CHAPTER IV.

MINUTE AND GRADUAL MODIFICATIONS.

There are Difficulties as to Minute Modifications, even if not fortuitous.—Examples of Sudden and Considerable Modifications of Different Kinds.—Prof. Owen's View.—Mr. Wallace.—Prof. Huxley.—Objections to Sudden Changes.—Labyrinthodont.—Potto.—Cetacea.—As to Origin of Bird's Wing.—Tendrils of Climbing Plants.—Animals once supposed to be Connecting Links.—Early Specialization of Structure.—Macrauchenia.—Glyptodon.—Sabre-toothed Tiger.—Conclusion.

Not only are there good reasons against the acceptance of the exclusive operation of "Natural Selection" as the one means of specific origination, but there are difficulties in the way of accounting for such origination by the sole action of modifications which are infinitesimal and minute, whether fortuitous or not.

Arguments may yet be advanced in favor of the view that new species have from time to time manifested themselves with suddenness, and by modifications appearing at once (as great in degree as are those which separate *Hipparion* from *Equus*), the species remaining stable in the intervals of such modifications: by stable being meant that their variations only extend for a certain degree in various directions, like oscillations in a stable equilibrium. This is the conception of Mr. Galton,[1] who compares the development of species with a many-facetted spheroid tumbling over from one facet, or stable equilibrium, to another. The existence of internal conditions in animals corresponding

[1] "Hereditary Genius, an Inquiry into its Laws," etc. By Francis Galton, F. R. S. (London: Macmillan.)

with such facets is denied by pure Darwinians, but it is contended in this work, though not in this chapter, that something may also be said for their existence.

The considerations brought forward in the last two chapters, namely, the difficulties with regard to incipient and closely-similar structures respectively, together with paleontological considerations to be noticed later, appear to point strongly in the direction of sudden and considerable changes. This is notably the case as regards the young oysters already mentioned, which were taken from the shores of England and placed in the Mediterranean, and at once altered their mode of growth and formed prominent diverging rays, *like those of the proper Mediterranean oyster;* as also the twenty-nine kinds of American trees, all differing from their nearest European allies *similarly*—"leaves less toothed, buds and seeds smaller, fewer branchlets," etc. To these may be added other facts given by Mr. Darwin. Thus he says, that "climate, to a certain extent, directly modifies the form of dogs."[2]

The Rev. R. Everett found that setters at Delhi, though most carefully paired, yet had young with "nostrils more contracted, noses more pointed, size inferior, and limbs more slender." Again, cats at Mombas, on the coast of Africa, have short, stiff hairs, instead of fur; and a cat at Algoa Bay, when left only eight weeks at Mombas, "underwent a complete metamorphosis, having parted with its sandy-colored fur."[3] The conditions of life seem to produce a considerable effect on horses, and instances are given by Mr. Darwin of pony breeds[4] having independently arisen in different parts of the world, possessing a certain similarity in their physical conditions. Also changes due to climate may be brought about at once in a second generation, though no appreciable modification is shown

[2] "Animals and Plants under Domestication," vol. i., p. 37.

[3] Ibid., p. 47. [4] Ibid., p. 52.

by the first. Thus "Sir Charles Lyell mentions that some Englishmen, engaged in conducting the operations of the Real del Monte Company in Mexico, carried out with them some greyhounds, of the best breed, to hunt the hares which abound in that country. It was found that the greyhounds could not support the fatigues of a long chase in this attenuated atmosphere, and, before they could come up with their prey, they lay down gasping for breath; but these same animals have produced whelps, which have grown up, and are not in the least degree incommoded by the want of density in the air, but run down the hares with as much ease as do the fleetest of their race in this country." [5]

We have here no action of "Natural Selection;" it was not that certain puppies happened accidentally to be capable of enduring more rarefied air, and so survived, but the offspring were directly modified by the action of surrounding conditions. Neither was the change elaborated by minute modifications in many successive generations, but appeared at once in the second.

With regard once more to sudden alterations of form, Nathusius is said to state positively as to pigs,[6] that the result of common experience and of his experiments was that rich and abundant food, given during youth, tends by some direct action to make the head broader and shorter. Curious jaw appendages often characterize Normandy pigs, according to M. Eudes Deslongchamps. Richardson figures these appendages on the old "Irish greyhound pig," and they are said by Nathusius to appear occasionally in all the long-eared races. Mr. Darwin observes,[7] "As no wild pigs are known to have analogous appendages, we have at present no reason to suppose that their appearance is due to

[5] Carpenter's "Comparative Physiology," p. 987, quoted by Mr. J. J. Murphy, "Habit and Intelligence," vol. i., p. 171.

