it has in common with other theories; which should not be mentioned in the same breath with it, except, as now, with the accompaniment of protest and apology. We refer to its remarkable simplicity, and the ready way in which phenomena the most complex appear explicable by a cause for the comprehension of which laborious and persevering efforts are not required, but which may be represented by the simple phrase "survival of the fittest." With nothing more than this, can, on the Darwinian theory, all the most intricate facts of distribution and affinity, form, and colour, be accounted for; as well the most complex instincts and the most admirable adjustments, such as those of the human eye and ear. It is in great measure then, owing to this supposed simplicity, and to a belief in its being yet easier and more simple than it is, that Darwinism, however imperfectly understood, has become a subject for general conversation, and has been able thus widely to increase a certain knowledge of biological matters; and this excitation of interest in quarters where otherwise it would have been entirely wanting, is an additional motive for gratitude on the part of naturalists to the authors of the new theory. At the same time it must be admitted that a similar "simplicity"—the apparently easy explanation of complex phenomena—also constitutes the charm of such matters as hydropathy and phrenology, in the eyes of the unlearned or half-educated public. It is indeed *the* charm of all those seeming "short cuts" to knowledge, by which the labour of mastering scientific details is spared to those who yet believe that without such [12]

labour they can attain all the most valuable results of scientific research. It is not, of course, for a moment meant to imply that its "simplicity" tells at all against "Natural Selection," but only that the actual or supposed possession of that quality is a strong reason for the wide and somewhat hasty acceptance of the theory, whether it be true or not.

In the second place, it was inevitable that a theory appearing to have very grave relations with questions of the last importance and interest to man, that is, with questions of religious belief, should call up an army of assailants and defenders. Nor have the supporters of the theory much reason, in many cases, to blame the more or less unskilful and hasty attacks of adversaries, seeing that those attacks have been in great part due to the unskilful and perverse advocacy of the cause on the part of some of its adherents. If the *odium theologicum* has inspired some of its opponents, it is undeniable that the *odium antitheologicum* has possessed not a few of its supporters. It is true (and in appreciating some of Mr. Darwin's expressions it should never be forgotten) that the theory has been both at its first promulgation and since vehemently attacked and denounced as unchristian, nay, as necessarily atheistic; but it is not less true that it has been made use of as a weapon of offence by irreligious writers, and has been again and again, especially in continental Europe, thrown, as it were, in the face of believers, with sneers and contumely. When we recollect the warmth with which what he thought was Darwinism was advocated by such a writer as Professor Vogt, one cause of his zeal was not far to seek—a zeal, by the way, certainly not "according to knowledge;" for few conceptions could have been more conflicting with true Darwinism than the theory he formerly maintained, but has since abandoned, viz. that the men of the Old World were descended from African and Asiatic apes, while, similarly, the American apes were the progenitors of the human beings of the New World. The cause of this palpable error in a too eager disciple one might hope was not anxiety [13]
to snatch up all or any arms available against Christianity, were it not for the tone unhappily adopted by this author. But it is unfortunately quite impossible to mistake his meaning and intention, for he is a writer whose offensiveness is gross, while it is sometimes almost surpassed by an amazing shallowness. Of course, as might fully be expected, he adopts and reproduces the absurdly trivial objections to absolute morality drawn from differences in national customs.[7] And he seems to have as little conception of the distinction between "formally" moral actions and those which are only "materially" moral, as of that between the *verbum mentale* and the *verbum oris*. As an example of his onesidedness, it may be remarked that he compares the skulls of the American monkeys (*Cebus apella* and *C. albifrons*) with the intention of showing that man is of several distinct species, because skulls of different men are less alike than are those of these two monkeys; and he does this regardless of how the skulls of domestic animals (with which it is far more legitimate to compare races of men than with wild kinds), *e.g.* of different dogs or pigeons, tell precisely in the opposite direction. Regardless also of the fact that perhaps no genus of monkeys is in a more unsatisfactory state as to the determination of its different kinds than the genus chosen by him for illustration. This is so much the case that J. A. Wagner (in his supplement to Schreber's great work on Beasts) at first included all the kinds in a single species.

As to the strength of his prejudice and his regretable coarseness, one quotation will be enough to display both. Speaking of certain early Christian missionaries, he says,[8] "It is not so very improbable that the new religion, before which the flourishing Roman civilization relapsed into a state of barbarism, should have been introduced by people in whose skulls the anatomist finds [14]
simious characters so well developed, and in which the phrenologist finds the organ of veneration so much enlarged. I shall, in the meanwhile, call these simious narrow skulls of Switzerland 'Apostle skulls,' as I imagine that in life they must have resembled the type of Peter, the Apostle, as represented in Byzantine-Nazarene art."

In face of such a spirit, can it be wondered at that disputants have grown warm? Moreover, in estimating the vehemence of the opposition which has been offered, it should be borne in mind that the views defended by religious writers are, or should be, all-important in their eyes. They could not be expected to view with equanimity the destruction in many minds of "theology, natural and revealed, psychology, and metaphysics;" nor to weigh with calm and frigid impartiality arguments which seemed to them to be fraught with results of the highest moment

to mankind, and, therefore, imposing on their consciences strenuous opposition as a first duty. Cool judicial impartiality in them would have been a sign perhaps of intellectual gifts, but also of a more important deficiency of generous emotion.

It is easy to complain of the onesidedness of many of those who oppose Darwinism in the interest of orthodoxy; but not at all less patent is the intolerance and narrow-mindedness of some of those who advocate it, avowedly or covertly, in the interest of heterodoxy. This hastiness of rejection or acceptance, determined by ulterior consequences believed to attach to "Natural Selection," is unfortunately in part to be accounted for by some expressions and a certain tone to be found in Mr. Darwin's writings. That his expressions, however, are not always to be construed literally is manifest. His frequent use metaphorically of the expressions, "contrivance," for example, and "purpose," has elicited, from the Duke of Argyll and others, criticisms which fail to tell against their opponent, because such expressions are, in Mr. [15] Darwin's writings, merely figurative—metaphors, and nothing more.

It may be hoped, then, that a similar looseness of expression will account for passages of a directly opposite tendency to that of his theistic metaphors.

Moreover, it must not be forgotten that he frequently uses that absolutely theological term, "the Creator," and that he has retained in all the editions of his "Origin of Species" an expression which has been much criticised. He speaks "of life, with its several powers, having been originally breathed by the Creator into a few forms, or into one."[9] This is merely mentioned in justice to Mr. Darwin, and by no means because it is a position which this book is intended to support. For, from Mr. Darwin's usual mode of speaking, it appears that by such divine action he means a supernatural intervention, whereas it is here contended that throughout the whole process of physical evolution—the first manifestation of life included—*supernatural* action is assuredly not to be looked for.

Again, in justice to Mr. Darwin, it may be observed that he is addressing the general public, and opposing the ordinary and common objections of popular religionists, who have inveighed against "Evolution" and "Natural Selection" as atheistic, impious, and directly conflicting with the dogma of creation.

Still, in so important a matter, it is to be regretted that he did not take the trouble to distinguish between such merely popular views and those which repose upon some more venerable authority. Mr. John Stuart Mill has replied to similar critics, and shown that the assertion that his philosophy is irreconcilable with theism is unfounded; and it would have been better if Mr. Darwin had dealt in the same manner with some of his assailants, and shown the futility of certain of their objections when viewed from a more elevated religious standpoint. Instead of so [16] doing, he seems to adopt the narrowest notions of his opponents, and, far from endeavouring to expand them, appears to wish to endorse them, and to lend to them the weight of his authority. It is thus that Mr. Darwin seems to admit and assume that the idea of "creation" necessitates a belief in an interference with, or dispensation of, natural laws, and that "creation" must be accompanied by arbitrary and unorderly phenomena. None but the crudest conceptions are placed by him to the credit of supporters of the dogma of creation, and it is constantly asserted that they, to be consistent, must offer "creative fiats" as explanations of physical phenomena, and be guilty of numerous other such absurdities. It is impossible, therefore, to acquit Mr. Darwin of at least a certain carelessness in this matter; and the result is, he has the appearance of opposing ideas which he gives no clear evidence of having ever fully appreciated. He is far from being alone in this, and perhaps merely takes up and reiterates, without much consideration, assertions previously assumed by others. Nothing could be further from Mr. Darwin's mind than any, however small, intentional misrepresentation; and it is therefore the more unfortunate that he should not have shown any appreciation of a position opposed to his own other than that gross and crude one which he combats so superfluously—that he should appear, even for a moment, to be one of those, of whom there are far too many, who first misrepresent their adversary's view, and then elaborately refute it; who, in fact, erect a doll utterly incapable of self-defence and then, with a flourish of trumpets and many vigorous strokes, overthrow the helpless dummy they had previously raised.

This is what many do who more or less distinctly oppose theism in the interests, as they believe, of physical science; and they often represent, amongst other things, a gross and narrow anthropomorphism as the necessary consequence of views opposed to those which they [17] themselves advocate. Mr. Darwin and others may perhaps be excused if they have not devoted much time to the study of Christian philosophy; but they have no right to assume or accept, without careful examination, as an unquestioned fact, that in that philosophy there is a necessary antagonism between the two ideas, "creation" and "evolution," as applied to organic forms.

It is notorious and patent to all who choose to seek, that many distinguished Christian thinkers have accepted and do accept both ideas, *i.e.* both "creation" and "evolution."

As much as ten years ago, an eminently Christian writer observed: "The creationist theory does not necessitate the perpetual search after manifestations of miraculous powers and perpetual 'catastrophes.' Creation is not a miraculous interference with the laws of nature, but the very institution of those laws. Law and regularity, not arbitrary intervention, was the patristic ideal of creation. With this notion, they admitted without difficulty the most surprising origin of living creatures, provided it took place by *law*. They held that when God said, 'Let the waters produce,' 'Let the earth produce,' He conferred forces on the elements of earth and water, which enabled them naturally to produce the various species of organic beings. This power, they thought, remains attached to the elements throughout all time."[10] The same writer quotes St. Augustine and St. Thomas Aquinas, to the effect that, "in the institution of nature we do not look for miracles, but for the laws of nature."[11] And, again, St. Basil,[12] speaks of the continued operation of natural laws in the production of all organisms. [18]

So much for writers of early and mediæval times. As to the present day, the Author can confidently affirm that there are many as well versed in theology as Mr. Darwin is in his own department of natural knowledge, who would not be disturbed by the thorough demonstration of his theory. Nay, they would not even be in the least painfully affected at witnessing the generation of animals of complex organization by the skilful artificial arrangement of natural forces, and the production, in the future, of a fish, by means analogous to those by which we now produce urea.

And this because they know that the possibility of such phenomena, though by no means actually foreseen, has yet been fully provided for in the old philosophy centuries before Darwin, or even before Bacon, and that their place in the system can be at once assigned them without even disturbing its order or marring its harmony.

Moreover, the old tradition in this respect has never been abandoned, however much it may have been ignored or neglected by some modern writers. In proof of this it may be observed that perhaps no post-mediæval theologian has a wider reception amongst Christians throughout the world than Suarez, who has a separate section[13] in opposition to those who maintain the distinct creation of the various kinds—or substantial forms—of organic life.

But the consideration of this matter must be deferred for the present, and the question of evolution, whether Darwinian or other, be first gone into. It is proposed, after that has been done, to return to this subject (here merely alluded to), and to consider at some length the bearing of "Evolution," whether Darwinian or non-Darwinian, upon "Creation and Theism."

Now we will revert simply to the consideration of the theory of "Natural Selection" itself.

Whatever may have hitherto been the amount of acceptance that this theory has met with, all, I [19] think, anticipated that the appearance of Mr. Darwin's large and careful work on "Animals and Plants under Domestication" could but further increase that acceptance. It is, however, somewhat problematical how far such anticipations will be realized. The newer book seems to add after all but little in support of the theory, and to leave most, if not all, its difficulties exactly where they were. It is a question, also, whether the hypothesis of "Pangenesis"[14] may not be found rather to encumber than to support the theory it was intended to subserve. However, the work in question treats only of domestic animals, and probably the next instalment will address

itself more vigorously and directly to the difficulties which seem to us yet to bar the way to a complete acceptance of the doctrine.

