THE GENESIS OF SPECIES.

CHAPTER VI.

SPECIES AND TIME.

Two Relations of Species to Time. - No Evidence of Past Existence of Minutely-intermediate Forms when such might be expected *a priori*. - Bats, Pterodactyls, Dinosauria, and Birds. - Ichthyosauria, Chelonia, and Anoura. - Horse Ancestry. - Labyrinthodonts and Trilobites. - Two Subdivisions of the Second Relation of Species to Time. - Sir William Thomson's Views. - Probable Period required for Ultimate Specific Evolution from Primitive Ancestral Forms. - Geometrical Increase of Time required for Rapidly-multiplying Increase of Structural Differences. - Proboscis Monkey. - Time required for Deposition of Strata necessary for Darwinian Evolution. - High Organization of Silurian Forms of Life. - Absence of Fossils in Oldest Rocks. - Summary and Conclusion.

Two considerations present themselves with regard to the necessary relation of species to time if the theory of "Natural Selection" is valid and sufficient.

The first is with regard to the evidences of the past existence of intermediate forms, their duration and succession.

The second is with regard to the total amount of time required for the evolution of all organic forms from a few original ones, and the bearing of other sciences on this question of time.

As to the first consideration, evidence is as yet against the modification of species by "Natural Selection" alone, because not only are minutely transitional forms generally absent, but they are absent in cases where we might certainly *a priori* have expected them to be present.

Now it has been said: [1] "If Mr. Darwin's theory be true, the number of varieties differing one from another a

[1] *North British Review,* New Series, vol. vii., March, 1867, p. 317.

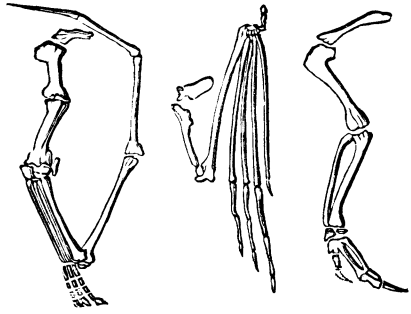
very little must have been indefinitely great, so great indeed as probably far to exceed the number of individuals which have existed of any one variety. If this be true, it would be more probable that no two specimens preserved as fossils should be of one variety than that we should find a great many specimens collected from a very few varieties, provided, of course, the chances of preservation are equal for all individuals." "It is really strange that vast numbers of perfectly similar specimens should he found, the chances against their perpetuation as fossils are so great; but it is also very strange that the specimens should be so exactly alike as they are, if, in fact, they came and vanished by a gradual change."

Mr. Darwin attempts [2] to show cause why we should believe *a priori* that intermediate varieties would exist in lesser numbers than the more extreme forms; but though they would doubtless do so sometimes, it seems too much to assert that they would do so generally, still less universally. Now little less than universal and very marked inferiority in numbers would account for the absence of certain series of minutely intermediate fossil specimens. The mass of paleontological evidence is indeed overwhelmingly against minute and gradual modification. It is true that when once an animal has obtained powers of flight its means of diffusion are indefinitely increased, and we might expect to find many relics of an aërial form and few of its antecedent state - with nascent wings just commencing their suspensory power. Yet had such a slow mode of origin, as Darwinians contend for, operated exclusively in all cases, it is absolutely incredible that birds, bats, and pterodactyls, should have left the remains they have, and yet not a single relic be preserved in any one instance of any of these different forms of wing in their incipient and relatively imperfect functional condition!

[2] "Origin of Species," 5th edit., 1869, p. 212.

Whenever the remains of bats have been found they have presented the exact type of existing forms, and there is as yet no indication of the conditions of an incipient elevation from the ground.

The pterodactyls, again, though a numerous group, are all true and perfect pterodactyls, though surely *some* of



WING-BONES OF PTERODACTYL, BAT, AND BIRD.

the many incipient forms, which on the Darwinian theory have existed, must have had a good chance of preservation.