[6] "Animals and Plants under Domestication," vol. i., p. 72.

[7] Ibid., p. 76.

reversion; and if this be so, we are forced to admit tha somewhat complex, though apparently useless structures may be suddenly developed without the aid of selection." Again, "Climate directly affects the thickness of the skin and hair" of cattle.[8] In the English climate an individual Porto Santo rabbit[9] recovered the proper color of its fur in rather less than four years. The effect of the climate of India on the turkey is considerable. Mr. Blyth[10] describes it as being much degenerated in size, "utterly incapable of rising on the wing," of a black color, and "with long pendulous appendages over the beak enormously developed." Mr. Darwin again tells us that there has suddenly appeared in a bed of common broccoli a peculiar variety, faithfully transmitting its newly-acquired and remarkable characters;[11] also that there have been a rapid transformation and transplantation of American varieties of maize with a European variety;[12] that certainly "the Ancon and Manchamp breeds of sheep," and that (all but certainly) Niata cattle, turnspit and pug dogs, jumper and frizzled fowls, short-faced tumbler pigeons, hook-billed ducks, etc., and a multitude of vegetable varieties, have suddenly appeared in nearly the same state as we now see them.[13] Lastly, Mr. Darwin tells us that there has been an occasional development (in five distinct cases) in England of the "japanned" or "black-shouldered peacock," (*Pavo nigripennis*), a distinct species, according to Dr. Sclater,[14] yet arising in Sir J. Trevelyan's flock composed entirely of the common kind, and increasing, "*to the extinction of the previously-existing breed.*"[15] Mr. Darwin's only explanation of the phenomena (on the supposition of the

[8] "Animals and Plants under Domestication," vol. i., p. 71.
[9] Ibid., p. 114. [10] Quoted, ibid., p. 274. [11] Ibid., p. 324.
[12] Ibid., p. 322. [13] Ibid., vol. ii., p. 414.
[14] Proc. Zool. Soc. of London, April 24, 1860.
[15] "Animals and Plants under Domestication," vol. i., p. 291.

species being distinct) is by reversion, owing to a supposed ancestral cross. But he candidly admits, "I have heard of no other such case in the animal or vegetable kingdom." On the supposition of its being only a variety, he observes, "The case is the most remarkable ever recorded of the abrupt appearance of a new form, which so closely resembles a true species, that it has deceived one of the most experienced of living ornithologists."

As to plants, M. C. Naudin[16] has given the following instances of the sudden origination of apparently permanent forms: "The first case mentioned is that of a poppy, which took on a remarkable variation in its fruit—a crown of secondary capsules being added to the normal central capsule. A field of such poppies was grown, and M. Göppert, with seed from this field, obtained still this monstrous form in great quantity. Deformities of ferns are sometimes sought after by fern-growers. They are now always obtained by taking spores from the abnormal parts of the monstrous fern; from which spores ferns presenting the same peculiarities invariably grow. . . . The most remarkable case is that observed by Dr. Godron, of Nancy. In 1861 that botanist observed, among a sowing of *Datura tatula*, the fruits of which are very spinous, a single individual of which the capsule was perfectly smooth. The seeds taken from this plant all furnished plants having the character of this individual. The fifth and sixth generations are now growing without exhibiting the least tendency to revert to the spinous form. More remarkable still, when crossed with the normal *Datura tatula*, hybrids were produced, which, in the second generation, reverted to the original types, as true hybrids do."

There are, then, abundant instances to prove that considerable modifications may suddenly develop themselves,

[16] Extracted by J. J. Murphy, vol. i., p. 197, from the *Quarterly Journal of Science*, of October, 1867, p. 527.

either due to external conditions or to obscure internal causes in the organisms which exhibit them. Moreover, these modifications, from whatever cause arising, are capable of reproduction—the modified individuals "breeding true."

The question is, whether new species have been developed by non-fortuitous variations which are insignificant and minute, or whether such variations have been comparatively sudden, and of appreciable size and importance? Either hypothesis will suit the views here maintained equally well (those views being opposed only to fortuitous, indefinite variations), but the latter is the more remote from the Darwinian conception, and yet has much to be said in its favor.