If the theory of Natural Selection can be shown to be quite insufficient to explain any considerable number of important phenomena connected with the origin of species, that theory, as *the* explanation, must be considered as provisionally discredited.

If other causes than Natural (including sexual) Selection can be proved to have acted—if variation can in any cases be proved to be subject to certain determinations in special directions by other means than Natural Selection, it then becomes probable *a priori* that it is so in others, and that Natural Selection depends upon, and only supplements, such means, which conception [20] is opposed to the pure Darwinian position.

Now it is certain, *a priori*, that variation is obedient to some law and therefore that "Natural Selection" itself must be capable of being subsumed into some higher law; and it is evident, I believe, *a posteriori*, that Natural Selection is, at the very least, aided and supplemented by some other agency.

Admitting, then, organic and other evolution, and that new forms of animals and plants (new species, genera, &c.) have from time to time been evolved from preceding animals and plants, it follows, if the views here advocated are true, that this evolution has not taken place by the action of "Natural Selection" *alone*, but through it (amongst other influences) aided by the concurrent action of some other natural law or laws, at present undiscovered; and probably that the genesis of species takes place partly, perhaps mainly, through laws which may be most conveniently spoken of as special powers and tendencies existing in each organism; and partly through influences exerted on each by surrounding conditions and agencies organic and inorganic, terrestrial and cosmical, among which the "survival of the fittest" plays a certain but subordinate part.

The theory of "Natural Selection" may (though it need not) be taken in such a way as to lead men to regard the present organic world as formed, so to speak, *accidentally*, beautiful and wonderful as is confessedly the hap-hazard result. The same may perhaps be said with regard to the system advocated by Mr. Herbert Spencer, who, however, also relegates "Natural Selection" to a subordinate *rôle*. The view here advocated, on the other hand, regards the whole organic world as arising and going forward in one harmonious development similar to that which displays itself in the growth and action of each separate individual organism. It also regards each such separate organism as the expression of powers and tendencies not to be accounted for [21] by "Natural Selection" alone, or even by that together with merely the direct influence of surrounding conditions.

The difficulties which appear to oppose themselves to the reception of "Natural Selection" or "the survival of the fittest," as the one explanation of the origin of species, have no doubt been already considered by Mr. Darwin. Nevertheless, it may be worth while to enumerate them, and to state the considerations which appear to give them weight; and there is no doubt but that a naturalist so candid and careful as the author of the theory in question, will feel obliged, rather than the reverse, by the suggestion of all the doubts and difficulties which can be brought against it.

What is to be brought forward may be summed up as follows:—

That "Natural Selection" is incompetent to account for the incipient stages of useful structures.

That it does not harmonize with the co-existence of closely similar structures of diverse origin.

That there are grounds for thinking that specific differences may be developed suddenly instead of gradually.

That the opinion that species have definite though very different limits to their variability is still tenable.

That certain fossil transitional forms are absent, which might have been expected to be present.

That some facts of geographical distribution supplement other difficulties.

That the objection drawn from the physiological difference between "species" and "races" still exists unrefuted.

That there are many remarkable phenomena in organic forms upon which "Natural Selection" throws no light whatever, but the explanations of which, if they could be attained, might throw light upon specific origination. [22]

Besides these objections to the sufficiency of "Natural Selection," others may be brought against the hypothesis of "Pangenesis," which, professing as it does to explain great difficulties, seems to do so by presenting others not less great—almost to be the explanation of *obscurum per obscurius*. [23]

CHAPTER II.

THE INCOMPETENCY OF "NATURAL SELECTION" TO ACCOUNT FOR THE INCIPIENT STAGES OF USEFUL STRUCTURES.

> Mr. Darwin supposes that natural selection acts by slight variations.—These must be useful at once.—Difficulties as to the giraffe; as to mimicry; as to the heads of flat-fishes; as to the origin and constancy of the vertebrate limbs; as to whalebone; as to the young kangaroo; as to sea-urchins; as to certain processes of metamorphosis; as to the mammary gland; as to certain ape characters; as to the rattlesnake and cobra; as to the process of formation of the eye and ear; as to the fully developed condition of the eye and ear; as to the voice; as to shell-fish; as to orchids; as to ants.—The necessity for the simultaneous modification of many individuals.—Summary and conclusion.

"Natural Selection," simply and by itself, is potent to explain the maintenance or the further extension and development of favourable variations, which are at once sufficiently considerable to be useful from the first to the individual possessing them. But Natural Selection utterly fails to account for the conservation and development of the minute and rudimentary beginnings, the slight and infinitesimal commencements of structures, however useful those structures may afterwards become.

Now, it is distinctly enunciated by Mr. Darwin, that the spontaneous variations upon which his theory depends are individually slight, minute, and insensible. He says,[15] "Slight individual differences, however, suffice for the work, and are probably the sole differences which are effective in the production of new species." And again, after mentioning the frequent sudden appearances of domestic varieties, he speaks of "the false belief as to the similarity of natural species in this respect."[16] In his work on the "Origin of Species," he also observes, "Natural Selection acts only by the preservation and accumulation of small inherited modifications."[17] And "Natural Selection, if it be a true principle, will banish the belief ... of any great and sudden modification in their structure."[18] Finally, he adds, "If it could be demonstrated that any complex organ existed, which could not possibly have been formed by numerous, successive, slight modifications, my theory would absolutely break down."[19] [24]

Now the conservation of minute variations in many instances is, of course, plain and intelligible enough; such, *e.g.*, as those which tend to promote the destructive faculties of beasts of prey on the one hand, or to facilitate the flight or concealment of the animals pursued on the other; provided always that these minute beginnings are of such a kind as really to have a certain efficiency, however small, in favour of the conservation of the individual possessing them; and also provided that no unfavourable peculiarity in any other direction accompanies and neutralizes, in the struggle for life, the minute favourable variation.

But some of the cases which have been brought forward, and which have met with very general acceptance, seem less satisfactory when carefully analysed than they at first appear to be. Amongst these we may mention "the neck of the giraffe."

At first sight it would seem as though a better example in support of "Natural Selection" could hardly have been chosen. Let the fact of the occurrence of occasional, severe droughts in the [25]
country which that animal has inhabited be granted. In that case, when the ground vegetation has been consumed, and the trees alone remain, it is plain that at such times only those individuals (of what we assume to be the nascent giraffe species) which were able to reach high up would be preserved, and would become the parents of the following generation, some individuals of which would, of course, inherit that high-reaching power which alone preserved their parents. Only the high-reaching issue of these high-reaching individuals would again, *cæteris paribus*, be preserved at the next drought, and would again transmit to their offspring their still loftier stature; and so on, from period to period, through æons of time, all the individuals tending to revert to the ancient shorter type of body, being ruthlessly destroyed at the occurrence of each drought.

(1.) But against this it may be said, in the first place, that the argument proves too much; for, on this supposition, many species must have tended to undergo a similar modification, and we ought to have at least several forms, similar to the giraffe, developed from different Ungulata. [20] A careful observer of animal life, who has long resided in South Africa, explored the interior, and lived in the giraffe country, has assured the Author that the giraffe has powers of locomotion and endurance fully equal to those possessed by any of the other Ungulata of that continent. It would seem, therefore, that some of these other Ungulates ought to have developed in a similar manner as to the neck, under pain of being starved, when the long neck of the giraffe was in its incipient stage.

To this criticism it has been objected that different kinds of animals are preserved, in the struggle for life, in very different ways, and even that "high reaching" may be attained in more [26]
modes than one—as, for example, by the trunk of the elephant. This is, indeed, true, but then none of the African Ungulata[21] have, nor do they appear ever to have had, any proboscis whatsoever; nor have they acquired such a development as to allow them to rise on their hind limbs and graze on trees in a kangaroo-attitude, nor a power of climbing, nor, as far as known, any other modification tending to compensate for the comparative shortness of the neck. Again, it may perhaps be said that leaf-eating forms are exceptional, and that therefore the struggle to attain high branches would not affect many Ungulates. But surely, when these severe droughts necessary for the theory occur, the ground vegetation is supposed to be exhausted; and, indeed, the giraffe is quite capable of feeding from off the ground. So that, in these cases, the other Ungulata *must* have taken to leaf eating or have starved, and thus must have had any accidental long-necked varieties favoured and preserved exactly as the long-necked varieties of the giraffe are supposed to have been favoured and preserved.

The argument as to the different modes of preservation has been very well put by Mr. Wallace, [22] in reply to the objection that "colour, being dangerous, should not exist in nature." This objection appears similar to mine; as I say that a giraffe neck, being needful, there should be many animals with it, while the objector noticed by Mr. Wallace says, "a dull colour being needful, all animals should be so coloured." And Mr. Wallace shows in reply how porcupines, tortoises and mussels, very hard-coated bombadier beetles, stinging insects and nauseous-tasted caterpillars, can afford to be brilliant by the various means of active defence or passive protection they possess, other than obscure colouration. He says "the attitudes of some insects [27]
may also protect them, as the habit of turning up the tail by the harmless rove-beetles (Staphylinidæ) no doubt leads other animals, besides children, to the belief that they can sting. The curious attitude assumed by sphinx caterpillars is probably a safeguard, as well as the blood-red tentacles which can suddenly be thrown out from the neck by the caterpillars of all the true swallow-tailed butterflies."

But, because many different kinds of animals can elude the observation or defy the attack of enemies in a great variety of ways, it by no means follows that there are any similar number and variety of ways for attaining vegetable food in a country where all such food, other than the lofty branches of trees, has been for a time destroyed. In such a country we have a number of vegetable-feeding Ungulates, all of which present minute variations as to the length of the neck. If, as Mr. Darwin contends, the natural selection of these favourable variations has alone lengthened the neck of the giraffe by preserving it during droughts; similar variations, in similarly-feeding forms, at the same times, ought similarly to have been preserved and so lengthened the neck of some other Ungulates by similarly preserving them during the same droughts.

(2.) It may be also objected, that the power of reaching upwards, acquired by the lengthening of the neck and legs, must have necessitated a considerable increase in the entire size and mass of the body (larger bones requiring stronger and more voluminous muscles and tendons, and these again necessitating larger nerves, more capacious blood-vessels, &c.), and it is very problematical whether the disadvantages thence arising would not, in times of scarcity, more than counterbalance the advantages.

For a considerable increase in the supply of food would be requisite on account of this increase in size and mass, while at the same time there would be a certain decrease in strength; for, as [28]
Mr. Herbert Spencer says,[23] "It is demonstrable that the excess of absorbed over expended nutriment must, other things equal, become less as the size of an animal becomes greater. In similarly-shaped bodies, the masses vary as the cubes of the dimensions; whereas the strengths vary as the squares of the dimensions."... "Supposing a creature which a year ago was one foot high, has now become two feet high, while it is unchanged in proportions and structure—what are the necessary concomitant changes that have taken place in it? It is eight times as heavy; that is to say, it has to resist eight times the strain which gravitation puts on its structure; and in producing, as well as in arresting, every one of its movements, it has to overcome eight times the inertia. Meanwhile, the muscles and bones have severally increased their contractile and resisting powers, in proportion to the areas of their transverse sections; and hence are severally but four times as strong as they were. Thus, while the creature has doubled in height, and while its ability to overcome forces has quadrupled, the forces it has to overcome have grown eight times as great. Hence, to raise its body through a given space, its muscles have to be contracted with twice the intensity, at a double cost of matter expended." Again, as to the cost at which nutriment is distributed through the body, and effete matters removed from it, "Each increment of growth being added at the periphery of an organism, the force expended in the transfer of matter must increase in a rapid progression—a progression more rapid than that of the mass."

