

Pages 274-282 from Lyell, C. (1868). *Principles of Geology or the Modern Changes of the Earth and Its Inhabitants Considered as Illustrative of Geology*. 10th edition, Vol. 2. London: John Murray. i-xviii, 1-649.

The question of species as treated in the 'Vestiges of Creation'-- But, speaking generally, it may be said that all the most influential teachers of geology, paleontology, zoology, and botany continued till near the middle of this century either to assume the independent creation and immutability of species, or carefully to avoid expressing any opinion on this important subject. In England the calm was first broken by the appearance in 1844 of a work entitled 'The Vestiges of Creation,' in which the anonymous author had gathered together and presented to the public, with great clearness and skill, the new facts brought to light in geology and the kindred sciences since the time of Lamarck in favour of the transmutation of species and their progressive development in time. He availed himself of the generalisations of paleontologists on the changes observable in the fossil fauna and flora of successive epochs of the past, showing that the structural affinity was greatest in those which stood nearest each other in position when the strata were arranged in chronological order, and that there had been a gradual approximation of the animate world as it changed from period to period to the state of things now represented by the living creation.

The embryological investigations of Tiedemann and others were referred to as being in harmony with the doctrine of transmutation; the various phases of development through which a mammifer passes when in the foetal state representing in succession the likeness of a fish, reptile and bird, and lastly putting on the characters proper to the highest class of vertebrata. It was also suggested that these metamorphoses were comparable to the creative additions made in like chronological order to the organic world of past ages as revealed to us by the fossil remains preserved in the rocks. The arguments which Lamarck and others had derived from rudimentary organs in favour of their views were re-stated and their validity emphatically insisted upon. The unity of plan exhibited by the whole organic creation fossil and recent, and the mutual affinities of all the different classes of the animal and vegetable kingdoms, were declared to be in harmony with the idea of new forms having proceeded from older ones by generation, species having been gradually modified by the influence of external conditions.

Lamarck had rendered his hypothesis very complete by embracing without any essential change the notions of Aristotle as to spontaneous generation. The simplest rudiments or germs of life were assumed to be always coming into being. This would account for the present abundance of species of the lowest grades of animal and vegetable existence in spite of the constant advance throughout past time of the organic creation towards a more perfect state. In his eagerness to supply the evidence which was wanting to confirm the reality of the working of this part of the plan of nature, the author of the 'Vestiges' displayed an extraordinary want of philosophical caution. For he cited experiments which were supposed to prove that the action of a voltaic pile on a solution of potash could give origin to new species of insects. The careless way in which these experiments had been conducted contrasted in a striking manner with the extreme caution displayed by those who had been endeavouring to test the truth or falsehood of Harvey's dictum that 'every living thing comes from an egg.' The result of every increase in the power of the microscope had been to refute the theory of spontaneous generation, or at least to force the abettors of the old doctrine to take refuge in the obscure region of the infinitely minute. Distrust of the soundness of the

author's judgment was also engendered by a suspicion that he was not practically versed in the study of any one department of natural knowledge. Every weak point, moreover, in this treatise was exposed with unsparing severity by critics who were impatient of the popularity it enjoyed, in spite of the writer's adoption of Lamarck's doctrine that Man was not only the last link of a long series of progressive developments, but had been connected by descent with the inferior animals.

Wallace on species.--The next important effort to determine the manner in which new species may have originated was made in 1855 by Mr. Alfred Wallace in the "Annals of Natural History,"¹ in an essay entitled 'On the Law which has regulated the Introduction of New Species.' The opinions announced in this paper carried with them the authority of one who was well versed in several departments of natural history, especially ornithology and entomology. He had first explored during four years, conjointly with Mr. H. W. Bates, the valley of the river Amazons, and the neighbouring equatorial parts of South America, their expedition having been expressly undertaken to collect facts 'towards solving the problem of the origin of species.'² Mr. Wallace had afterwards, spent many years in studying the zoology of the Malay Archipelago, devoting his attention especially to the birds and insects; and the result of his experience, aided by the information obtained from geological writers, was summed up in the following proposition, 'that every species has come into existence coincident both in space and time with a preexisting closely allied species.'³ Mr. Darwin,⁴ when referring subsequently to this paper in his 'Origin of Species,' has stated that he knew from correspondence with Mr. Wallace that the cause to which he attributed the coincidence here alluded to was no other than 'generation with modification,' or, in other words, the 'closely allied anti-type' was the parent stock from which the new form had been derived by variation. All the most telling arguments which Lamarck had brought forward, and those drawn from various sources which the 'Vestiges' had superadded, in favour of species being the result of indefinite modification, instead of special creation, were briefly and ably summed up by Mr. Wallace; but it was clear that the evidence which had most powerfully influenced his mind, was that derived from his own experience of the geographical distribution of species, and especially of birds and insects.