Prof. Owen considers, with regard to specific origination, that natural history "teaches that the change would be sudden and considerable: it opposes the idea that species are transmitted by minute and slow degrees."[17] "An innate tendency to deviate from parental type, operating through periods of adequate duration," being "the most probable nature, or way of operation of the secondary law, whereby species have been derived one from the other."[18]

Now, considering the number of instances adduced of sudden modifications in domestic animals, it is somewhat startling to meet with Mr Darwin's dogmatic assertion that it is "a *false belief*" that natural species have often originated in the same abrupt manner. The belief *may* be false, but it is difficult to see how its falsehood can be positively asserted.

It is demonstrated by Mr. Darwin's careful weighings and measurements that, though little-used parts in domestic animals get reduced in weight and somewhat in size,

[17] "Anatomy of Vertebrates," vol. iii., p. 795.

[18] Ibid., p. 807.

yet that they show no inclination to become truly "rudimentary structures." Accordingly he asserts[19] that such rudimentary parts are formed "suddenly by arrest of development" in domesticated animals, but in wild animals slowly. The latter assertion, however, is a *mere assertion;* necessary, perhaps, for the theory of "Natural Selection," but as yet unproved by facts.

But why should not these changes take place suddenly in a state of nature? As Mr. Murphy says,[20] "It may be true that we have no evidence of the origin of wild species in this way. But this is not a case in which negative evidence proves any thing. We have never witnessed the origin of a wild species by any process whatever; and if a species were to come suddenly into being in the wild state, as the Ancon Sheep did under domestication, how could you ascertain the fact? If the first of a newly-begotten species were found, the fact of its discovery would tell nothing about its origin. Naturalists would register it as a very rare species, having been only once met with, but they would have no means of knowing whether it were the first or the last of its race."

To this Mr. Wallace has replied (in his review of Mr. Murphy's work in *Nature*[21]), by objecting that sudden changes could very rarely be useful, because each kind of animal is a nicely-balanced and adjusted whole, any one sudden modification of which would in most cases be hurtful unless accompanied by other simultaneous and harmonious modifications. If, however, it is not unlikely that there is an innate tendency to deviate at certain times, and under certain conditions, it is no more unlikely that that innate tendency should be a harmonious one, calculated to simultaneously adjust the various parts of the organism to their

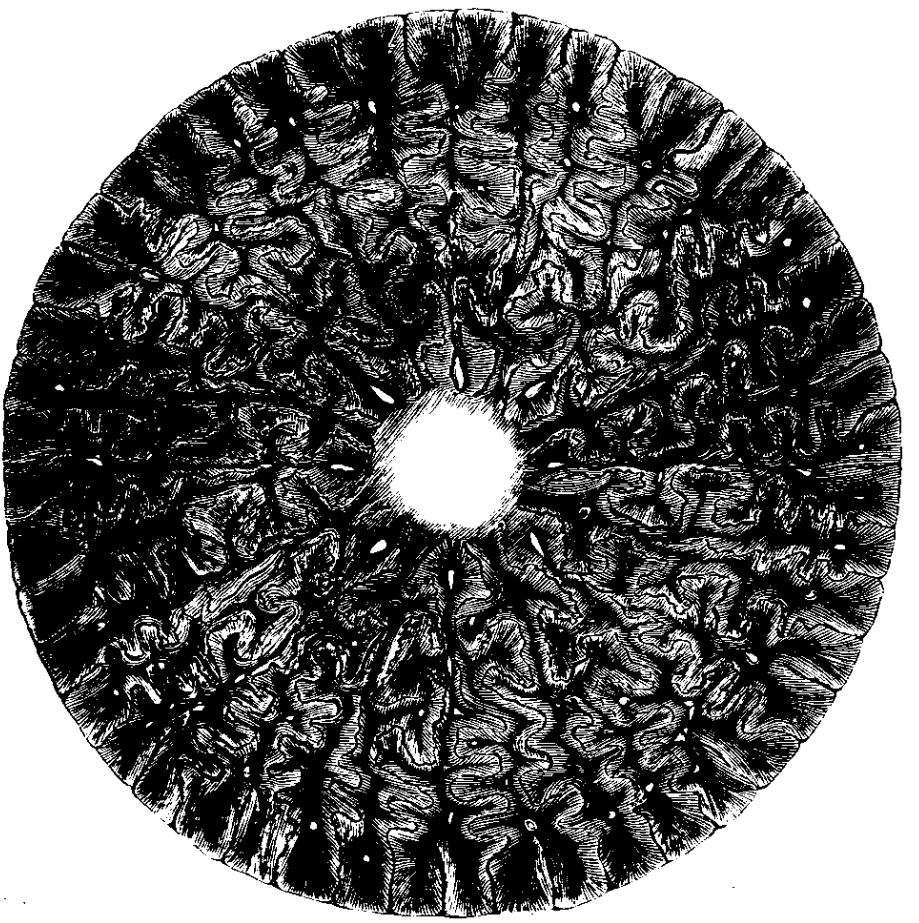
[19] "Animals and Plants under Domestication," vol. ii., p. 318.