There is yet another point. Vast as may have been the time during which the process of evolution has continued, it is nevertheless not infinite. Yet, as every kind, on the Darwinian hypothesis, varies slightly but indefinitely in every organ and every part of every organ, how very generally must favourable variations as to the length of the neck have been accompanied [29]
by some unfavourable variation in some other part, neutralizing the action of the favourable one, the latter, moreover, only taking effect during these periods of drought! How often must not individuals, favoured by a slightly increased length of neck, have failed to enjoy the elevated foliage which they had not strength or endurance to attain; while other individuals, exceptionally robust, could struggle on yet further till they arrived at vegetation within their reach.

However, allowing this example to pass, many other instances will be found to present great difficulties.

Let us take the cases of mimicry amongst lepidoptera and other insects. Of this subject Mr. Wallace has given a most interesting and complete account,[24] showing in how many and strange instances this superficial resemblance by one creature to some other quite distinct creature acts as a safeguard to the first. One or two instances must here suffice. In South America there is a family of butterflies, termed *Heliconidæ*, which are very conspicuously coloured and slow in flight, and yet the individuals abound in prodigious numbers, and take no

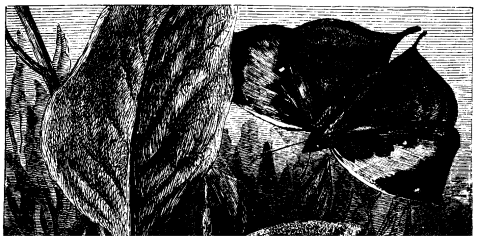
precautions to conceal themselves, even when at rest, during the night. Mr. Bates (the author of the very interesting work "The Naturalist on the River Amazons," and the discoverer of "Mimicry") found that these conspicuous butterflies had a very strong and disagreeable odour; so much so that any one handling them and squeezing them, as a collector must do, has his fingers stained and so infected by the smell, as to require time and much trouble to remove it.

It is suggested that this unpleasant quality is the cause of the abundance of the Heliconidæ; Mr. Bates and other observers reporting that they have never seen them attacked by the birds, reptiles, or insects which prey upon other lepidoptera.

Now it is a curious fact that very different South American butterflies put on, as it were, the exact dress of these offensive beauties and mimic them even in their mode of flight. [30]

In explaining the mode of action of this protecting resemblance Mr. Wallace observes:[25] "Tropical insectivorous birds very frequently sit on dead branches of a lofty tree, or on those which overhang forest paths, gazing intently around, and darting off at intervals to seize an insect at a considerable distance, with which they generally return to their station to devour. If a bird began by capturing the slow-flying conspicuous Heliconidæ, and found them always so disagreeable that it could not eat them, it would after a very few trials leave off catching them at all; and their whole appearance, form, colouring, and mode of flight is so peculiar, that there can be little doubt birds would soon learn to distinguish them at a long distance, and never waste any time in pursuit of them. Under these circumstances, it is evident that any other butterfly of a group which birds were accustomed to devour, would be almost equally well protected by closely resembling a Heliconia externally, as if it acquired also the disagreeable odour; always supposing that there were only a few of them among a great number of Heliconias."

"The approach in colour and form to the Heliconidæ, however, would be at the first a positive, though perhaps a slight, advantage; for although at short distances this variety would be easily distinguished and devoured, yet at a longer distance it might be mistaken for one of the uneatable group, and so be passed by and gain another day's life, which might in many cases be sufficient for it to lay a quantity of eggs and leave a numerous progeny, many of which would inherit the peculiarity which had been the safeguard of their parent."



LEAF BUTTERFLY IN FLIGHT AND
REPOSE.
(*From Mr. Wallace's "Malay Archipelago.*")

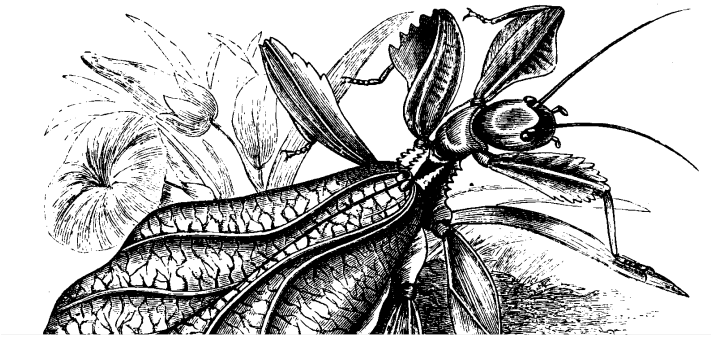
As a complete example of mimicry Mr. Wallace refers to a common Indian butterfly. He says: [26] "But the most wonderful and undoubted case of protective resemblance in a butterfly, which [31]

I have ever seen, is that of the common Indian *Kallima inachis*, and its Malayan ally, *Kallima paralekta*. The upper surface of these is very striking and showy, as they are of a large size, and [32] are adorned with a broad band of rich orange on a deep bluish ground. The under side is very variable in colour, so that out of fifty specimens no two can be found exactly alike, but every one of them will be of some shade of ash, or brown, or ochre, such as are found among dead, dry, or decaying leaves. The apex of the upper wings is produced into an acute point, a very common form in the leaves of tropical shrubs and trees, and the lower wings are also produced into a short narrow tail. Between these two points runs a dark curved line exactly representing the midrib of a leaf, and from this radiate on each side a few oblique lines, which serve to indicate the lateral veins of a leaf. These marks are more clearly seen on the outer portion of the base of the wings, and on the inner side towards the middle and apex, and it is very curious to observe how the usual marginal and transverse striæ of the group are here modified and strengthened so as to become adapted for an imitation of the venation of a leaf." ... "But this resemblance, close as it is, would be of little use if the habits of the insect did not accord with it. If the butterfly sat upon leaves or upon flowers, or opened its wings so as to expose the upper surface, or exposed and moved its head and antennæ as many other butterflies do, its disguise would be of little avail. We might be sure, however, from the analogy of many other cases, that the habits of the insect are such as still further to aid its deceptive garb; but we are not obliged to make any such supposition, since I myself had the good fortune to observe scores of *Kallima paralekta*, in Sumatra, and to capture many of them, and can vouch for the accuracy of the following details. These butterflies frequent dry forests, and fly very swiftly. They were seen to settle on a flower or a green leaf, but were many times lost sight of in a bush or tree of dead leaves. On such occasions they were generally searched for in vain, for while gazing intently at the very spot where one had disappeared, it would often suddenly dart out, and again vanish twenty or fifty yards further on. On one or two occasions the insect was detected reposing, and [33] it could then be seen how completely it assimilates itself to the surrounding leaves. It sits on a nearly upright twig, the wings fitting closely back to back, concealing the antennæ and head, which are drawn up between their bases. The little tails of the hind wing touch the branch, and form a perfect stalk to the leaf, which is supported in its place by the claws of the middle pair of feet, which are slender and inconspicuous. The irregular outline of the wings gives exactly the perspective effect of a shrivelled leaf. We thus have size, colour, form, markings, and habits, all combining together to produce a disguise which may be said to be absolutely perfect; and the protection which it affords is sufficiently indicated by the abundance of the individuals that possess it."

Beetles also imitate bees and wasps, as do some Lepidoptera; and objects the most bizarre and unexpected are simulated, such as dung and drops of dew. Some insects, called bamboo and walking-stick insects, have a most remarkable resemblance to pieces of bamboo, to twigs and branches. Of these latter insects Mr. Wallace says:[27] "Some of these are a foot long and as thick as one's finger, and their whole colouring, form, rugosity, and the arrangement of the head, legs, and antennæ, are such as to render them absolutely identical in appearance with dry sticks. They hang loosely about shrubs in the forest, and have the extraordinary habit of stretching out their legs unsymmetrically, so as to render the deception more complete." Now let us suppose that the ancestors of these various animals were all destitute of the very special protections they at present possess, as on the Darwinian hypothesis we must do. Let it also be conceded that small deviations from the antecedent colouring or form would tend to make some of their ancestors escape destruction by causing them more or less frequently to be passed over, or [34] mistaken by their persecutors. Yet the deviation must, as the event has shown, in each case be in some definite direction, whether it be towards some other animal or plant, or towards some dead or inorganic matter. But as, according to Mr. Darwin's theory, there is a constant tendency to indefinite variation, and as the minute incipient variations will be in *all directions*, they must tend to neutralize each other, and at first to form such unstable modifications that it is difficult, if not impossible, to see how such indefinite oscillations of infinitesimal beginnings can ever build up a sufficiently appreciable resemblance to a leaf, bamboo, or other object, for "Natural Selection" to seize upon and perpetuate. This difficulty is augmented when we consider—a point to be dwelt upon hereafter—how necessary it is that many individuals should be similarly

modified simultaneously. This has been insisted on in an able article in the *North British Review* for June 1867, p. 286, and the consideration of the article has occasioned Mr. Darwin to make an important modification in his views.[28]

In these cases of mimicry it seems difficult indeed to imagine a reason why variations tending in an *infinitesimal degree* in any special direction should be preserved. All variations would be preserved which tended to obscure the perception of an animal by its enemies, whatever direction those variations might take, and the common preservation of conflicting tendencies would greatly favour their mutual neutralization and obliteration if we may rely on the many cases recently brought forward by Mr. Darwin with regard to domestic animals.



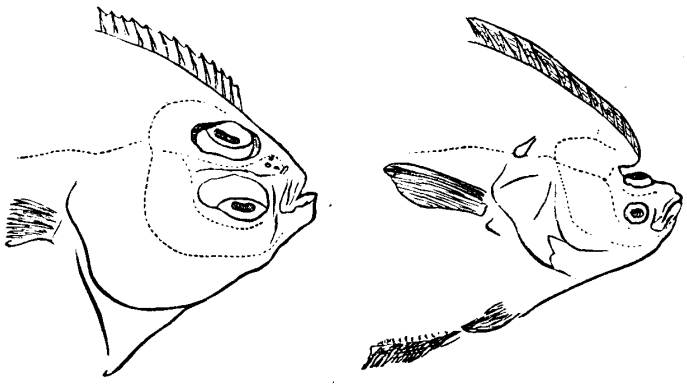
THE WALKING-LEAF INSECT.

Mr. Darwin explains the imitation of some species by others more or less nearly allied to it, by the common origin of both the mimic and the mimicked species, and the consequent possession by both (according to the theory of "Pangenesis") of gemmules tending to reproduce ancestral characters, which characters the mimic must be assumed first to have lost and then to have [35] recovered. Mr. Darwin says,[29] "Varieties of one species frequently mimic distinct species, a fact in perfect harmony with the foregoing cases, and explicable *only on the theory of descent*." But this at the best is but a partial and very incomplete explanation. It is one, moreover, which Mr. Wallace does not accept.[30] It is very incomplete, because it has no bearing on some of the most striking cases, and of course Mr. Darwin does not pretend that it has. We should have to go back far indeed to reach the common ancestor of the mimicking walking-leaf insect and the real [36] leaf it mimics, or the original progenitor of both the bamboo insect and the bamboo itself. As these last most remarkable cases have certainly nothing to do with heredity,[31] it is unwarrantable to make use of that explanation for other protective resemblances, seeing that its inapplicability, in certain instances, is so manifest.

Again, at the other end of the process it is as difficult to account for the last touches of perfection in the mimicry. Some insects which imitate leaves extend the imitation even to the very injuries on those leaves made by the attacks of insects or of fungi. Thus, speaking of one of the walking-stick insects, Mr. Wallace says:[32] "One of these creatures obtained by myself in Borneo (*Ceroxylus laceratus*) was covered over with foliaceous excrescences of a clear olive-green colour, so as exactly to resemble a stick grown over by a creeping moss or jungermannia. The Dyak who brought it me assured me it was grown over with moss although alive, and it was only after a most minute examination that I could convince myself it was not so." Again, as to the leaf butterfly, he says:[33] "We come to a still more extraordinary part of the imitation, for we find representations of leaves in every stage of decay, variously blotched, and mildewed, and pierced with holes, and in many cases irregularly covered with powdery black dots, gathered into patches and spots, so closely resembling the various kinds of minute fungi that grow on

dead leaves, that it is impossible to avoid thinking at first sight that the butterflies themselves have been attacked by real fungi."