As to birds, the only notable instance in which discoveries recently made appear to fill up an important hiatus, is the interpretation given by Prof. Huxley [3] to the remains of Dinosaurian reptiles, and which were noticed in the third chapter of this work. The learned professor has (as also has Prof. Cope in America) shown that in very important and significant points the skeletons of the Iguanodon and of its allies approach very closely to that existing in the ostrich, emeu, rhea, etc. He has given weighty reasons for thinking that the line of affinity between birds and

[3] See also the Popular Science Review for July, 1868

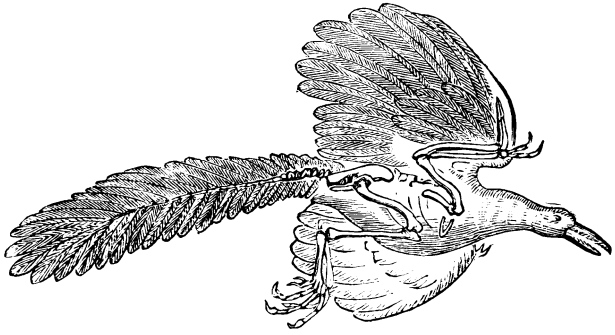
reptiles passes to the birds last named from the Dinosauria rather than from the Pterodactyls, through Archeopteryx-like forms to the ordinary birds. Finally, he has thrown out the suggestion that the celebrated footsteps left by some extinct three-toed creatures on the very ancient sandstone of Connecticut were made, not, as hitherto supposed, by true birds, but by more or less ornithic reptiles. But even supposing all that is asserted or inferred on this subject to be fully proved, it would not approach to a demonstration of specific origin by *minute* modification. And though it harmonizes well with "Natural Selection," it is equally consistent with the rapid and sudden development of new specific forms of life. Indeed, Prof. Huxley, with a laudable caution and moderation too little observed by some Teutonic Darwinians, guarded himself carefully from any imputation of asserting dogmatically the theory of "Natural Selection," while upholding fully the doctrine of evolution.

But, after all, it is by no means certain, though very probable, that the Connecticut footsteps were made by very ornithic reptiles, or extremely sauroid birds. And it must not be forgotten that a completely carinate [4] bird (the Archeopteryx) existed at a time, when, as yet, we have no evidence of some of the Dinosauria having come into being. Moreover, if the remarkable and minute similarity of the coracoid of a pterodactyl to that of a bird be merely the result of function, and no sign of genetic affinity, it is not inconceivable that pelvic and leg resemblances of Dinosauria to birds may be functional likewise, though such an explanation is, of course, by no means necessary to support the view maintained in this book.

But the number of forms represented by many individuals, yet by *no transitional ones*, is so great, that only two

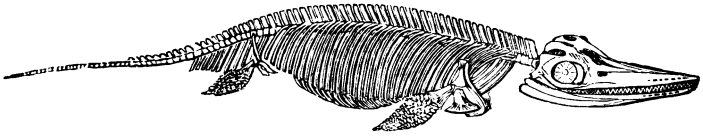
[4] A bird with a keeled breastbone, such as almost all existing birds possess.

or three can be selected as examples. Thus those remarkable fossil reptiles, the Ichthyosauria and Plesiosauria, extended,



THE AECHEOPTERYX (OF THE OOLITE STRATA).

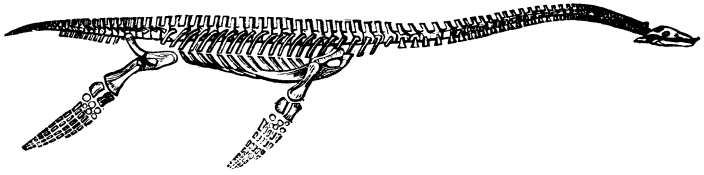
through the secondary period, probably over the greater part of the globe. Yet no single transitional form has yet been met with in spite of the multitudinous individuals preserved. Again, with their modern representatives



SKELETON OF AN ICHTHYOSAURUS

the Cetacea, one or two aberrant forms alone have been found, but no series of transitional ones indicating minutely the line of descent. This group, the whales, is a very marked one, and it is curious, on Darwinian principles,

that so few instances tending to indicate its mode of origin should have presented themselves. Here, as in the bats, we might surely expect that some relics of unquestionably incipient stages of its development would have been left.