[20] "Habit and Intelligence," vol. i., p. 344.

[21] See Decembér 2, 1869, vol. i., p. 132.

new relations. The objection as to the sudden abortion of rudimentary organs may be similarly met.

Prof. Huxley seems now disposed to accept the, at least occasional, intervention of sudden and considerable variations. In his review of Prof. Kölliker's[22] criticisms, he



MUCH ENLARGED HORIZONTAL SECTION OF THE TOOTH OF A LABYRINTHODON.

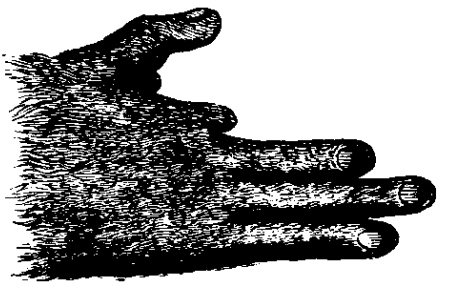
himself says,[23] "We greatly suspect that she" (i. e., Nature) "does make considerable jumps in the way of variation now and then, and that these saltations give rise to

[22] "Über die Darwin'sche Schöpfungstheorie:" ein Vortrag, von Kölliker; Leipzig, 1864. [23] See "Lay Sermons," p. 342.

some of the gaps which appear to exist in the series of known forms."

In addition to the instances brought forward in the second chapter against the minute action of Natural Selection, may be mentioned such structures as the wonderfully folded teeth of the labyrinthodonts. The marvellously complex structure of these organs is not merely unaccountable as due to "Natural Selection," but its production by insignificant increments of complexity is hardly less difficult to comprehend.

Similarly the aborted index of the Potto (*Perodicticus*) is a structure not likely to have been induced by minute changes; while, as to "Natural Selection," the reduction of the fore-finger to a mere rudiment is inexplicable indeed! "How this mutilation can have aided in the strug-



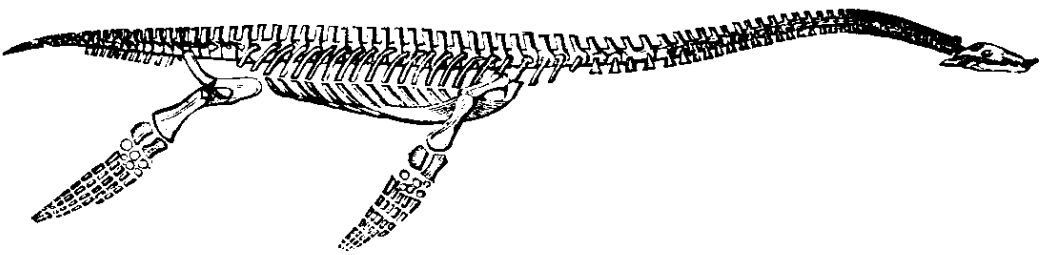
HAND OF THE POTTO (PERODICTICUS), FROM LIFE.

gle for life, we must confess, baffles our conjectures on the subject; for that any very appreciable gain to the individual can have resulted from the slightly-lessened degree of required nourishment thence resulting (i. e., from the suppression), seems to us to be an almost absurd proposition."[24]

Again, to anticipate somewhat, the great group of whales (Cetacea) was fully developed at the deposition of the Eocene strata. On the other hand, we may pretty safely conclude that these animals were absent as late as

[24] "Anatomy of the Lemuroidea," by James Murie, M. D., and St. George Mivart. Trans. Zool. Soc., March, 1866, p. 91

the latest secondary rocks, so that their development could not have been so very slow, unless geological time is (although we shall presently see there are grounds to believe it is not) practically infinite. It is quite true that it is, in general, very unsafe to infer the absence of any animal forms during a certain geological period, because no remains of them have as yet been found in the strata then deposited: but in the case of the Cetacea it is safe to do so; for, as Sir Charles Lyell remarks,[25] they are animals, the remains of which are singularly likely to have been preserved had they existed, in the same way that the remains were



SKELETON OF A PLESIOSAURUS.