Here imitation has attained a development which seems utterly beyond the power of the mere "survival of the fittest" to produce. How this double mimicry can importantly aid in the struggle for life seems puzzling indeed, but much more so how the first faint beginnings of the imitation [37] of such injuries in the leaf can be developed in the animal into such a complete representation of them—*a fortiori* how simultaneous and similar first beginnings of imitations of such injuries could ever have been developed in several individuals, out of utterly indifferent and indeterminate infinitesimal variations in all conceivable directions.



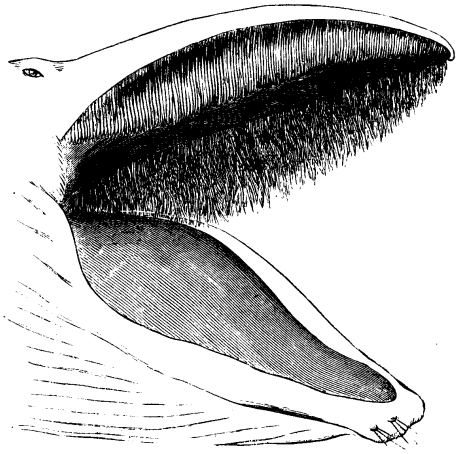
PLEURONECTIDÆ, WITH THE PECULIARLY PLACED EYE IN DIFFERENT POSITIONS.
(*From Dr. Traquair's paper in the "Transactions of the Linnean Society, 1865."*)

Another instance which may be cited is the asymmetrical condition of the heads of the flat-fishes (Pleuronectidæ), such as the sole, the flounder, the brill, the turbot, &c. In all these fishes the two eyes, which in the young are situated as usual one on each side, come to be placed, in the adult, both on the same side of the head. If this condition had appeared at once, if in the hypothetically fortunate common ancestor of these fishes an eye had suddenly become thus transferred, then the perpetuation of such a transformation by the action of "Natural Selection" is conceivable enough. Such sudden changes, however, are not those favoured by the Darwinian theory, and indeed the accidental occurrence of such a spontaneous transformation is hardly conceivable. But if this is not so, if the transit was gradual, then how such transit of one eye a [38] minute fraction of the journey towards the other side of the head could benefit the individual is indeed far from clear. It seems, even, that such an incipient transformation must rather have been injurious. Another point with regard to these flat-fishes is that they appear to be in all probability of recent origin—*i.e.* geologically speaking. There is, of course, no great stress to be laid on the mere absence of their remains from the secondary strata, nevertheless that absence is noteworthy, seeing that existing fish families, *e.g.* sharks (Squalidæ), have been found abundantly even down so far as the carboniferous rocks, and traces of them in the Upper Silurian.

Another difficulty seems to be the first formation of the limbs of the higher animals. The lowest Vertebrata[34] are perfectly limbless, and if, as most Darwinians would probably assume, the primeval vertebrate creature was also apodal, how are the preservation and development of the first rudiments of limbs to be accounted for—such rudiments being, on the hypothesis in question, infinitesimal and functionless?

In reply to this it has been suggested that a mere flattening of the end of the body has been useful, such, *e.g.*, as we see in sea-snakes,[35] which may be the rudiment of a tail formed strictly to aid in swimming. Also that a mere *roughness* of the skin might be useful to a swimming animal by holding the water better, that thus minute processes might be selected and preserved, and that, in the same way, these might be gradually increased into limbs. But it is, to

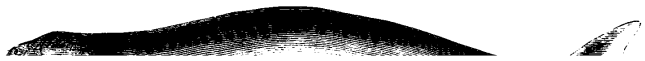
say the least, very questionable whether a roughness of the skin, or minute processes, would be useful to a swimming animal; the motion of which they would as much impede as aid, unless [39] they were at once capable of a suitable and appropriate action, which is against the hypothesis. Again, the change from mere indefinite and accidental processes to two regular pairs of symmetrical limbs, as the result of merely fortuitous, favouring variations, is a step the feasibility of which hardly commends itself to the reason, seeing the very different positions assumed by the ventral fins in different fishes. If the above suggestion made in opposition to the views here asserted be true, then the general constancy of position of the limbs of vertebrata may be considered as due to the position assumed by the primitive rugosities from which those limbs were generated. Clearly only two pairs of rugosities were so preserved and developed, and all limbs (on this view) are descendants of the same two pairs, as all have so similar a fundamental structure. Yet we find in many fishes the pair of fins, which correspond to the hinder limbs of other animals, placed so far forwards as to be either on the same level with, or actually in front of, the normally anterior pair of limbs; and such fishes are from this circumstance called "thoracic," or "jugular" fishes respectively, as the weaver fishes and the cod. This is a wonderful contrast to the fixity of position of vertebrate limbs generally. If then such a change can have taken place in the comparatively short time occupied by the evolution of these special fish forms, we might certainly expect other and far more bizarre structures would (did not some law forbid) have been developed, from other rugosities, in the manifold exigencies of the multitudinous organisms which must (on the Darwinian hypothesis) have been gradually evolved during the enormous period intervening between the first appearance of vertebrate life and the present day. Yet, with these exceptions, the position of the limbs is constant from the lower fishes up to man, there being always an anterior pectoral pair placed in front of a posterior or pelvic pair when both are present, and in no single instance are there more [40] than these two pairs.



MOUTH OF A WHALE.

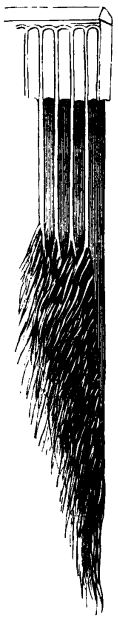
The development of whalebone (baleen) in the mouth of the whale is another difficulty. A whale's mouth is furnished with very numerous horny plates, which hang down from the palate along each side of the mouth. They thus form two longitudinal series, each plate of which is placed transversely to the long axis of the body, and all are very close together. On depressing the lower lip the free outer edges of these plates come into view. Their inner edges are furnished with numerous coarse hair-like processes, consisting of some of the constituent fibres of the horny plates—which, as it were, fray out—and the mouth is thus lined, except below, by a network of countless fibres formed by the inner edges of the two series of plates. This network [41] acts as a sort of sieve. When the whale feeds it takes into its mouth a great gulp of water, which it drives out again through the intervals of the horny plates of baleen, the fluid thus traversing the sieve of horny fibres, which retains the minute creatures on which these marine monsters subsist. Now it is obvious, that if this baleen had once attained such a size and development as to be at all useful, then its preservation and augmentation within serviceable limits, would be promoted by "Natural Selection" alone. But how to obtain the beginning of such useful

development? There are indeed certain animals of exclusively aquatic habits (the dugong and manatee) which also possess more or less horn on the palate, and at first sight this might be taken as a mitigation of the difficulty; but it is not so, and the fact does not help us one step further along the road: for, in the first place, these latter animals differ so importantly in structure from whales and porpoises that they form an altogether distinct order, and cannot be thought to approximate to the whale's progenitors. They are vegetarians, the whales feed on animals; the former never have the ribs articulated in the mode in which they are in some of the latter; the former have pectoral mammæ, and the latter are provided with two inguinal [42] mammary glands, and have the nostrils enlarged into blowers, which the former have not. The former thus constitute the order Sirenia, while the latter belong to the Cetacea. In the second place, the horny matter on the palates of the dugong and manatee has not, even initially, that "strainer" action, which is the characteristic function of the Cetacean "baleen."



DUGONG.

There is another very curious structure, the origin or the disappearance of which it seems impossible to account for on the hypothesis of minute indefinite variations. It is that of the mouth of the young kangaroo. In all mammals, as in ourselves, the air-passage from the lungs opens in the floor of the mouth behind the tongue, and in front of the opening of the gullet, so that each particle of food as it is swallowed passes over the opening, but is prevented from falling into it (and thus causing death from choking) by the action of a small cartilaginous shield (the epiglottis), which at the right moment bends back and protects the orifice. Now the kangaroo is born in such an exceedingly imperfect and undeveloped condition, that it is quite unable to suck. The mother therefore places the minute blind and naked young upon the nipple, and then injects milk into it by means of a special muscular envelope of the mammary gland. Did no special provision exist, the young one must infallibly be choked by the intrusion of the milk into the windpipe. But there *is* a special provision. The larynx is so elongated that it rises up into the posterior end of the nasal passage, and is thus enabled to give free entrance to the air for the lungs, while the milk passes harmlessly on each side of this elongated larynx, and so safely attains the gullet behind it.



FOUR PLATES OF BALEEN SEEN OBLIQUELY FROM WITHIN.

Now, on the Darwinian hypothesis, either all mammals descended from marsupial progenitors, or else the marsupials, sprung from animals having in most respects the ordinary mammalian structure. [43]

On the first alternative, how did "Natural Selection" remove this (at least perfectly innocent and harmless) structure in almost all other mammals, and, having done so, again reproduce it in precisely those forms which alone require it, namely, the Cetacea? That such a harmless structure *need not* be removed any Darwinian must confess, since a structure exists in both the crocodiles and gavials, which enables the former to breathe themselves while drowning the prey which they hold in their mouths. On Mr. Darwin's hypothesis it could only have been developed where useful, therefore not in the gavials(!) which feed on fish, but which yet retain, as we might expect, this, in them superfluous but harmless formation.

On the second alternative, how did the elongated larynx itself arise, seeing that if its development lagged behind that of the maternal structure, the young primeval kangaroo must be choked: while without the injecting power in the mother, it must be starved? The struggle by the sole action of which such a form was developed must indeed have been severe!

AN ECHINUS, OR SEA-URCHIN
(The spines removed from one-half.)

The sea-urchins (Echinus) present us also with structures the origin of which it seems impossible to explain by the action of "Natural Selection" only. These lowly animals belong to [44] that group of the star-fish class (Echinodermata), the species of which possess generally spheroidal bodies, built up of multitudinous calcareous plates, and constitute the order Echinoidea. They are also popularly known as sea-eggs. Utterly devoid of limbs, the locomotion of these creatures is effected by means of rows of small tubular suckers (which protrude through pores in the calcareous plates) and by moveable spines scattered over the body.

PEDICELLARIÆ.
(Immensely enlarged.)

Besides these spines and suckers there are certain very peculiar structures, termed "Pedicellariæ." Each of these consists of a long slender stalk, ending in three short limbs—or rather jaws—the whole supported by a delicate internal skeleton. The three limbs (or jaws), which start from a common point at the end of the stalk, are in the constant habit of opening and closing together again with a snapping action, while the stalk itself sways about. The utility of these appendages is, even now, problematical. It may be that they remove from the surface of the animal's body foreign substances which would be prejudicial to it, and which it cannot otherwise get rid of. But granting this, what would be the utility of the *first rudimentary beginnings* of such structures, and how could such incipient buddings have ever preserved the life of a single Echinus? It is true that on Darwinian principles the ancestral form from which the sea-urchin developed was different, and must not be conceived merely as an Echinus devoid of pedicellariæ; but this makes the difficulty none the less. It is equally hard to imagine that the first rudiments of such structures could have been useful to *any* animal from which the Echinus [45] might have been derived. Moreover, not even the *sudden* development of the snapping action could have been beneficial without the freely moveable stalk, nor could the latter have been efficient without the snapping jaws, yet no minute merely indefinite variations could simultaneously evolve these complex co-ordinations of structure; to deny this seems to do no less than to affirm a startling paradox.