SKELETON OF A PLESIOSAURUS.

The singular order Chelonia, including the tortoises, turtles, and terrapins (or fresh-water tortoises), is another instance of an extreme form without any, as yet known, transitional stages. Another group may be finally mentioned, viz., the frogs and toads, anourous Batrachians, of which we have at present no relic of any kind linking them on to the Eft group on the one hand, or to reptiles on the other.

The only instance in which an approach toward a series of nearly-related forms has been obtained is the existing horse, its predecessor Hipparion, and other extinct forms. But even here there is no proof whatever of modification by minute and infinitesimal steps; *a fortiori* no approach to a proof of modification by "Natural Selection," acting upon indefinite fortuitous variations. On the contrary, the series is an admirable example of successive modification in one special direction along one beneficial line, and the teleologist must here be allowed to consider that one motive of this modification (among probably an indefinite number of motives inconceivable to us) was the relationship

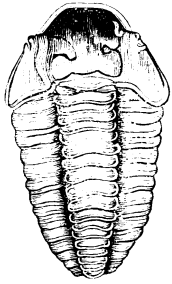
in which the horse was to stand to the human inhabitants of this planet. These extinct forms, as Prof. Owen remarks, [5] "differ from each other in a greater degree than do the horse, zebra, and ass," which are not only good *zoological* species as to form, but are species *physiologically*, i. e., they cannot produce a race of hybrids fertile *inter se*.

As to the mere action of surrounding conditions, the same professor remarks: [6] "Any modification affecting the density of the soil might so far relate to the changes of limb-structure, as that a foot with a pair of small hoofs, dangling by the sides of the large one, like those behind the cloven hoof of the ox, would cause the foot of Hipparion, e. g., and *a fortiori* the broader based three-hoofed foot of the Palæothere, to sink less deeply into swampy soil, and be more easily withdrawn than the more concentratively simplified and specialized foot of the horse. Rhinoceroses and zebras, however, tread together the arid plains of Africa in the present day; and the horse has multiplied in that half of America where two or more kinds of tapir still exist. That the continents of the Eocene or Miocene periods were less diversified, in respect of swamp and sward, pampas, or desert, than those of the Pliocene period, has no support from observation or analogy."

Not only, however, do we fail to find any traces of the incipient stages of numerous very peculiar groups of animals, but it is undeniable that there are instances which appeared at first to indicate a *gradual transition*, yet which instances have been shown, by further investigation and discovery, not to indicate truly any thing of the kind. Thus at one time the remains of Labyrinthodonts, which, up till then, had been discovered, seemed to justify the opinion that, as time went on, forms had successively appeared

[5] "Anatomy of Vertebrates," vol. iii., p. 792. [6] Ibid., p. 793.

with more and more complete segmentation and ossification of the backbone, which, in the earliest forms, was (as it is in the lowest fishes now) a soft, continuous rod or



TRILOBITE.

notochord. Now, however, it is considered probable that the soft backboned Labyrinthodon Archegosaurus was an immature or larval form, [7] while Labyrinthodonts, with completely developed vertebræ, have been found to exist among the very earliest forms yet discovered. The same may be said regarding the eyes of the trilobites, some of the oldest forms having been found as well furnished in that respect as the very last of the group which has left its remains accessible to observation.

Such instances, however, as well as the way in which marked and special forms (as the Pterodactyls, etc., before referred to) appear at once in and similarly disappear from the geological record, are of course explicable on the Darwinian theory, provided a sufficiently enormous amount of past time be allowed. The alleged extreme, and probably great, imperfection of that record may indeed be pleaded in excuse. But it *is* an excuse. [8] Nor is it possible to deny

[7] As a tadpole is the *larval form* of a frog.

[8] As Prof. Huxley, with his characteristic candor, fully admitted in his lecture on the Dinosauria before referred to.

the *a priori* probability of the preservation of at least a few *minutely transitional* forms in some instances if *every* species without exception has arisen exclusively by such minute and gradual transitions.