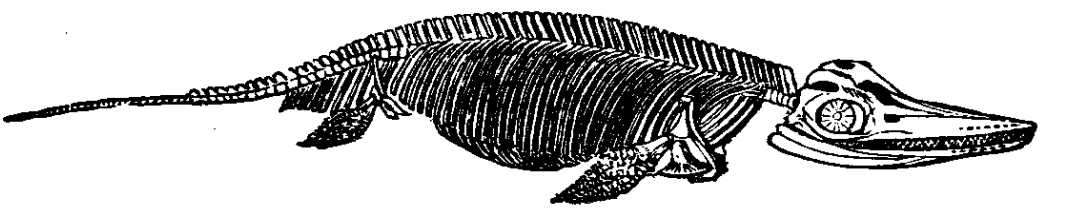
preserved of the Ichthyosauri and Plesiosauri, which appear to have represented the Cetacea during the secondary geological period.

As another example, let us take the origin of wings, such as exist in birds. Here we find an arm, the bones of the hand of which are atrophied and reduced in number, as compared with those of most other Vertebrates. Now, if the wing arose from a terrestrial or subaërial organ, this abortion of the bones could hardly have been serviceable—hardly have preserved individuals in the struggle for life. If it arose from an aquatic organ, like the wing of the penguin, we have then a singular divergence from the ordinary

[25] "Principles of Geology," last edition, vol. i., p. 163.

vertebrate fin-limb. In the ichthyosaurus, in the plesiosaurus, in the whales, in the porpoises, in the seals, and in others, we have shortening of the bones, but no reduction in the number either of the fingers or of their joints, which are, on the contrary, multiplied in Cetacea and the ichthyosaurus. And even in the turtles we have eight carpal bones and five digits, while no finger has less than two phalanges. It is difficult, then, to believe that the Avian limb was developed in any other way than by a comparatively sudden modification of a marked and important kind.

How, once more, can we conceive the peculiar actions of the tendrils of some climbing plants to have been produced by minute modifications? These, according to Mr. Darwin,[26] oscillate till they touch an object, and then embrace it. It is stated by that observer, that "a thread weighing no more than the thirty-second of a grain, if placed on the tendril of the *Passiflora gracilis*, will cause it to bend; and merely to touch the tendril with a twig causes it to bend; but if the twig is at once removed, the



SKELETON OF AN ICHTHYOSAURUS.

tendril soon straightens itself. But the contact of other tendrils of the plant, or of the falling of drops of rain, do not produce these effects.[27] But some of the zoological and anatomical discoveries of late years tend rather to diminish than to augment the evidence in favor of minute and grad-

[26] *Quarterly Journal of Science*, 1866, pp. 257, 258.

[27] "Habit and Intelligence," vol. i., p. 178.

ual modification. Thus all naturalists now admit that certain animals, which were at one time supposed to be connecting links between groups, belong altogether to one group, and not at all to the other. For example, the aye-aye[28] (*Chiromys Madagascariensis*) was till lately considered to be allied to the squirrels, and was often classed with them in the rodent order, principally on account of its dentition; at the same time that its affinities to the lemurs and apes were admitted. The thorough investigation into

THE AYE-AYE.

its anatomy that has now been made, demonstrates that it has no more essential affinity to rodents than any other lemurine creature has.

[28] This animal belongs to the order Primates, which includes man, the apes, and the lemurs. The lemurs are the lower kinds of the order, and differ much from the apes. They have their headquarters in the Island of Madagascar. The aye-aye is a lemur, but it differs singularly from all its congeners, and still more from all apes. In its dentition it strongly approximates to the rodent (rat, squirrel, and guinea-pig) order, as it has two cutting teeth above, and two below, growing from permanent pulps, and in the adult condition has no canines.

Bats were, by the earliest observers, naturally supposed to have a close relationship to birds, and cetaceans to fishes. It is almost superfluous to observe that all now agree that these mammals make not even an approach to either one or other of the two inferior classes.