Mr. Darwin explains the appearance of some structures, the utility of which is not apparent, by the existence of certain "laws of correlation." By these he means that certain parts or organs of the body are so related to other organs or parts, that when the first are modified by the action of "Natural Selection," or what not, the second are simultaneously affected, and increase proportionally or possibly so decrease. Examples of such are the hair and teeth in the naked Turkish dog, the general deafness of white cats with blue eyes, the relation between the presence of more or less down on young birds when first hatched, and the future colour of their plumage,[36] with many others. But the idea that the modification of any internal or external part of the body of an Echinus carries with it the effect of producing elongated, flexible, triradiate, snapping processes, is, to say the very least, fully as obscure and mysterious as what is here contended for, viz. the efficient presence of an unknown internal natural law or laws conditioning the evolution of new specific forms from preceding ones, modified by the action of surrounding conditions, by "Natural Selection" and by other controlling influences.

The same difficulty seems to present itself in other examples of exceptional structure and action. In the same Echinus, as in many allied forms, and also in some more or less remote ones, a very peculiar mode of development exists. The adult is not formed from the egg directly, but [46] the egg gives rise to a creature which swims freely about, feeds, and is even somewhat complexly organized. Soon a small lump appears on one side of its stomach; this enlarges, and, having established a communication with the exterior, envelopes and appropriates the creature's stomach, with which it swims away and develops into the complete adult form, while the dispossessed individual perishes.

Again, certain flies present a mode of development equally bizarre, though quite different. In these flies, the grub is, as usual, produced from the ovum, but this grub, instead of growing up

into the adult in the ordinary way, undergoes a sort of liquefaction of a great part of its body, while certain patches of formative tissue, which are attached to the ramifying air tubes, or tracheæ (and which patches bear the name of "imaginal disks"), give rise to the legs, wings, eyes, &c., respectively; and these severally formed parts grow together, and build up the head and body by their mutual approximation. Such a process is unknown outside the class of insects, and inside that class it is only known in a few of the two-winged flies. Now, how "Natural Selection," or any "laws of correlation," can account for the gradual development of such an exceptional process of development—so extremely divergent from that of other insects—seems nothing less than inconceivable. Mr. Darwin himself[37] gives an account of a very peculiar and abnormal mode of development of a certain beetle, the sitaris, as described by M. Fabre. This insect, instead of at first appearing in its grub stage, and then, after a time, putting on the adult form, is at first active and furnished with six legs, two long antennæ, and four eyes. Hatched in the nests of bees, it at first attaches itself to one of the males, and then crawls, when the opportunity offers, upon a female bee. When the female bee lays her eggs, the young sitaris springs upon them and devours them. Then, losing its eyes, legs, and antennæ, and becoming [47] rudimentary, it sinks into an ordinary grub-like form, and feeds on honey, ultimately undergoing another transformation, re-acquiring its legs, &c., and emerging a perfect beetle! That such a process should have arisen by the accumulation of minute accidental variations in structure and habit, appears to many minds, quite competent to form an opinion on the subject, absolutely incredible.

It may be objected, perhaps, that these difficulties are *difficulties of ignorance*—that we cannot explain them because we do not know *enough* of the animals. But it is here contended that this is not the case; it is not that we merely fail to see how Natural Selection acted, but that there is a positive incompatibility between the cause assigned and the results. It will be stated shortly what wonderful instances of co-ordination and of unexpected utility Mr. Darwin has discovered in orchids. The discoveries are not disputed or undervalued, but the explanation of their *origin* is deemed thoroughly unsatisfactory—utterly insufficient to explain the incipient, infinitesimal beginnings of structures which are of utility only when they are considerably developed.

Let us consider the mammary gland, or breast. Is it conceivable that the young of any animal was ever saved from destruction by accidentally sucking a drop of scarcely nutritious fluid from an accidentally hypertrophied cutaneous gland of its mother? And even if one was so, what chance was there of the perpetuation of such a variation? On the hypothesis of Natural Selection itself, we must assume that up to that time the race had been well adapted to the surrounding conditions; the temporary and accidental trial and change of conditions, which caused the so-sucking young one to be the "fittest to survive" under the supposed circumstances, would soon cease to act, and then the progeny of the mother, with the accidentally hypertrophied, sebaceous glands, would have no tendency to survive the far outnumbering descendants of the normal [48] ancestral form. If, on the other hand, we assume the change of conditions not to have been temporary but permanent, and also assume that this permanent change of conditions was accidentally synchronous with the change of structure, we have a coincidence of very remote probability indeed. But if, again, we accept the presence of some harmonizing law simultaneously determining the two changes, or connecting the second with the first by causation, then, of course, we remove the accidental character of the coincidence.

Again, how explain the external position of the male sexual glands in certain mammals? The utility of the modification, when accomplished, is problematical enough, and no less so the incipient stages of the descent.

As was said in the first chapter, Mr. Darwin explains the brilliant plumage of the peacock or the humming-bird by the action of sexual selection: the more and more brilliant males being selected by the females (which are thus attracted) to become the fathers of the next generation, to which generation they tend to communicate their own bright nuptial vesture. But there are peculiarities of colour and of form which it is exceedingly difficult to account for by any such action. Thus, amongst apes, the female is notoriously weaker, and is armed with much less powerful canine tusks than the male. When we consider what is known of the emotional nature

of these animals, and the periodicity of its intensification, it is hardly credible that a female would often risk life or limb through her admiration of a trifling shade of colour, or an infinitesimally greater though irresistibly fascinating degree of wartiness.[38]

[49]

RATTLESNAKE.

Yet the males of some kinds of ape are adorned with quite exceptionally brilliant local decoration, and the male orang is provided with remarkable, projecting, warty lumps of skin upon the cheeks. As we have said, the weaker female can hardly be supposed to have developed these by persevering and long-continued selection, nor can they be thought to tend to the preservation of the individual. On the contrary, the presence of this enlarged appendage must occasion a slight increase in the need of nutriment, and in so far must be a detriment, although its detrimental effect would not be worth speaking of except in relation to "Darwinism," according to which, "selection" has acted through unimaginable ages, and has ever tended to [50] suppress any useless development by the struggle for life.[39]

COBRA.
(*Copied, by permission, from Sir Andrew Smith's "Reptiles of South Africa."*)

In poisonous serpents, also, we have structures which, at all events at first sight, seem positively hurtful to those reptiles. Such are the rattle of the rattlesnake, and the expanding neck of the cobra, the former seeming to warn the ear of the intended victim, as the latter warns the eye. It is true we cannot perhaps demonstrate that the victims are alarmed and warned, but, on Darwinian principles, they certainly ought to be so. For the rashest and most incautious of the [51] animals preyed on would always tend to fall victims, and the existing individuals being the long-descended progeny of the timid and cautious, ought to have an inherited tendency to distrust, amongst other things, both "rattling" and "expanding" snakes. As to any power of fascination exercised by means of these actions, the most distinguished naturalists, certainly the most distinguished erpetologists, entirely deny it, and it is opposed to the careful observations of those known to us.[40]

The mode of formation of both the eye and the ear of the highest animals is such that, if it is (as most Darwinians assert processes of development to be) a record of the actual steps by which such structures were first evolved in antecedent forms, it almost amounts to a demonstration that those steps were never produced by "Natural Selection."

The eye is formed by a simultaneous and corresponding ingrowth of one part and outgrowth of another. The skin in front of the future eye becomes depressed, the depression increases and assumes the form of a sac, which changes into the aqueous humour and lens. An outgrowth of brain substance, on the other hand, forms the retina, while a third process is a lateral ingrowth of connective tissue, which afterwards changes into the vitreous humour of the eye.

The internal ear is formed by an involution of the integument, and not by an outgrowth of the brain. But tissue, in connexion with it, becomes in part changed, thus forming the auditory nerve, which places the tegumentary sac in direct communication with the brain itself.

Now, these complex and simultaneous co-ordinations could never have been produced by [52] infinitesimal beginnings, since, until so far developed as to effect the requisite junctions, they are useless. But the eye and ear when fully developed present conditions which are hopelessly difficult to reconcile with the mere action of "Natural Selection." The difficulties with regard to the eye have been well put by Mr. Murphy, especially that of the concordant result of visual development springing from different starting-points and continued on by independent roads.

He says,[41] speaking of the beautiful structure of the perfect eye, "The higher the organization, whether of an entire organism or of a single organ, the greater is the number of the parts that co-operate, and the more perfect is their co-operation; and consequently, the more necessity there is for corresponding variations to take place in all the co-operating parts at once, and the more useless will be any variation whatever unless it is accompanied by corresponding variations in the co-operating parts; while it is obvious that the greater the number of variations which are needed in order to effect an improvement, the less will be the probability of their all occurring at once. It is no reply to this to say, what is no doubt abstractedly true, that whatever is possible becomes probable, if only time enough be allowed. There are improbabilities so great that the common sense of mankind treats them as impossibilities. It is not, for instance, in the strictest sense of the word, impossible that a poem and a mathematical proposition should be obtained by the process of shaking letters out of a box; but it is improbable to a degree that cannot be distinguished from impossibility; and the improbability of obtaining an improvement in an organ by means of several spontaneous variations, all occurring together, is an improbability of the same kind. If we suppose that any single variation occurs on the average once in *m* times, [53] the probability of that variation occurring in any individual will be

$$\frac{1}{m};$$

and suppose that *x* variations must concur in order to make an improvement, then the probability of the necessary variations all occurring together will be

$$\frac{1}{m^x}.$$

Now suppose, what I think a moderate proposition, that the value of *m* is 1,000, and the value of *x* is 10, then

$$\frac{1}{m^x} = \frac{1}{1000^{10}} = \frac{1}{10^{30}}.$$

A number about ten thousand times as great as the number of waves of light that have fallen on the earth since historical time began. And it is to be further observed, that no improvement will give its possessor a *certainty* of surviving and leaving offspring, but only an *extra chance*, the value of which it is quite impossible to estimate." This difficulty is, as Mr. Murphy points out, greatly intensified by the undoubted fact that the wonderfully complex structure has been arrived at quite independently in beasts on the one hand and in cuttle-fishes on the other; while creatures of the insect and crab division present us with a third and quite separately developed complexity.

As to the ear, it would take up too much space to describe its internal structure;[42] it must suffice to say that in its interior there is an immense series of minute rod-like bodies, termed *fibres of Corti*, having the appearance of a key-board, and each fibre being connected with a filament of the auditory nerve, these nerves being like strings to be struck by the keys, *i.e.* by the fibres of Corti. Moreover, this apparatus is supposed to be a key-board in function as well as [54] in appearance, the vibration of each one fibre giving rise, it is believed, to the sensation of one particular tone, and combinations of such vibrations producing chords. It is by the action of this complex organ then, that all the wonderful intricacy and beauty of Beethoven and Mozart come, most probably, to be perceived and appreciated.

Now it can hardly be contended that the preservation of any race of men in the struggle for life ever depended on such an extreme delicacy and refinement of the internal ear,—a perfection only exercised in the enjoyment and appreciation of the most perfect musical performances.

How, then, could either the minute incipient stages, or the final perfecting touches of this admirable structure, have been brought about by vague, aimless, and indefinite variations in all conceivable directions of an organ, suitable to enable the rudest savage to minister to his necessities, but no more?

Mr. Wallace[43] makes an analogous remark with regard to the organ of voice in man—the human larynx. He says of singing: "The habits of savages give no indication of how this faculty could have been developed by Natural Selection, because it is never required or used by them. The singing of savages is a more or less monotonous howling, and the females seldom sing at all. Savages certainly never choose their wives for fine voices, but for rude health, and strength, and physical beauty. Sexual selection could not therefore have developed this wonderful power, which only comes into play among civilized people."

Reverting once more to beauty of form and colour, there is one manifestation of it for which no one can pretend that sexual selection can possibly account. The instance referred to is that presented by bivalve shell-fish.[44] Here we meet with charming tints and elegant forms and markings of no direct use to their possessors[45] in the struggle for life, and of no indirect utility [55] as regards sexual selection, for fertilization takes place by the mere action of currents of water, and the least beautiful individual has fully as good a chance of becoming a parent as has the one which is the most favoured in beauty of form and colour.