In geography, he remarked, a genus or species rarely occurs in two very distant localities without being also found in the intermediate space; so in geology the life of a genus or species is not interrupted, no species having come into existence twice, or having been renewed after having once died out.

For the manner in which the gradual extinction of species had been brought about and was still in progress, Mr. Wallace referred to my chapter on that subject in the 'Principles of Geology,' confining his speculations to the manner in which new forms were introduced from time to time to replace those which were lost.

Darwin on Natural Selection and on the origin of species.-- Meanwhile Mr. Charles Darwin, well known by his 'Voyage in the Beagle,' and various works on Geology, had been for many years busily engaged in collecting materials for a great work on the origin of species; having made for that purpose a vast series of original observations and experiments on domesticated animals and cultivated plants, and having reflected profoundly on those problems in geology and biology which were calculated to throw most light on that question. For eighteen years these researches had all been pointing to the same conclusion, namely, that the species now living had been derived by variation and generation from those which had pre-existed, and these again from others of still older date. Several of his MS. volumes on this subject had

been read by Dr. Hooker as long ago as 1844, and how long the ever-accumulating store of facts and reasonings might have remained unknown to the general public, had no one else attempted to work out the same problem, it is impossible to say. But at length Mr. Darwin received a communication, dated February 1858, from Mr. Wallace, then residing at Ternate in the Malay Archipelago, entitled 'On the Tendency of Varieties to depart indefinitely from the Original Type.'

The Author requested Mr. Darwin to show this essay to me should he think it sufficiently novel and interesting. It was brought to me by Dr. Hooker, who remarked how complete was the coincidence of Mr. Wallace's new views and those contained in one of the chapters of Mr. Darwin's unpublished work. Accordingly, he suggested that it would be unfair to let Mr. Wallace's essay go to press unaccompanied by the older memoir on the same subject. Although, therefore, Mr. Darwin was willing to waive his claim to priority, the two papers were read on the same evening to the Linnaean Society and published in their Proceedings for 1858. The title of the chapter extracted from Mr. Darwin's MS. ran as follows: 'On the Tendency of Species to form Varieties, and on the Perpetuation of Species and Varieties by Natural Means of Selection.'

Already in the previous year, September 1857, Mr. Darwin had sent to Professor Asa Gray, the celebrated American botanist, a brief sketch of his forthcoming treatise on what he then termed 'Natural Selection.' This letter, also printed by the Linnaean Society together with the papers above alluded to, contained an outline of the leading features of his theory of selection as since explained, showing how new races were formed by the breeder, and how analogous results might or must occur in nature under changed conditions in the animate and inanimate world. Reference was made in the same letter to the law of human population first enunciated by Malthus, or the tendency in man to increase in a geometrical ratio, while the means of subsistence cannot be made to augment in the same ratio. We were reminded that in some countries the human population has doubled in twenty-five years, and would have multiplied faster if food could have been supplied. In like manner every animal and plant is capable of increasing so rapidly, that if it were unchecked by other species, it would soon occupy the greater part of the habitable globe; but in the general struggle for life few only of those which are born into the world can obtain subsistence and arrive at maturity. In any given species those alone survive which have some advantage over others, and this is often determined by a slight peculiarity capable in a severe competition of turning the scale in their favour. Notwithstanding the resemblance to each other and to their parents of all the individuals of the same family, no two of them are exactly alike. The breeder chooses out from among the varieties presented to him those best suited to his purpose, and the divergence from the original stock is more and more increased by breeding in each successive generation from individuals which possess the desired characters in the most marked degree. In this manner Mr. Darwin suggests that as the surrounding conditions in the organic and inorganic world slowly alter in the course of geological periods, new races which are more in harmony with the altered state of things must be formed in a state of nature, and must often supplant the parent type.