It remains, then, to turn to the other considerations with regard to the relation of species to time: namely (1), as to the total amount of time allowable by other sciences for organic evolution; and (2) the proportion existing, on Darwinian principles, between the time anterior to the earlier fossils, and the time since; as evidenced by the proportion between the amount of evolutionary change during the latter epoch and that which must have occurred anteriorly.

Sir William Thomson has lately [9] advanced arguments from three distinct lines of inquiry, and agreeing in one approximate result. The three lines of inquiry were - 1. The action of the tides upon the earth's rotation. 2. The probable length of time during which the sun has illuminated this planet; and 3. The temperature of the interior of the earth. The result arrived at by these investigations is a conclusion that the existing state of things on the earth, life on the earth, all geological history showing continuity of life, must be limited within some such period of past time as one hundred million years. The first question which suggests itself, supposing Sir W. Thomson's views to be correct, is, Is this period any thing like enough for the evolution of all organic forms by "Natural Selection?" The second is, Is this period any thing like enough for the deposition of the strata which must have been deposited if all organic forms have been evolved by *minute* steps, according to the Darwinian theory?

In the first place, as to Sir William Thomsom's views, the author of this book cannot presume to advance any opinion; but the fact that they have not been refuted, pleads

[9] "Transactions of the Geological Society of Glasgow," vol. iii.

strongly in their favor when we consider how much they tell against the theory of Mr. Darwin. The last-named author only remarks that "many of the elements in the calculation are more or less doubtful." [10] and Prof. Huxley [11] does not attempt to *refute* Sir W. Thomson's arguments, but only to show cause for suspense of judgment, inasmuch as the facts *may be* capable of other explanations.

Mr. Wallace, on the other hand, [12] seems more disposed to accept them, and, after considering Sir William's objections and those of Mr. Croll, puts the probable date of the beginning of the Cambrian deposits [13] at only twenty-four million years ago. On the other hand, he seems to consider that specific change has been more rapid than generally supposed, and exceptionally stable during the last score or so of thousand years.

Now, first, with regard to the time required for the evolution of all organic forms by merely accidental, minute, and fortuitous variations, the useful ones of which have been preserved.

Mr. Murphy [14] is distinctly of opinion that there has not been time enough. He says: "I am inclined to think that geological time is too short for the evolution of the higher forms of life out of the lower by that accumulation of imperceptibly slow variations, to which alone Darwin ascribes the whole process."

"Darwin justly mentions the greyhound as being equal to any natural species in the perfect coördination of its parts, 'all adapted for extreme fleetness and for running down weak prey.'" "Yet it is an artificial species (and not *physiologically* a species *at all*), formed by long-continued

[10] "Origin of Species," 5th edit., p. 354

[11] See his address to the Geological Society, on February 19, 1869.

[12] See *Nature*, vol. i., p. 399, February 17, 1870.

[13] Ibid., vol. i., p. 454.

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

selection under domestication; and there is no reason to suppose that any of the variations which have been selected to form it have been other than gradual and almost imperceptible. Suppose that it has taken five hundred years to form the greyhound out of his wolf-like ancestor. This is a mere guess, but it gives the order of the magnitude." Now, if so, "how long would it take to obtain an elephant from a protozoon, or even from a tadpole-like fish? Ought it not to take much more than a million times as long? [15] "

Mr. Darwin [16] would compare with the natural origin of a species "unconscious selection, that is, the preservation of the most useful or beautiful animals, with no intention of modifying the breed." He adds: "But by this process of unconscious selection, various breeds have been sensibly changed in the course of two or three centuries."

"Sensibly changed!" but not formed into "new species." Mr. Darwin, of course, could not mean that species generally change so rapidly, which would be strangely at variance with the abundant evidence we have of the stability of animal forms as represented on Egyptian monuments and as shown by recent deposits. Indeed, he goes on to say: "Species, however, probably change much more slowly, and within the same country only a few change at the same time. This slowness follows from all the inhabitants of the same country being already so well adapted to each other, that places in the polity of Nature do not occur until after long intervals, when changes of some kind in the physical conditions, or through immigration, have occurred, and individual differences and variations of the right nature, by which some of the inhabitants might be better fitted to their new places under altered circumstances, might not at once occur." This is true, and not only will

[15] "Habit and Intelligence," vol. i., p. 345.