Again, the peculiar outline and coloration of certain orchids—notably of our own bee, fly, and spider orchids—seem hardly explicable by any action of "Natural Selection." Mr. Darwin says very little on this singular resemblance of flowers to insects, and what he does say seems hardly to be what an advocate of "Natural Selection" would require. Surely, for minute accidental indefinite variations to have built up such a striking resemblance to insects, we ought to find that the preservation of the plant, or the perpetuation of its race, depends almost constantly on relations between bees, spiders, and flies respectively and the bee, spider, and fly orchids.[46] This process must have continued for ages constantly and perseveringly, and yet what is the fact? Mr. Darwin tells us, in his work on the Fertilization of Orchids, that neither the spider nor the fly orchids are much visited by insects, while, with regard to the bee orchid, he says, "I have never seen an insect visit these flowers." And he shows how this species is even wonderfully and specially modified to effect self-fertilization.

In the work just referred to Mr. Darwin gives a series of the most wonderful and minute contrivances by which the visits of insects are utilized for the fertilization of orchids,—structures so wonderful that nothing could well be more so, except the attribution of their origin [56] to minute, fortuitous, and indefinite variation.

The instances are too numerous and too long to quote, but in his "Origin of Species"[47] he describes two which must not be passed over. In one (*Coryanthes*) the orchid has its lower lip enlarged into a bucket, above which stand two water-secreting horns. These latter replenish the bucket from which, when half-filled, the water overflows by a spout on one side. Bees visiting the flower fall into the bucket and crawl out at the spout. By the peculiar arrangement of the parts of the flower, the first bee which does so carries away the pollen-mass glued to his back, and then when he has his next involuntary bath in another flower, as he crawls out the pollen-mass attached to him comes in contact with the stigma of that second flower and fertilizes it. In the other example (*Catasetum*), when a bee gnaws a certain part of the flower, he inevitably touches a long delicate projection, which Mr. Darwin calls the antenna. "This antenna transmits a vibration to a certain membrane, which is instantly ruptured; this sets free a spring by which the pollen-mass is shot forth like an arrow in the right direction, and adheres by its viscid extremity to the back of the bee!"

Another difficulty, and one of some importance, is presented by those communities of ants which have not only a population of sterile females, or workers, but two distinct and very different castes of such. Mr. Darwin believes that he has got over this difficulty by having found individuals intermediate in form and structure[48] between the two working castes; others may

think that we have in this belief of Mr. Darwin, an example of the unconscious action of volition upon credence. A vast number of difficulties similar to those which have been mentioned might easily be cited—those given, however, may suffice. [57]

There remains, however, to be noticed a very important consideration, which was brought forward in the *North British Review* for June 1867, p. 286, namely, the necessity for the simultaneous modification of *many individuals*. This consideration seems to have escaped Mr. Darwin, for at p. 104 of his last (fifth) edition of "Natural Selection," he admits, with great candour, that until reading this article he did not "appreciate how rarely single variations, whether slight or strongly marked, could be perpetuated."

The *North British Review* (speaking of the supposition that a species is changed by the survival of a few individuals in a century through a similar and favourable variation) says: "It is very difficult to see how this can be accomplished, even when the variation is eminently favourable indeed; and still more difficult when the advantage gained is very slight, as must generally be the case. The advantage, whatever it may be, is utterly outbalanced by numerical inferiority. A million creatures are born; ten thousand survive to produce offspring. One of the million has twice as good a chance as any other of surviving; but the chances are fifty to one against the gifted individuals being one of the hundred survivors. No doubt the chances are twice as great against any one other individual, but this does not prevent their being enormously in favour of *some* average individual. However slight the advantage may be, if it is shared by half the individuals produced, it will probably be present in at least fifty-one of the survivors, and in a larger proportion of their offspring; but the chances are against the preservation of any one 'sport' (*i.e.* sudden, marked variation) in a numerous tribe. The vague use of an imperfectly understood doctrine of chance has led Darwinian supporters, first, to confuse the two cases [58] above distinguished; and, secondly, to imagine that a very slight balance in favour of some individual sport must lead to its perpetuation. All that can be said is that in the above example the favoured sport would be preserved once in fifty times. Let us consider what will be its influence on the main stock when preserved. It will breed and have a progeny of say 100; now this progeny will, on the whole, be intermediate between the average individual and the sport. The odds in favour of one of this generation of the new breed will be, say one and a half to one, as compared with the average individual; the odds in their favour will, therefore, be less than that of their parents; but owing to their greater number, the chances are that about one and a half of them would survive. Unless these breed together, a most improbable event, their progeny would again approach the average individual; there would be 150 of them, and their superiority would be, say in the ratio of one and a quarter to one; the probability would now be that nearly two of them would survive, and have 200 children, with an eighth superiority. Rather more than two of these would survive; but the superiority would again dwindle, until after a few generations it would no longer be observed, and would count for no more in the struggle for life than any of the hundred trifling advantages which occur in the ordinary organs. An illustration will bring this conception home. Suppose a white man to have been wrecked on an island inhabited by negroes, and to have established himself in friendly relations with a powerful tribe, whose customs he has learnt. Suppose him to possess the physical strength, energy, and ability of a dominant white race, and let the food and climate of the island suit his constitution; grant him every advantage which we can conceive a white to possess over the native; concede that in the struggle for existence his chance of a long life will be much superior to that of the native chiefs; yet from all these admissions, there does not follow the conclusion that, after a limited or [59] unlimited number of generations, the inhabitants of the island will be white. Our shipwrecked hero would probably become king; he would kill a great many blacks in the struggle for existence; he would have a great many wives and children." ... "In the first generation there will be some dozens of intelligent young mulattoes, much superior in average intelligence to the negroes. We might expect the throne for some generations to be occupied by a more or less yellow king; but can any one believe that the whole island will gradually acquire a white, or even a yellow, population?"

"Darwin says that in the struggle for life a grain may turn the balance in favour of a given structure, which will then be preserved. But one of the weights in the scale of nature is due to

the number of a given tribe. Let there be 7000 A's and 7000 B's, representing two varieties of a given animal, and let all the B's, in virtue of a slight difference of structure, have the better chance of life by 1/7000 part. We must allow that there is a slight probability that the descendants of B will supplant the descendants of A; but let there be only 7001 A's against 7000 B's at first, and the chances are once more equal, while if there be 7002 A's to start, the odds would be laid on the A's. True, they stand a greater chance of being killed; but then they can better afford to be killed. The grain will only turn the scales when these are very nicely balanced, and an advantage in numbers counts for weight, even as an advantage in structure. As the numbers of the favoured variety diminish, so must its relative advantages increase, if the chance of its existence is to surpass the chance of its extinction, until hardly any conceivable advantage would enable the descendants of a single pair to exterminate the descendants of many thousands if they and their descendants are supposed to breed freely with the inferior variety, and so gradually lose their ascendency."

Mr. Darwin himself says of the article quoted: "The justice of these remarks cannot, I think, be disputed. If, for instance, a bird of some kind could procure its food more easily by having its [60] beak curved, and if one were born with its beak strongly curved, and which consequently flourished, nevertheless there would be a very poor chance of this one individual perpetuating its kind to the exclusion of the common form." This admission seems almost to amount to a change of front in the face of the enemy!

These remarks have been quoted at length because they so greatly intensify the difficulties brought forward in this chapter. If the most favourable variations have to contend with such difficulties, what must be thought as to the chance of preservation of the slightly displaced eye in a sole or of the incipient development of baleen in a whale?

SUMMARY AND CONCLUSION.

It has been here contended that a certain few facts, out of many which might have been brought forward, are inconsistent with the origination of species by "Natural Selection" only or mainly.

Mr. Darwin's theory requires minute, indefinite, fortuitous variations of all parts in all directions, and he insists that the sole operation of "Natural Selection" upon such is sufficient to account for the great majority of organic forms, with their most complicated structures, intricate mutual adaptations and delicate adjustments.

To this conception has been opposed the difficulties presented by such a structure as the form of the giraffe, which ought not to have been the solitary structure it is; also the minute beginnings and the last refinements of protective mimicry equally difficult or rather impossible to account for by "Natural Selection." Again the difficulty as to the heads of flat-fishes has been insisted on, as also the origin, and at the same time the constancy, of the limbs of the highest animals. Reference has also been made to the whalebone of whales, and to the impossibility of [61] understanding its origin through "Natural Selection" only; the same as regards the infant kangaroo, with its singular deficiency of power compensated for by maternal structures on the one hand, to which its own breathing organs bear direct relation on the other. Again, the delicate and complex pedicellariæ of Echinoderms, with a certain process of development (through a secondary larva) found in that class, together with certain other exceptional modes of development, have been brought forward. The development of colour in certain apes, the hood of the cobra, and the rattle of the rattlesnake have also been cited. Again, difficulties as to the process of formation of the eye and ear, and as to the fully developed condition of those complex organs, as well as of the voice, have been considered. The beauty of certain shell-fish; the wonderful adaptations of structure, and variety of form and resemblance, found in orchids; together with the complex habits and social conditions of certain ants, have been hastily passed in review. When all these complications are duly weighed and considered, and when it is borne in mind how necessary it is for the permanence of a new variety that many individuals in each case should be simultaneously modified, the cumulative argument seems irresistible.

The Author of this book can say that though by no means disposed originally to dissent from the theory of "Natural Selection," if only its difficulties could be solved, he has found each successive year that deeper consideration and more careful examination have more and more brought home to him the inadequacy of Mr. Darwin's theory to account for the preservation and intensification of incipient, specific, and generic characters. That minute, fortuitous, and indefinite variations could have brought about such special forms and modifications as have been enumerated in this chapter, seems to contradict not imagination, but reason. [62]

That either many individuals amongst a species of butterfly should be simultaneously preserved through a similar accidental and minute variation in one definite direction, when variations in many other directions would also preserve; or that one or two so varying should succeed in supplanting the progeny of thousands of other individuals, and that this should by no other cause be carried so far as to produce the appearance (as we have before stated) of spots of fungi, &c.—are alternatives of an improbability so extreme as to be practically equal to impossibility.

In spite of all the resources of a fertile imagination, the Darwinian, pure and simple, is reduced to the assertion of a paradox as great as any he opposes. In the place of a mere assertion of our ignorance as to the way these phenomena have been produced, he brings forward, as their explanation, a cause which it is contended in this work is demonstrably insufficient.

Of course in this matter, as elsewhere throughout nature, we have to do with the operation of fixed and constant natural laws, and the knowledge of these may before long be obtained by human patience or human genius; but there is, it is believed, already enough evidence to show that these as yet unknown natural laws or law will never be resolved into the action of "Natural Selection," but will constitute or exemplify a mode and condition of organic action of which the Darwinian theory takes no account whatsoever. [63]

CHAPTER III.

THE CO-EXISTENCE OF CLOSELY SIMILAR STRUCTURES OF DIVERSE ORIGIN.

> Chances against concordant variations.—Examples of discordant ones.—Concordant variations not unlikely on a non-Darwinian evolutionary hypothesis.—Placental and implacental mammals.—Birds and reptiles.—Independent origins of similar sense organs.—The ear.—The eye.—Other coincidences.—Causes besides Natural Selection produce concordant variations in certain geographical regions.—Causes besides Natural Selection produce concordant variations in certain zoological and botanical groups.—There are homologous parts not genetically related.—Harmony in respect of the organic and inorganic worlds.—Summary and conclusion.

The theory of "Natural Selection" supposes that the varied forms and structure of animals and plants have been built up merely by indefinite, fortuitous,[49] minute variations in every part and in all directions—those variations only being preserved which are directly or indirectly useful to the individual possessing them, or necessarily correlated with such useful variations.