In the same way it has been recently supposed that those extinct flying saurians, the pterodactyls, had an affinity with birds more marked than any other known animals. Now, however, as has been said earlier, it is contended that not only had they no such close affinity, but that other extinct reptiles had a far closer one.

The *amphibia* (i. e., frogs, toads, and efts) were long considered (and are so still by some) to be reptiles, showing an affinity to fishes. It now appears that they form with the latter one great group—the ichthyopsida of Prof. Huxley—which differs widely from reptiles; while its two component classes (fishes and amphibians) are difficult to separate from each other in a thoroughly satisfactory manner.

If we admit the hypothesis of gradual and minute modification, the succession of organisms on this planet must have been a progress from the more general to the more special, and no doubt this has been the case in the majority of instances. Yet it cannot be denied that some of the most recently-formed fossils show a structure singularly more generalized than any exhibited by older forms; while others are more specialized than are any allied creatures of the existing creation.

A notable example of the former circumstance is offered by macrauchenia—a hoofed animal, which was at first supposed to be a kind of great llama (whence its name)—the llama being a ruminant, which, like all the rest, has two toes to each foot. Now hoofed animals are divisible into two very distinct series, according as the number of functional toes on each hind-foot is odd or even. And many

other characters are found to go with this obvious one. Even the very earliest Ungulata show this distinction, which is completely developed and marked even in the Eocene palæotherium and anoplotherium found in Paris by Cuvier. The former of these has the toes odd (perissodactyl), the other has them even (artiodactyl).

Now, the macrauchenia, from the first relics of it which were found, was thought to belong, as has been said, to the even-toed division. Subsequent discoveries, however, seemed to give it an equal claim to rank among the perissodactyl forms. Others, again, inclined the balance of probability toward the artiodactyl. Finally, it appears that this very recently extinct beast presents a highly-generalized type of structure, uniting in one organic form both artiodactyl and perissodactyl characters, and that in a manner not similarly found in any other known creature living, or fossil. At the same time the differentiation of artiodactyl and perissodactyl forms existed as long ago as in the period of the Eocene ungulata, and that in a marked degree, as has been before observed.

Again, no armadillo *now living* presents nearly so remarkable a specialty of structure as was possessed by the *extinct* glyptodon. In that singular animal the spinal column had most of its joints fused together, forming a rigid cylindrical rod, a modification, as far as yet known, absolutely peculiar to it.

In a similar way the *extinct* machairodus, or sabre-toothed tiger, is characterized by a more highly differentiated and specially carnivorous dentition than is shown by any predacious beast of the *present day*. The specialization is of this kind: The grinding teeth (or molars) of beasts are divided into premolars and true molars. The premolars are molars which have deciduous vertical predecessors (or milk-teeth), and any which are in front of such, i. e., between such and the canine tooth. The true molars

are those placed behind the molars having deciduous vertical predecessors. Now, as a dentition becomes more dis-

DENTITION OF THE SABRE-TOOTHED TIGER (MACHAIRODUS).

tinctly carnivorous, so the hindmost molars and the foremost premolars disappear. In the existing cats this process is carried so far that in the upper jaw only one true molar is left on each side. In the machairodus there is no upper true molar at all, while the premolars are reduced to two, there being only these two teeth above, on each side, behind the canine.

Now, with regard to these instances of early specialization, as also with regard to the changed estimate of the degrees of affinity between forms, it is not pretended for a moment that such facts are irreconcilable with "Natural Selection." Nevertheless, they point in an opposite direction. Of course not only is it conceivable that certain antique types arrived at a high degree of specialization and then disappeared; but it is manifest they did do so. Still the fact of this early degree of excessive specialization tells to a certain, however small, extent against a progress through excessively minute steps, whether fortuitous or

not; as also does the distinctness of forms formerly supposed to constitute connecting links. For, it must not be forgotten that, if species have manifested themselves generally by gradual and minute modifications, then the absence, not in one, but in *all cases*, of such connecting links, is a phenomenon which remains to be accounted for.

It appears then that, apart from fortuitous changes, there are certain difficulties in the way of accepting extremely minute modifications of any kind, although these difficulties may not be insuperable. Something, at all events, is to be said in favor of the opinion that sudden and appreciable changes have, from time to time, occurred, however they may have been induced. Marked *races* have undoubtedly so arisen (some striking instances having been here recorded), and it is at least conceivable that such may be the mode of *specific* manifestation generally, the possible conditions as to which will be considered in a later chapter.