[16] "Origin of Species," 5th edit., p. 353.

these changes occur at distant intervals, but it must be borne in mind that in tracing back an animal to a remote ancestry, we pass through modifications of such rapidly-increasing number and importance that a geometrical progression can alone indicate the increase of periods which such profound alterations would require for their evolution through "Natural Selection" only.

Thus let us take for an example the proboscis monkey of Borneo (*Semnopithecus nasalis*). According to Mr. Darwin's own opinion, this form might have been "sensibly changed" in the course of two or three centuries. According to this, to evolve it as a true and perfect species one thousand years would be a very moderate period. Let ten thousand years be taken to represent approximately the period of substantially constant conditions, during which no considerable change would be brought about. Now, if one thousand years may represent the period required for the evolution of the species *S. nasalis*, and of the other species of the genus Semnopithecus, ten times that period should, I think, be allowed for the differentiation of that genus, the African Cercopithecus, and the other genera of the family Simiidæ - the differences between the genera being certainly more than tenfold greater than those between the species of the same genus. Again, we may perhaps interpose a period of ten thousand years' comparative repose.

For the differentiation of the families Simiidæ and Cebidæ - so very much more distinct and different than any two genera of either family - a period ten times greater should, I believe, be allowed than that required for the evolution of the subordinate groups. A similarly increasing ratio should be granted for the successive developments of the difference between the Lemuroid and the higher forms of primates; for those between the original primate and other root-forms of placental mammals; for those between

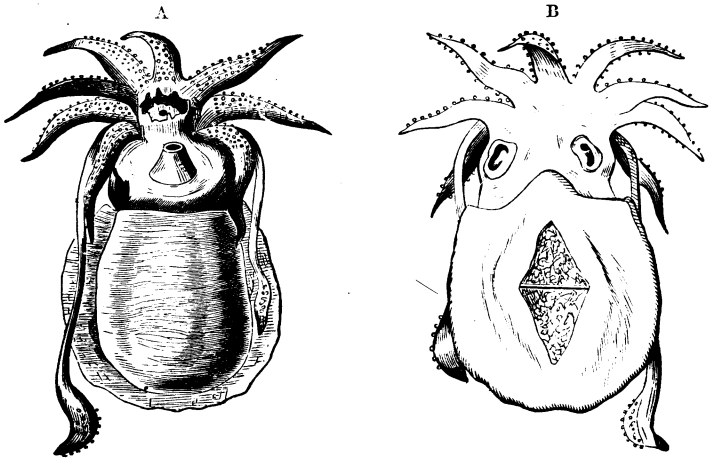
primary placental and implacental mammals, and perhaps also for the divergence of the most ancient stock of these and of the monotremes, for in all these cases modifications of structure appear to increase in complexity in at least that ratio. Finally, a vast period must be granted for the development of the lowest mammalian type from the primitive stock of the whole vertebrate sub-kingdom. Supposing this primitive stock to have arisen directly from a very lowly-organized animal indeed (such as a nematoid worm, or an ascidian, or a jelly-fish), yet it is not easy to believe that less than two thousand million years would be required for the totality of animal development by no other means than minute, fortuitous, occasional, and intermitting variations in all conceivable directions. If this be even an approximation to the truth, then there seem to be strong reasons for believing that geological time is not sufficient for such a process.

The second question is, whether there has been time enough for the deposition of the strata which must have been deposited, if all organic forms have been evolved according to the Darwinian theory?

Now this may at first seem a question for geologists only, but, in fact, in this matter geology must in some respects rather take its time from zoology than the reverse; for if Mr. Darwin's theory be true, past time, down to the deposition of the Upper Silurian strata, can have been but a very small fraction of that during which strata have been deposited. For when those Upper Silurian strata were formed, organic evolution had already run a great part of its course, perhaps the longest, slowest, and most difficult part of that course.