Although this law of natural selection constituted one only of the grounds on which Mr. Darwin relied for establishing his views as to the origin of species by variation, yet it formed so original and prominent a part of his theory that the fact of Mr. Wallace having independently thought out the same principle and illustrated it by singularly analogous examples, is remarkable. It raises at the same time a strong presumption in favour of the truth of the doctrine. Both writers referred to the number of the feathered tribe which perish

annually. 'Very few birds,' says Mr. Wallace, 'produce less than two young ones each year, while many have six, eight, or ten; and if we suppose that each pair produce young only four times in their life, each would at this rate increase in fifteen years to nearly ten millions, whereas we have no reason to believe that the number of the birds of any country increases at all in fifteen or even in 150 years. It is evident, therefore, that each year an immense number of birds must perish, as many in fact as are born; and as on the lowest calculation the progeny are each year twice as numerous as their parents, it follows that whatever be the average number of individuals existing in any given country, twice that number must perish annually.'

'Large broods are superfluous: on the average all above one become food for hawks and kites, wild cats and weazels, or perish of cold and hunger as winter comes on.'⁵ The most remarkable instance of an immense bird population is that of the passenger pigeon of the United States, 'which lays only one or at most two eggs, and is said to rear generally but one young one. Why is this bird so extraordinarily abundant, while others producing two or three times as many young are much less plentiful? The explanation is not difficult. The food most congenial to this species, and on which it thrives best, is abundantly distributed over a very extensive region, offering such differences of soil and climate, that in one part or another of the area the supply never fails. The bird is capable of very rapid and long-continued flight, so that it can pass without fatigue over the whole of the district it inhabits, and as soon as the supply of food begins to fail in one place is able to discover a fresh feeding-ground. This example strikingly shows us that the procuring a constant supply of wholesome food is almost the sole condition requisite for ensuring the rapid increase of a given species, since neither the limited fecundity, nor the unrestrained attacks of birds of prey and of man, are here sufficient to check it.'⁶

When pointing out how every variation from the typical form of a species gives an advantage to some individuals over others, Mr. Wallace shows that even a change of colour, by rendering certain animals more or less distinguishable, affects their safety. He also observes that in a state of nature, a race better fitted for changed conditions would never revert to the form which it had displaced; although in the case of domesticated animals allowed to run wild or become 'feral,' they must, to a certain extent, recover the character which they had lost during their subjugation to man, for reasons which will be explained in Chapter XXXVII. The essay concluded with some judicious criticisms on Lamarck's notion that animals may by their own efforts promote the development of some of their organs, or even acquire new ones. 'Changes,' says Mr. Wallace, 'have been brought about, not by the volition of the creatures themselves, but by the survival of varieties which had the greatest facilities of obtaining food. The giraffe did not acquire its long neck by desiring to reach the foliage of lofty trees and by constantly stretching out its neck for that purpose, but varieties which occurred with a longer neck than usual had an advantage over their shorter-necked companions, and, on the first scarcity of food, were enabled to survive them.'⁷

After the publication of the detached chapter of his book in the Linnaean Proceedings, Mr. Darwin was persuaded by his friends that he ought no longer to withhold from the world the result of his investigations on the nature and origin of species, and his theory of Natural Selection. Great was the sensation produced in the scientific world by the appearance of the abridged and condensed statement of his views comprised in his work entitled 'On the Origin of Species by means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life.' From the hour of its appearance it gave, as Professor Huxley truly said, 'a new direction to biological speculation,' for even where it failed to make proselytes, it gave a shock to old and time-honoured opinions from which they have never since recovered. It

effected this not merely by the manner in which it explained how new races and species might be formed by Natural Selection, but also by showing that, if we assume this principle, much light is thrown on many very distinct and otherwise unconnected classes of phenomena, both in the present condition and past history of the organic world.

FOOTNOTES

¹ Series 2, vol. xvi.

² Bates' Preface to his 'Naturalist on the River Amazons.'

³ Annals of Nat. Hist. ser. 2, vol. xvi. p. 186.

⁴ 1st ed. p. 355; 4th ed. p. 424.

⁵ Journ. of Linnaean Soc., vol. iii. p. 55. 1858.

⁶ Ibid. p. 55.

⁷ Journ. of Linnaean Soc. p. 61.