WINGBONES OF PTERODACTYLE, BAT, AND BIRD.
(*Copied, by permission, from Mr. Andrew Murray's "Geographical Distribution of Mammals."*)

On this theory the chances are almost infinitely great against the independent, accidental occurrence and preservation of two similar series of minute variations resulting in the independent development of two closely similar forms. In all cases, no doubt (on this same theory), *some* adaptation to habit or need would gradually be evolved, but that adaptation would [64] surely be arrived at by different roads. The organic world supplies us with multitudes of examples of similar functional results being attained by the most diverse means. Thus the body

is sustained in the air by birds and by bats. In the first case it is so sustained by a limb in which the bones of the hand are excessively reduced, but which is provided with immense outgrowths from the skin—namely, the feathers of the wing. In the second case, however, the body is sustained in the air by a limb in which the bones of the hand are enormously increased in length, and so sustain a great expanse of naked skin, which is the flying membrane of the bat's wing. Certain fishes and certain reptiles can also flit and take very prolonged jumps in the air. The flying-fish, however, takes these by means of a great elongation of the rays of the pectoral fins —parts which cannot be said to be of the same nature as the constituents of the wing of either the bat or the bird. The little lizard, which enjoys the formidable name of "flying-dragon," flits by means of a structure altogether peculiar—namely, by the liberation and great elongation of some of the ribs which support a fold of skin. In the extinct pterodactyles—which were *truly* [65] flying reptiles—we meet with an approximation to the structure of the bat, but in the pterodactyle we have only one finger elongated in each hand: a striking example of how the very same function may be provided for by a modification similar in principle, yet surely manifesting the independence of its origin. When we go to lower animals, we find flight produced by organs, as the wings of insects, which are not even modified limbs at all; or we find even the function sometimes subserved by quite artificial means, as in the aërial spiders, which use their own threads to float with in the air. In the vegetable kingdom the atmosphere is often made use of for the scattering of seeds, by their being furnished with special structures of very different kinds. The diverse modes by which such seeds are dispersed are well expressed by Mr. Darwin. He says:[50] "Seeds are disseminated by their minuteness,—by their capsule [66] being converted into a light balloon-like envelope,—by being embedded in pulp or flesh, formed of the most diverse parts, and rendered nutritious, as well as conspicuously coloured, so as to attract and be devoured by birds,—by having hooks and grapnels of many kinds and serrated awns, so as to adhere to the fur of quadrupeds,—and by being furnished with wings and plumes, as different in shape as elegant in structure, so as to be wafted by every breeze."

SKELETON OF THE FLYING-DRAGON.
(Showing the elongated ribs which support the flitting organ.)

Again, if we consider the poisoning apparatus possessed by different animals, we find in serpents a perforated—or rather very deeply channelled—tooth. In wasps and bees the sting is formed of modified parts, accessory in reproduction. In the scorpion, we have the median terminal process of the body specially organized. In the spider, we have a specially constructed antenna; and finally in the centipede a pair of modified thoracic limbs.

A CENTIPEDE.

It would be easy to produce a multitude of such instances of similar ends being attained by dissimilar means, and it is here contended that by "the action of Natural Selection" *only* it is so improbable as to be practically impossible for two exactly similar structures to have ever been independently developed. It is so because the number of possible variations is indefinitely great, [67] and it is therefore an indefinitely great number to one against a similar series of variations occurring and being similarly preserved in any two independent instances.

The difficulty here asserted applies, however, only to pure Darwinism, which makes use *only* of indirect modifications through the survival of the fittest.

Other theories (for example, that of Mr. Herbert Spencer) admit the *direct* action of conditions upon animals and plants—in ways not yet fully understood—there being conceived to be at the same time a certain peculiar but limited power of response and adaptation in each animal and plant so acted on. Such theories have not to contend against the difficulty proposed, and it is here urged that even very complex extremely similar structures have again and again been developed quite independently one of the other, and this because the process has taken place not

by merely haphazard, indefinite variations in all directions, but by the concurrence of some other and internal natural law or laws co-operating with external influences and with Natural Selection in the evolution of organic forms.

It must never be forgotten that to admit any such constant operation of any such unknown natural cause is to deny the purely Darwinian theory, which relies upon the survival of the fittest by means of minute fortuitous indefinite variations.

Amongst many other obligations which the Author has to acknowledge to Professor Huxley, are the pointing out of this very difficulty, and the calling his attention to the striking resemblance between certain teeth of the dog and of the thylacine as one instance, and certain ornithic peculiarities of pterodactyles as another.

[68] Mammals[51] are divisible into one great group, which comprises the immense majority of kinds termed, from their mode of reproduction, *placental Mammals*, and into another very much smaller group comprising the pouched-beasts or marsupials (which are the kangaroos, bandicoots, phalangers, &c., of Australia), and the true opossums of America, called *implacental Mammals*. Now the placental mammals are subdivided into various orders, amongst which are the flesh-eaters (Carnivora, *i.e.* cats, dogs, otters, weasels, &c.), and the insect-eaters (Insectivora, *i.e.* moles, hedgehogs, shrew-mice, &c.). The marsupial mammals also present a variety of forms (some of which are carnivorous beasts, whilst others are insectivorous), so marked that it has been even proposed to divide them into orders parallel to the orders of placental beasts.

The resemblance, indeed, is so striking as, on Darwinian principles, to suggest the probability of genetic affinity; and it even led Professor Huxley, in his Hunterian Lectures, in 1866, to promulgate the notion that a vast and widely-diffused marsupial fauna may have existed anteriorly to the development of the ordinary placental, non-pouched beasts, and that the carnivorous, insectivorous, and herbivorous placentals may have respectively descended from the carnivorous, insectivorous, and herbivorous marsupials.

TEETH OF UROTRICHUS AND PERAMELES.

[69] Amongst other points Professor Huxley called attention to the resemblance between the anterior molars of the placental dog with those of the marsupial thylacine. These, indeed, are strikingly similar, but there are better examples still of this sort of coincidence. Thus it has often been remarked that the insectivorous marsupials, *e.g. Perameles*, wonderfully correspond, as to the form of certain of the grinding teeth, with certain insectivorous placentals, *e.g. Urotrichus*.

Again, the saltatory insectivores of Africa (*Macroscelides*) not only resemble the kangaroo family (*Macropodidæ*) in their jumping habits and long hind legs, but also in the structure of their molar teeth, and even further, as I have elsewhere[52] pointed out, in a certain similarity of the upper cutting teeth, or incisors.

Now these correspondences are the more striking when we bear in mind that a similar dentition is often put to very different uses. The food of different kinds of apes is very different, yet how uniform is their dental structure! Again, who, looking at the teeth of different kinds of bears, would ever suspect that one kind was frugivorous, and another a devourer exclusively of animal food?

The suggestion made by Professor Huxley was therefore one which had much to recommend it to Darwinians, though it has not met with any notable acceptance, and though he seems himself to have returned to the older notion, namely, that the pouched-beasts, or marsupials, are a special ancient offshoot from the great mammalian class.

But whichever view may be the correct one, we have in either case a number of forms similarly modified in harmony with surrounding conditions, and eloquently proclaiming some natural plastic power, other than mere fortuitous variation with survival of the fittest. If, however, the Reader thinks that teeth are parts peculiarly qualified for rapid variation (in which view the Author cannot concur), he is requested to suspend his judgment till he has considered the question of the independent evolution of the *highest organs of sense*. If this seems to establish the existence of some other law than that of "Natural Selection," then the operation of that other law may surely be also traced in the harmonious co-ordinations of dental form. [70]

The other difficulty, kindly suggested to me by the learned Professor, refers to the structure of birds, and of extinct reptiles more or less related to them.

The class of birds is one which is remarkably uniform in its organization. So much is this the case, that the best mode of subdividing the class is a problem of the greatest difficulty. Existing birds, however, present forms which, though closely resembling in the greater part of their structure, yet differ importantly the one from the other. One form is exemplified by the ostrich, rhea, emeu, cassowary, apteryx, dinornis, &c. These are the *struthious* birds. All other existing birds belong to the second division, and are called (from the keel on the breast-bone) *carinate* birds.

Now birds and reptiles have such and so many points in common, that Darwinians must regard the former as modified descendants of ancient reptilian forms. But on Darwinian principles it is impossible that the class of birds so uniform and homogeneous should have had a double reptilian origin. If one set of birds sprang from one set of reptiles, and another set of birds from another set of reptiles, the two sets could never, by "Natural Selection" only, have grown into such a perfect similarity. To admit such a phenomenon would be equivalent to abandoning the theory of "Natural Selection" as the sole origin of species.

Now, until recently it has generally been supposed by evolutionists that those ancient flying reptiles, the pterodactyles, or forms allied to them, were the progenitors of the class of birds; and certain parts of their structure especially support this view. Allusion is here made to the bladebone (scapula), and the bone which passes down from the shoulder-joint to the breast-bone (viz. the coracoid). These bones are such remarkable anticipations of the same parts in ordinary (*i.e.* carinate) birds that it is hardly possible for a Darwinian not to regard the resemblance as due to community of origin. This resemblance was carefully pointed out by Professor Huxley in his "Hunterian Course" for 1867, when attention was called to the existence in *Dimorphodon macronyx* of even that small process which in birds gives attachment to the upper end of the merrythought. Also Mr. Seeley[53] has shown that in pterodactyles, as in birds, the optic lobes of the brain were placed low down on each side—"lateral and depressed." Nevertheless, the view has been put forward and ably maintained by the same Professor,[54] as also by Professor Cope in the United States, that the line of descent from reptiles to birds has not been from ordinary reptiles, through pterodactyle-like forms, to ordinary birds, but to the struthious ones from certain extinct reptiles termed Dinosauria; one of the most familiarly known of which is the Iguanodon of the Wealden formation. In these Dinosauria we find skeletal characters unlike those of ordinary (*i.e.* carinate) birds, but closely resembling in certain points the osseous structure of the struthious birds. Thus a difficulty presents itself as to the explanation of the three following relationships:—(1) That of the Pterodactyles with carinate birds; (2) that of the Dinosauria with struthious birds; (3) that of the carinate and struthious birds with each other. [71]

Either birds must have had two distinct origins whence they grew to their present conformity, or the very same skeletal, and probably cerebral characters must have spontaneously and independently arisen. Here is a dilemma, either horn of which bears a threatening aspect to the exclusive supporter of "Natural Selection," and between which it seems somewhat difficult to choose. [72]

It has been suggested to me that this difficulty may be evaded by considering pterodactyles and carinate birds as independent branches from one side of an ancient common trunk, while similarly the Dinosauria and struthious birds are taken to be independent branches from the

other side of the same common trunk; the two kinds of birds resembling each other so much on account of their later development from that trunk as compared with the development of the reptilian forms. But to this it may be replied that the ancient common stock could not have had at one and the same time a shoulder structure of *both kinds*. It must have been that of the struthious birds or that of the carinate birds, or something different from both. If it was that of the struthious birds, how did the pterodactyles and carinate birds independently arrive at the very same divergent structure? If it was that of the carinate birds, how did the struthious birds and Dinosauria independently agree to differ? Finally, if it was something different from either, how did the carinate birds and pterodactyles take on independently one special common structure when disagreeing in so many; while the struthious birds, agreeing in many points with the Dinosauria, agree yet more with the carinate birds? Indeed by no arrangement of branches from a stem can the difficulty be evaded.

Professor Huxley seems inclined[55] to cut the Gordian knot by considering the shoulder structure of the pterodactyle as independently educed, and having relation to physiology only. This conception is one which harmonizes completely with the views here advocated, and with those of Mr. Herbert Spencer, who also calls in direct modification to the aid of "Natural Selection." That merely minute, indefinite variations in all directions should unaided have independently built up the shoulder structure of the pterodactyles and carinate birds, and have [73]
laterally depressed their optic lobes, at a time so far back as the deposition of the Oolite strata, [56] is a coincidence of the highest improbability; but that an innate power and evolutionary law, aided by the corrective action of "Natural Selection," should have furnished like needs with like aids, is not at all improbable. The difficulty does not tell against the theory of evolution, but only against the specially Darwinian form of it. Now this form has never been expressly adopted by Professor Huxley; so far from it, in his lecture on this subject at the Royal Institution before referred to, he observes,[57] "I can testify, from personal experience, it is possible to have a complete faith in the general doctrine of evolution, and yet to hesitate in accepting the Nebular, or the Uniformitarian, or the Darwinian hypotheses in all their integrity and fulness."