At that ancient epoch, not only were the vertebrate, molluscous, and arthropod types distinctly and clearly differentiated, but highly-developed forms had been produced in each of these sub-kingdoms. Thus in the Vertebrata

there were fishes not belonging to the lowest but to the very highest groups which are known to have ever been developed, namely, the Elasmobranchs (the highly-organized sharks and rays), and the Ganoids, a group now poorly represented, but for which the sturgeon may stand as a type, and which in many important respects more nearly resemble higher Vertebrata than do the ordinary or



CUTTLE-FISH.

A. Ventral aspect. B. Dorsal aspect.

osseous fishes. Fishes in which the ventral fins are placed in front of the pectoral ones (i.e., jugular fishes) have been generally considered to be comparatively modern forms. But Prof. Huxley has kindly informed me that he has discovered a jugular fish in the Permian deposits.

Among the molluscous animals we have members of the very highest known class, namely, the Cephalopods, or cuttle-fish class; and among articulated animals we find Trilobites and Eurypterida, which do not belong to any

incipient worm-like group, but are distinctly differentiated Crustacea of no low form.

We have in all these animal types nervous systems differentiated on distinctly different patterns, fully-formed organs of circulation, digestion, excretion, and generation, complexly-constructed eyes and other sense organs; in fact, all the most elaborate and complete animal structures built up, and not only once, for in the fishes and mollusca we have (as described in the third chapter of this work) the coincidence of the independently-developed organs of sense attaining a nearly similar complexity in two quite distinct forms. If then, so small an advance has been made in fishes, mollusks, and anthropods, since the Upper Silurian deposits, it will probably be within the mark to consider that the period before those deposits (during which all these organs would, on the Darwinian theory, have slowly built up their different perfections and complexities) occupied time at least a hundredfold greater.

Now it will be a moderate computation to allow 25,000,000 years for the deposition of the strata down to and including the Upper Silurian. 1f then, the evolutionary work done during this deposition only represents a hundredth part of the sum total, we shall require 2,500,000,000 (two thousand five hundred million) years for the complete development of the whole animal kingdom to its present state. Even one-quarter of this, however, would far exceed the time which physics and astronomy seem able to allow for the completion of the process.

Finally, a difficulty exists as to the reason of the absence of rich fossiliferous deposits in the oldest strata - if life was then as abundant and varied as, on the Darwinian theory, it must have been. Mr. Darwin himself admits [17] "the case at present must remain inexplicable; and may be truly urged as a valid argument against the views" entertained in his book.

[17] "Origin of Species," 5th edit., p. 381.

Thus, then, we find a wonderful (and, on Darwinian principles, an all but inexplicable) absence of minutely transitional forms. All the most marked groups, bats, pterodactyls, chelonians, ichthyosauria, anoura, etc., appear at once upon the scene. Even the horse, the animal whose pedigree has been probably best preserved, affords no conclusive evidence of specific origin by infinitesimal, fortuitous variations; while some forms, as the labyrinthodonts and trilobites, which seemed to exhibit gradual change, are shown by further investigation to do nothing of the sort. As regards the time required for evolution (whether estimated by the probably minimum period required for organic change, or for the deposition of strata which accompanied that change), reasons have been suggested why it is likely that the past history of the earth does not supply us with enough: First, because of the prodigious increase in the importance and number of differences and modifications which we meet with as we traverse successively greater and more primary zoological groups; and, secondly, because of the vast series of strata necessarily deposited if the period since the Lower Silurian marks but a small fraction of the period of organic evolution. Finally, the absence or rarity of fossils in the oldest rocks is a point at present inexplicable, and not to be forgotten or neglected.

Now all these difficulties are avoided if we admit that new forms of animal life of all degrees of complexity appear from time to time with comparative suddenness, being evolved according to laws in part depending on surrounding conditions, in part internal - similar to the way in which crystals (and, perhaps from recent researches, the lowest forms of life) build themselves up according to the internal laws of their component substance, and in harmony and correspondence with all environing influences and conditions.