THE ARCHEOPTERYX (of the Oolite strata).

It is quite consistent, then, in the Professor to explain the difficulty as he does; but it would not [74]
be similarly so with an absolute and pure Darwinian.

Yet stronger arguments of an analogous kind are, however, to be derived from the highest organs of sense. In the most perfectly organized animals—those namely which, like ourselves, possess a spinal column—the internal organs of hearing consist of two more or less complex membranous sacs (containing calcareous particles—otoliths), which are primitively or permanently lodged in two chambers, one on each side of the cartilaginous skull. The primitive cartilaginous cranium supports and protects the base of the brain, and the auditory nerves pass from that brain into the cartilaginous chambers to reach the auditory sacs. These complex arrangements of parts could not have been evolved by "Natural Selection," *i.e.* by minute accidental variations, except by the action of such through a vast period of time; nevertheless, it was fully evolved at the time of the deposition of the upper Silurian rocks.

Cuttle-fishes (*Cephalopoda*) are animals belonging to the molluscous primary division of the animal kingdom, which division contains animals formed upon a type of structure utterly remote from that on which the animals of the higher division provided with a spinal column are constructed. And indeed no transitional form (tending even to bridge over the chasm between these two groups) has ever yet been discovered, either living or in a fossilized condition.[58]

Nevertheless, in the two-gilled Cephalopods (*Dibranchiata*) we find the brain supported and protected by a cartilaginous cranium. In the base of this cranium are two cartilaginous chambers. In each chamber is a membranous sac containing an otolith, and the auditory nerves pass from the cerebral ganglia into the cartilaginous chambers to reach the auditory sacs.

Moreover, it has been suggested by Professor Owen that sinuosities between processes projecting from the inner wall of each chamber "seem to be the first rudiments of those which, in the higher classes (*i.e.* in animals with a spinal column), are extended in the form of canals and spiral chambers, within the substance of the dense nidus of the labyrinth."[59] [75]

CUTTLE-FISH.
A. Ventral aspect. B. Dorsal aspect.

Here, then, we have a wonderful coincidence indeed; two highly complex auditory organs, marvellously similar in structure, but which must nevertheless have been developed in entire and complete independence one of the other! It would be difficult to calculate the odds against the independent occurrence and conservation of two such complex series of merely accidental and minute haphazard variations. And it can never be maintained that the sense of hearing could not be efficiently subserved otherwise than by such sacs, in cranial cartilaginous capsules so situated in relation to the brain, &c. [76]

Our wonder, moreover, may be increased when we recollect that the two-gilled cephalopods have not yet been found below the lias, where they at once abound; whereas the four-gilled cephalopods are Silurian forms. Moreover, the absence is in this case significant in spite of the imperfection of the geological record, because when we consider how many individuals of various kinds of four-gilled cephalopods have been found, it is fair to infer that at the least a certain small percentage of dibranchs would also have left traces of their presence had they existed. Thus it is probable that some four-gilled form was the progenitor of the dibranch cephalopods. Now the four-gilled kinds (judging from the only existing form, the nautilus) had the auditory organ in a very inferior condition of development to what we find in the dibranch; thus we have not only evidence of the independent high development of the organ in the former, but also evidence pointing towards a certain degree of comparative rapidity in its development.

Such being the case with regard to the organ of hearing, we have another yet stronger argument with regard to the organ of sight, as has been well pointed out by Mr. J. J. Murphy.[60] He calls attention to the fact that the eye must have been perfected in at least "three distinct lines of descent," alluding not only to the molluscous division of the animal kingdom, and the division provided with a spinal column, but also to a third primary division, namely, that which includes all insects, spiders, crabs, &c., which are spoken of as Annulosa, and the type of whose structure is as distinct from that of the molluscous type on the one hand, as it is from that of the type with a spinal column (*i.e.* the vertebrate type) on the other.

In the cuttle-fishes we find an eye even more completely constructed on the vertebrate type than is the ear. Sclerotic, retina, choroid, vitreous humour, lens, aqueous humour, all are present. The correspondence is wonderfully complete, and there can hardly be any hesitation in saying that for such an exact, prolonged, and correlated series of similar structures to have been brought about in two independent instances by merely indefinite and minute accidental variations, is an improbability which amounts practically to impossibility. Moreover, we have here again the same imperfection of the four-gilled cephalopod, as compared with the two-gilled, and therefore (if the latter proceeded from the former) a similar indication of a certain comparative rapidity of development. Finally, and this is perhaps one of the most curious circumstances, the process of formation appears to have been, at least in some respects, the same in the eyes of these molluscous animals as in the eyes of vertebrates. For in these latter the cornea is at first perforated, while different degrees of perforation of the same part are presented by different adult cuttle-fishes—large in the calamaries, smaller in the octopods, and reduced to a minute foramen in the true cuttle-fish sepia. [77]

Some may be disposed to object that the conditions requisite for effecting vision are so rigid that similar results in all cases must be independently arrived at. But to this objection it may well be replied that Nature herself has demonstrated that there is no such necessity as to the details of the process. For in the higher Annulosa, such as the dragon-fly, we meet with an eye

of an unquestionably very high degree of efficiency, but formed on a type of structure only remotely comparable with that of the fish or the cephalopod. The last-named animal might have had an eye as efficient as that of a vertebrate, but formed on a distinct type, instead of being another edition, as it were, of the very same structure.

In the beginning of this chapter examples have been given of the very diverse mode in which similar results have in many instances been arrived at; on the other hand, we have in the fish and the cephalopod not only the eye, but at one and the same time the ear also similarly evolved, yet with complete independence. [78]

Thus it is here contended that the similar and complex structures of both the highest organs of sense, as developed in the vertebrates on the one hand, and in the mollusks on the other, present us with residuary phenomena for which "Natural Selection" alone is quite incompetent to account. And that these same phenomena must therefore be considered as conclusive evidence for the action of some other natural law or laws conditioning the simultaneous and independent evolution of these harmonious and concordant adaptations.

Provided with this evidence, it may be now profitable to enumerate other correspondences, which are not perhaps in themselves inexplicable by Natural Selection, but which are more readily to be explained by the action of the unknown law or laws referred to—which action, as its necessity has been demonstrated in one case, becomes *a priori* probable in the others.

SKELETON OF AN ICHTHYOSAURUS.

Thus the great oceanic Mammalia—the whales—show striking resemblances to those prodigious, extinct, marine reptiles, the Ichthyosauria, and this not only in structures readily referable to similarity of habit, but in such matters as greatly elongated premaxillary bones, together with the concealment of certain bones of the skull by other cranial bones. [79]

Again, the aërial mammals, the bats, resemble those flying reptiles of the secondary epoch, the pterodactyles; not only to a certain extent in the breast-bone and mode of supporting the flying membrane, but also in the proportions of different parts of the spinal column and the hinder (pelvic) limbs.

Also bivalve shell-fish (*i.e.* creatures of the mussel, cockle, and oyster class, which receive their name from the body being protected by a double shell, one valve of which is placed on each side) have their two shells united by one or two powerful muscles, which pass directly across from one shell to the other, and which are termed "adductor muscles" because by their contraction they bring together the valves and so close the shell.

CYTHERIDEA TOROSA.
[An ostracod (Crustacean), externally like a bivalve shell-fish (Lamellibranch).

Now there are certain animals which belong to the crab and lobster class (Crustacea)—a class constructed on an utterly different type from that on which the bivalve shell-fish are constructed—which present a very curious approximation to both the form and, in a certain respect, the structure of true bivalves. Allusion is here made to certain small Crustacea—certain phyllopods and ostracods—which have the hard outer coat of their thorax so modified as to look wonderfully like a bivalve shell, although its nature and composition are quite different. But this is by no means all,—not only is there this external resemblance between the thoracic armour of the crustacean and the bivalve shell, but the two sides of the ostracod and phyllopod thorax are connected together also by an adductor muscle! [80]

A POLYZOON WITH BIRD'S-HEAD PROCESSES.

The pedicellariæ of the echinus have been already spoken of, and the difficulty as to their origin from minute, fortuitous, indefinite variations has been stated. But structures essentially similar (called avicularia, or "bird's-head processes") are developed from the surface of the compound masses of certain of the highest of the polyp-like animals (viz. the Polyzoa or, as they are sometimes called, the Bryozoa). [81]

These compound animals have scattered over the surface of their bodies minute processes, each of which is like the head of a bird, with an upper and lower beak, the whole supported on a slender neck. The beak opens and shuts at intervals, like the jaws of the pedicellariæ of the echinus, and there is altogether, in general principle, a remarkable similarity between the structures. Yet the echinus can have, at the best, none but the most distant genetic relationship with the Polyzoa. We have here again therefore complex and similar organs of diverse and independent origin.

BIRD'S-HEAD PROCESSES VERY GREATLY ENLARGED.

In the highest class of animals (the Mammalia) we have almost always a placental mode of reproduction, *i.e.* the blood of the fœtus is placed in nutritive relation with the blood of the mother by means of vascular prominences. No trace of such a structure exists in any bird or in any reptile, and yet it crops out again in certain sharks. There indeed it might well be supposed to end, but, marvellous as it seems, it reappears in very lowly creatures; namely, in certain of the ascidians, sometimes called tunicaries or sea-squirts. [82]

Now, if we were to concede that the ascidians were the common ancestors[61] of both these sharks and of the higher mammals, we should be little, if any, nearer to an explanation of the phenomenon by means of "Natural Selection," for in the sharks in question the vascular prominences are developed from one fœtal structure (the umbilical vesicle), while in the higher mammals they are developed from quite another part, viz. the allantois.

Upper Figure—Antechinus minutissimus (*implacental*).
Lower Figure—Mus delicatulus (*placental*).

So great, however, is the number of similar, but apparently independent, structures, that we suffer from a perfect *embarras de richesses*. Thus, for example, we have the convoluted windpipe of the sloth, reminding us of the condition of the windpipe in birds; and in another mammal, allied to the sloth, namely the great ant-eater (Myrmecophaga), we have again an ornithic character in its horny gizzard-like stomach. In man and the highest apes the cæcum has a vermiform appendix, as it has also in the wombat! [83]

Also the similar forms presented by the crowns of the teeth in some seals, in certain sharks, and in some extinct Cetacea may be referred to; as also the similarity of the beak in birds, some reptiles, in the tadpole, and cuttle-fishes. As to entire external form, may be adduced the wonderful similarity between a true mouse (*Mus delicatulus*) and a small marsupial, pointed out by Mr. Andrew Murray in his work on the "Geographical Distribution of Mammals," p. 53, and represented in the frontispiece by figures copied from Gould's "Mammals of Australia;" but instances enough for the present purpose have been already quoted.

Additional reasons for believing that similarity of structure is produced by other causes than merely by "Natural Selection" are furnished by certain facts of zoological geography, and by a similarity in the mode of variation being sometimes extended to several species of a genus, or

even to widely different groups; while the restriction and the limitation of such similarity are often not less remarkable. Thus Mr. Wallace says,[62] as to local influence: "Larger or smaller districts, or even single islands, give a special character to the majority of their Papilionidæ. For instance:—1. The species of the Indian region (Sumatra, Java, and Borneo) are almost invariably smaller than the allied species inhabiting Celebes and the Moluccas. 2. The species of New Guinea and Australia are also, though in a less degree, smaller than the nearest species or varieties of the Moluccas. 3. In the Moluccas themselves the species of Amboyna are the largest. 4. The species of Celebes equal or even surpass in size those of Amboyna. 5. The [84] species and varieties of Celebes possess a striking character in the form of the anterior wings, different from that of the allied species and varieties of all the surrounding islands. 6. Tailed species in India or the Indian region become tailless as they spread eastward through the Archipelago. 7. In Amboyna and Ceram the females of several species are dull-coloured, while in the adjacent islands they are more brilliant." Again: