## Art. VIII.—DARWIN ON THE ORIGIN OF SPECIES.

*On the Origin of Species by means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life.* By Charles Darwin, M.A., F.R.S., F.G.S., F.L.S., &c., Author of "Journal of Researches during H.M.S. Beagle's Voyage round the World." London, 1859. Post 8vo, pp. 502.

*On the Tendency of Varieties to depart indefinitely from the Original Type.* By Alfred Russel Wallace. From "Journal of the Proceedings of the Linnæan Society," July 1, 1858.

*Essays on the Spirit of the Inductive Philosophy, the Unity of Worlds, and the Philosophy of Creation.* By the Rev. Baden Powell, M.A., F.R.S., F.R.A.S., F.G.S., Savilian Professor of Geometry in the University of Oxford. London, 1855. Post 8vo, pp. 503.

It has been calculated by an able naturalist,* on data which may be accepted as tolerably satisfactory, that the number of

* Swainson's Natural History and Classification of Quadrupeds, p. 28.

*distinct species* of Animals at present existing on the globe considerably exceeds *half-a-million;* about nineteen-twentieths of the whole being insects. Of Flowering Plants the number of species actually known to the botanist is commonly estimated at a hundred thousand; and if we include the Cryptogamia, and make allowance for the imperfect degree in which the botanical treasures of large portions of the surface of the globe have yet been searched out, the number of distinct species furnished by the vegetable kingdom would seem to be fairly set at a hundred and fifty thousand.

But even this aggregation, enormous as it is, would sink into insignificance if all the forms of organic life which have peopled our globe during the long succession of ages chronicled by the geologist, could be brought together within our mental view. For, looking to the large collection of types now extinct, which have been disinterred from a few scratches made here and there in the crust of the earth, it cannot be reasonably doubted that the whole number of fossil species of such animals as leave recognisable remains behind them must be many times as great as that of the forms which represent them at the present epoch. And if we further make due allowance for the fact, that the portion of the palæontological catalogue at present known to us really consists of but fragments of a few of the leaves of the great Stone Book, and that on the pages of that stone book a vast proportion of the past life of our planet can never by any possibility have recorded itself, we cannot fairly refuse to admit it as a probability (to which every new discovery gives additional weight), that the animal and vegetable life existing at any of that long succession of periods, each of which is marked out in geological time by a characteristic fauna and flora of its own, was at least as rich as it is at present, in regard alike to the number and to the variety of its distinct forms.

Now it seems to be a received article of faith, both amongst scientific naturalists and with the general public, that all these reputed species have (or have had) a real existence in nature; that each originated in a distinct act of creation; and that, once established, each type has continued to transmit its distinctive characters, without any essential change, from one generation to another, so long as the race has been permitted to exist. This idea of the *permanence of species,* embracing those of the common origin of all the individuals linked together by similarity of characters, and of the diverse origin of races distinguished by any marked and constant dissimilarity, is, in fact, embodied, in one shape or another, in every definition of the term which has been framed; and though some bold

speculator like Lamarck, or some ingenious theorist like the author of the *Vestiges*, has ventured from time to time to question the soundness of its basis, yet it has given no outward sign of instability, and is commonly regarded at the present time as one of those doctrines which no man altogether in his right senses will set himself up seriously to oppose.

Yet there have not been wanting indications, especially during the last few years, that a re-consideration of the whole subject is felt by several of the leading minds of our day to be called for by the progress of science; the difficulty of determining *what are* the characters as to which agreement shall be held to constitute specific identity, whilst disagreement shall be accepted as establishing specific diversity, having been found to increase instead of diminishing with the progress of knowledge. Differences of sufficient constancy and importance for the separation not merely of species, but of genera, in one group, may be found in another to be so inconstant that they cannot be admitted to rank higher than as individual varieties; and features of diversity which seem so well marked as to leave no room for hesitation when the comparison is limited to two or three individuals which exhibit them under their most pronounced aspect, are often found to shade off so gradationally when a large number of individuals are compared, that no lines of specific demarcation can be drawn among them. It has accordingly come to be recognised by many of our best zoologists and botanists, that no species can be fairly admitted as having a real existence in nature, until its *range of variation* has been determined both *over space* and *through time;* and that the species of the mere collector, who describes every form as new which does not precisely correspond with existing definitions, can only be accepted provisionally, to be verified or set aside by more extended research.*

A remarkable example of the results of an inquiry conducted in this spirit has lately made a considerable impression, alike on account of the nature of the subject and the deservedly high reputation of the naturalist by whom it has been conducted. No group of species has been more carefully or completely studied, after the ordinary fashion, than that of the British flowering plants and ferns. In Hooker and Arnott's *British Flora*, 1571 species of these were enumerated and described; whilst by Mr. Babington the number of species was raised to 1708. Within the last eighteen months, however, a new *British Flora* has been published by Mr. Bentham, one of those quiet painstaking workers who, not making fame but

* See on this subject Dr. Joseph D. Hooker's *Introduction to the New-Zealand Flora*, and Dr. Carpenter's *Memoir on Orbitolites* in the *Philosophical Transactions for* 1855, pp. 277 et sqq.

truth their goal, are content to spend as many years in the thorough investigation of a subject as other men bestow months. Mr. Bentham has devoted a large part of his time for many years past to the study of the British flowering plants, not as dried in herbaria, but as living and growing in their native habitats; and instead of confining himself to the area of our own islands, he has followed them to every part of Europe through which he has been able to trace them, carefully comparing the forms which they present under different conditions of soil, climate, exposure, &c., and diligently scrutinising with the educated eye of the really scientific botanist into the value of the distinctions, not merely among the species reputed doubtful, but among those commonly considered to be well established. The result has been, that not only has Mr. Bentham been led to add the weight of his authority to the side of those who pleaded for the wide range of variation in such genera as *Salix* and *Rubus*, regarding which there had been the greatest question; but he has shown that a considerable extent of variation is so far from being confined to willows and brambles, that the total number of well-marked species cannot fairly be reckoned at more than 1285; so that about a quarter of the reputed species of the British phanerogamic flora, on which so much pains have been bestowed and so many books written by botanists of the highest reputation, have been thus abolished "at one fell swoop."

Now this result, valuable as it is in itself, has a bearing of far deeper import upon the whole existing method of botanical and zoological systematisation; for it shows how far Nature is from tying herself down by the canons of species-mongers, and how mistaken has been the course of those who, instead of humbly searching for a knowledge of Nature's laws, have arrogated to themselves the right of making laws for Nature. The species of plants and animals which such men have added to our already overloaded catalogues, are of human, not of divine creation; and it is the business of the philosophic naturalist to get rid of all such as soon as possible. He cannot, however, proceed far in his inquiries, without having the question forced upon him as to the extent to which natural species,—that is to say, races which seem to be distinguished by certain constant characters that are transmitted by descent so far as our experience extends,—can be reasonably supposed to have varied *in time*, so as to have undergone in the lapse of ages, under the influence of natural causes, modifications at all corresponding with those which are presented by the races of plants and animals that have been subjected within a comparatively recent period to the influence of man.

This is a problem which Mr. Darwin has been for some years essaying to resolve. His attention was first directed to the inquiry by some facts which struck him in the distribution of the inhabitants of South America, and in the geological relations of the present to the past inhabitants of that continent, during that voyage on board H.M.S. *Beagle* of which he has given us so admirable a Journal. These facts seemed to him to throw some light on the origin of species—that mystery of mysteries, as one of our greatest philosophers has called it; and on his return home it occurred to him, in 1837, that something might perhaps be made out on this question by patiently accumulating and reflecting on all sorts of facts which could possibly have any bearing upon it. After five years' work, he allowed himself to speculate on the subject, and drew up some short notes; these he enlarged in 1844 into a sketch of the conclusions which then seemed to him probable; and from that time to the present he has steadily pursued the same object, with the intention of setting forth, not only his conclusions, but the mass of facts on which they are based, as soon as his imperfect health should permit him to complete a work so extensive. In the mean time it has happened that Mr. Wallace, an intelligent naturalist, who is at present engaged in studying the animal and vegetable productions of the Malay Archipelago, has arrived, without any knowledge of Mr. Darwin's inquiries, at a doctrine essentially the same as his own; namely, that a process of *natural selection* is constantly in operation, on a far grander scale, and with far more perfect results, than man can imitate; and that to this process, operating cumulatively through countless ages, we are justified in attributing an unlimited amount of divergence, not merely between species, but between genera, and, by parity of reasoning, even among the higher groups. A memoir on this subject having been sent to Mr. Darwin by Mr. Wallace, with a request that it should be forwarded to Sir C. Lyell, it was by the latter communicated to the Linnæan Society, and has been printed in its journal, together with extracts from Mr. Darwin's larger work; and as two or three years are likely still to elapse before the latter will be ready for publication, Mr. Darwin has complied with the urgent recommendations of his friends that he should at once put forth his views in a more concise form, so as to benefit the scientific world by such a knowledge of them as should enable them to take root in the minds of those who are not too much hardened by prejudice against their reception, and to bear good fruit by stimulating inquiry in the new direction he has opened up.

As the work before us is to be regarded but as the abstract of the larger treatise which Mr. Darwin has in preparation, we

feel it right to limit our discussion of it to an examination of the soundness of the main principle on which it is based. Minute criticism of details would, as it seems to us, be at present altogether misplaced. Indeed, we almost regret that the author has as yet gone into detail at all, since he has laid himself open to a great deal of objection on the score of minor difficulties, which will tend to prevent his fundamental doctrine from finding candid appreciation. And we cannot help thinking that it might have been better if, in this early stage of the inquiry, Mr. Darwin, like Mr. Wallace, had abstained from that explicit avowal of the ultimate conclusions to which it seems to him to lead, which will be pretty sure at once to frighten away many whom he might have otherwise obtained as adherents. Of course, if his principle be firmly based on truth, every thing that is legitimately deducible from it must also be true. But as it is in the nature of things impossible to obtain any thing like positive evidence on the remoter issues of the inquiry, we shall discard for the present all reference to the question whether (as Mr. Darwin thinks probable) men and tadpoles, birds and fishes, spiders and snails, insects and oysters, encrinites and sponges, had a common origin in the womb of time, and shall address ourselves only to the arguments urged by Mr. Darwin and Mr. Wallace in support of their doctrine of the modification of specific types by natural selection.

To such as look upon this question from the purely scientific point of view, any theological objection, even to Mr. Darwin's rather startling conclusion, much more to his very modest premises, seems simply absurd. We never heard of any body who thought that a religious question was involved in the inquiry whether our breeds of dog are derived from one or from several ancestral stocks; nor should we suppose that the stoutest believers in the Mosaic cosmogony would be much dismayed if it could be shown that the dog is really a derivation from the wolf. Orthodoxy (on this side of the Atlantic at least) is decidedly in favour of the abolition of the two-and-twenty species into which man has been divided by some zoologists, and of the reference of all the strongly-diversified races of man to the Adamic stock. We do not expect to see, even in our "most straitest" sectarian organs, any accusations brought against Mr. Bentham for impiety, because he affirms that three or four hundred of the reputed species of British plants are really descendants of others from which they have gradually diverged; and if he were led by the results of further inquiry to knock off as many more, we believe that he would be left to the criticism of his brother botanists, and that his *British Flora* would not run any risk of being put into the

Index Expurgatorius, alongside of Lamarck's *Philosophie Zoologique* and the *Vestiges of the Natural History of Creation.*

Why, then, should Mr. Darwin be attacked (as he most assuredly will be) for venturing to carry the same method of inquiry a step further; and be accused (in terms which it needs no spirit of prophecy to anticipate) of superseding the functions of the Creator, of blotting out his Attributes from the page of Nature, and of reducing Him to the level of a mere Physical Agency? To our apprehension, the Creator did not finish his labours with the creation of the protoplasts of each species; his work is always in progress; the origin and development of each new being that comes into life, is a new manifestation of his creative power; and the question is simply as to the mode in which it has pleased Him to exercise that power; whether, according to common ideas, He has every now and then swept off a greater or smaller proportion of the inhabitants of the globe, and has replaced them by new forms, brought into existence in some mode altogether unknown to us; or whether, as Mr. Darwin maintains, the apparent introduction of new forms has really been brought about by a gradual and successive modification of the old. For ourselves, we do not hesitate to say that the orderly and continuous working out of any plan which could evolve such harmony and completeness of results as the world of Nature (present and past) spreads out before us, is far more consistent with our idea of that Being who "knows no variableness, neither shadow of turning," than the intermittent action of a power that requires a succession of interferences to carry out its original design in conformity with successive changes in the physical conditions of the globe. And we have no sympathy with those who, to use the admirable language of Professor Powell (whose *Essay on the Philosophy of Creation* contains a masterly refutation of the current theological arguments bearing on this question), maintain that we "behold the Deity *more* clearly in the dark than in the light,—in confusion, interruption, and catastrophe, *more* than in order, continuity, and progress."

Our knowledge as to the Variability of Species in Time is of course mainly derived from observation of the changes induced by the agency of Man, in those species of plants and animals which have been longest subjected to the influence of cultivation and domestication; and although it may be questioned how far the modifications thus induced would tend to perpetuate themselves in a state of nature, yet we cannot shut our eyes to the fact that *the capacity for undergoing such modifications* under conditions how artificial soever, exhibits an elasticity of constitution which would equally tend to adapt these

animals to varieties of natural conditions, and thus to originate diversified races which would perpetuate themselves without man's interference. It may be well to adduce a few examples, in which peculiarities of organisation or constitution have sprung up and perpetuated themselves under the notice of competent witnesses. Such peculiarities have been ranked in two categories: those, namely, which are obviously "acquired" under the direct influence of external agencies; and those which, not seeming likely to have been thus occasioned, are spoken of as "spontaneous," or "accidental."

Of the acquirement of peculiarities, we have frequent experience in the changes which animals and plants undergo when they are transported to regions differing greatly in climatic conditions from those they previously inhabited. Thus the longest-woolled sheep that can be brought from Leicestershire or Sussex to the West Indies have their thick matted fleeces replaced in a year or two by short crisp hair; and in the lambs bred in their new country this hair is so brown as to render it somewhat difficult to distinguish them from the kids of the goats with which they are often seen associated. Sometimes the acclimatising process does not modify the character of the parent, but takes effect only on the young, born and bred under its influence. Thus, in a well-known case related by Sir C. Lyell, the English greyhounds that were taken out to hunt the hares which abound on a table-land in Mexico at an elevation of 9000 feet, were distanced in the chase by want of wind; yet the offspring of these same animals are not in the least incommoded by the rarity of the atmosphere in which they have passed their whole lives, but run down the hares with as much ease as the fleetest of their race in this country.

But peculiarities every now and then appear in the offspring at birth, which, not being traceable to any corresponding change of circumstances, are commonly regarded as "freaks of Nature;" such, for example, as the presence of a sixth finger, or of an additional joint in the thumb, on the human hand; or of that peculiar conformation of the limbs that distinguishes the "ancon" breed of sheep in New England; or the so-called "sporting" varieties of plants. No one, however, who believes in the universality of causation, can fail to perceive on reflection, that any such congenital peculiarities, like the differences among individuals of the same parentage, *must* have had their origin in the condition of the one or both parents at the time of procreation; and this inference is fully borne out by the special tendency of such peculiarities to become hereditary, though they frequently pass over a generation or two, to reappear in a subsequent one. The *latency* of such influences is often ex-

tremely remarkable; but sometimes we seem able to trace out their nature, though we cannot comprehend their mode of operation. Thus there is valid scientific evidence that the colour of the offspring of animals whose hue is disposed to vary, is influenced by strong mental impressions on the parents; and that it is in this way that variety of hue was first engendered in races previously of uniform colour, would seem to be indicated by the fact related by Mr. T. Bell, that a litter of puppies born in the Zoological Gardens from a male and female Australian dingo of pure breed, both of which were of the uniform reddish-brown hue that belongs to the race (the mother never having bred before), were all more or less spotted.

Now the art of the breeder consists first in carefully watching for this spontaneous appearance of any such peculiarities as he may deem it profitable to introduce, which then, by taking advantage of their tendency to become hereditary, especially when they are possessed by both parents, he establishes as the distinctive feature of a new race; and in this race he preserves them in full force by a rigorous weeding out of all the individuals which do not possess them. We cannot have a better example of this process than the recent creation of the Mauchamp breed of sheep, which produces a fine silky wool, distinguished by the strength as well as by the length and fineness of its fibre, and specially valuable for the manufacture of Cashmere shawls. In the year 1828, one of the ewes of the flock of merino sheep belonging to M. Graux, a farmer of Mauchamp, produced a male lamb, which, as it grew up, became remarkable for the silky character of its wool, and for the shortness of its horns; it was of small size, and of inferior general conformation. Desiring, however, to obtain other sheep having the same quality of wool, M. Graux determined to breed from this ram: at first he only obtained it in a single ram and a single ewe; in subsequent years he got it in a larger proportion of each progeny; and as his silky-woolled sheep multiplied, he was able to secure a constant succession by matching them with each other. Amongst the breed thus engendered, some resembled the ancestral ram in its physical defects as well as in its wool; but others, while possessing the same character of wool, reverted to the more symmetrical form of the breed from which this was an offset; and M. Graux, by a judicious system of crossing and intercrossing, at last established a race which not only possesses the silky wool of the first ram without the least deterioration, but is entirely free from its defects of general conformation.

The agency of Man in this procedure is that of *accumulative selection*. He can do nothing except on the basis of variations which are first given to him in some slight degree by nature

(the origin of such variations, however, being in the modifications induced by external conditions in the procreative action of the parents); these, which would soon disappear if left to themselves, by merging in the general aggregate, he not only perpetuates by selection, but augments by accumulation, adding them up (as Mr. Darwin felicitously phrases it) in certain directions useful to him. Now there are instances in which *varieties* have been thus engendered, differing so much from their original stock and from each other, that, if they were to be placed before a zoologist ignorant of their genetic relationship, he would unquestionably rank them not only as *distinct species*, but even as belonging to *distinct genera*. This is the case, for example, with the various heads of pigeons, which have been closely studied by Mr. Darwin. The English carrier, the short-faced tumbler, the runt, the barb, the pouter, and the fantail, differ from each other not merely in their plumage, but in those points of conformation of beak and skull on which generic distinctions among birds are chiefly founded; and subordinate to each of these breeds are several regularly propagating sub-breeds, which differ as much from each other in characters of minor importance as species do elsewhere. Yet there is no ground for questioning the general belief of scientific ornithologists, that all these breeds have had their origin in the rock pigeon; especially as the comparison of a large number of individuals of these breeds and sub-breeds, including those brought from distant countries, would enable an almost perfect gradational series to be formed between the types that differ most widely in structure.

It is obvious, then, that by such a process what we may designate as *Naturalists' species* might be artificially created to any extent. The question now arises, whether truly *Natural Species* can have been engendered in a similar manner; that is to say, whether any thing like accumulative selection has gone on amongst plants and animals in their feral state, by which the vast multitude of diverse forms now existing may have been evolved from a comparatively small number of original types, and that wonderful series of extinct forms may have been produced, which palæontology reveals to us as having peopled and repeopled our globe many times through the immeasurable succession of geological ages.

The answer to this question, according both to Mr. Darwin and Mr. Wallace, is to be found in a careful examination of the facts relating to the Struggle for Existence which all wild animals have to maintain. "The full exertion of all their faculties and all their energies," it is observed by Mr. Wallace, "is required to preserve their own existence, and provide for that of their in-

fant offspring. The possibility of procuring food during the least favourable seasons, and of escaping the attacks of their most dangerous enemies, are the primary conditions which determine the existence both of individuals and of entire species." It is remarkable how little the relative fecundity of different species influences their relative abundance or scarcity. We do not find those populations (if we may so use the term) increasing at the greatest rate, whose reproduction is the most rapid. There are many species of fish, for example, in which the eggs annually produced by each female are to be reckoned by the hundred thousand; and if but one in a thousand of her progeny were to come to maturity, the ocean-waters of the whole globe, from their surface to their lowest depths, would in a few years be turned into a mass of finny life. The multiplication of the common flesh-fly, if not kept down by natural checks, takes place at such a rate, that, according to the estimate of Linnæus, three of these insects and their progeny would devour the carcass of a dead horse more quickly than a lion would do. The Aphides, or plant-lice, have been proved to propagate so rapidly, that in the course of a few months, if all interference were excluded and adequate supplies of food were obtainable, no fewer than 1,000,000,000,000,000,000 would be evolved from a single individual; an amount which only becomes conceivable, when we learn that this mass of life would weigh somewhere about as much as *five hundred millions* of stout men.

Yet we find no reason to believe that there is a permanent increase in the number of any one of these or other productions of the inexhaustible fertility of nature. Our seas are so far from being glutted with fish, that the complaint is rather of their diminished abundance; and though this might be attributed with a show of reason to the hostile influence of man, yet when we bear in mind that even the vast shoals of herrings, pilchards, and mackerel, which he captures, *might* be the offspring of a few score of individuals, it is obvious that these would be replaced at least as rapidly as they are withdrawn, if there were no more powerful check to the increase of their respective tribes. So again, although we are sometimes inconvenienced by the swarms of flesh-flies that have been bred in some neighbouring mass of putrescence which the neglect of man has left to be removed by these scavengers of nature, we are not eaten out of house and home by them, as we very soon should be, if their reproduction were not kept most efficiently in check by the voracity of other animals to which they serve as a prey. Our roses and our hops are most seriously damaged every now and then by the excessive multiplication of the species of plant-lice which respectively attack them; but all the

roses and all the hops in the world would soon be destroyed, if the occasional increase of their insect blights were not restrained within bounds by the destruction, through natural agencies, of a vast proportion of every brood engendered. The population of each tribe is, in fact, kept down to a certain general average, subject to occasional excess or reduction, within no very wide limits.

There is no need, however, to go beyond the limits of our own familiar experience in search of evidence of the same general fact; an apposite illustration of which is found, both by Mr. Wallace and Mr. Darwin, in the class of birds. If we take *four* as the average annual production of a single pair, it is easily shown that, if there were no check to the multiplication of its progeny, this would increase within fifteen years to nearly *ten millions*. Yet we have no reason to believe that the bird-population of any country is undergoing an increase. And hence it becomes evident that in each year *as many birds perish as are born;* that is, the progeny being twice as numerous as the parents, whatever be the average number of individuals existing in any given country, *twice that number must perish annually*, either serving as food to hawks and kites, wild cats and weasels, or dying of cold and hunger as winter comes on.

How much more the multiplication of individuals of any type depends upon the general capabilities of the species than upon the number of its progeny, is remarkably illustrated by the case of the American passenger-pigeon, cited by Mr. Wallace. Though this bird lays but one or two eggs, and is said generally to rear but a single young one, yet it is far more abundant than other species which produce two or three times as many young; the vast flocks of these pigeons, whose migrations in search of food are so graphically described by Audubon, being the most extraordinary aggregations of animal life of which we have any knowledge. How are we to account for the maintenance of this wonderful bird-population, which probably exceeds that of any other half-dozen species in the American continent? Obviously by the fact that the food most suitable to this species is abundantly distributed over a very extensive region, offering such differences of soil and climate, that in one part or other of the area the supply never fails; whilst, on the other side, the organisation of the bird enables it to take advantage of this wide distribution of its means of sustenance, its powers of flight being remarkable both as to swiftness and endurance, so that it can pass without fatigue over the whole of the district it inhabits, and thus, when the supply of food begins to fail in one place, it is able to migrate in search of a fresh feeding-ground even at a remote distance. In no other birds are these conditions so strik-

ingly combined; for either their food is more liable to failure, or they have not sufficient power of wing to search for it over an extensive area, or during some season of the year it becomes very scarce, and less wholesome substitutes have to be found; and thus, though more fertile in offspring, they can never increase beyond the supply of food in the least favourable seasons.

Nothing is easier, as Mr. Darwin justly remarks, than to admit in words the truth of this universal struggle for life; nothing more difficult than to trace out this general fact in all its bearings. The system of checks and counter-checks provided in the economy of nature is a most complicated one; and we are for the most part only let a little way into the secrets of her arrangement, by some local disturbance in its harmonious working. Thus in Paraguay neither cattle nor horses nor dogs have ever run wild, although they swarm both southward and northward, in a feral state; and this limitation is due to the greater abundance in that area of a certain fly, which lays its eggs in the navels of these animals when first born. The increase of these flies, numerous as they are, must be habitually kept in check by some means, probably by birds. Hence, if certain insectivorous birds (whose numbers are probably regulated by hawks or beasts of prey) were to increase in Paraguay, the flies would decrease; then cattle and horses would become feral, and this would greatly alter the vegetation (as Mr. Darwin has himself observed in parts of South America); this, again, would largely modify the insects; this would affect the insectivorous birds, and so on in ever-extending circles of complexity. "Battle within battle must ever be recurring, with varying success; and yet in the long-run the forces are so nicely balanced, that the face of nature remains uniform for long periods of time, though assuredly the merest trifle would often give the victory to one organic being over another."

A very close connection often exists between agencies that would not at first be supposed to have any mutual relation. How, for example, could the number of domestic cats in a village be imagined to influence the Flora of the neighbourhood? Mr. Darwin shall make answer in his own words:

"I have reason to believe that humble-bees are indispensable to the fertilisation of the heartsease; for other bees do not visit this flower. From experiments which I have tried, I have found that the visits of bees, if not indispensable, are at least highly beneficial to the fertilisation of our clovers; but humble-bees alone visit the common red clover, as other bees cannot reach the nectar. Hence I have very little doubt that if the whole genus of humble-bees became extinct or very rare in England, the heartsease and red clover would become very

rare, or wholly disappear. The number of humble-bees in any district depends in a great degree on the number of field-mice, which destroy their combs and nests; and Mr. H. Newman, who has long attended to the habits of humble-bees, believes that 'more than two-thirds of them are thus destroyed all over England.' Now the number of mice is largely dependent, as every one knows, on the number of cats; and Mr. Newman says, 'Near villages and small towns I have found the nests of humble-bees more numerous than elsewhere, which I attribute to the number of cats that destroy the mice.' Hence it is quite credible that the presence of a feline animal in large numbers in a district might determine, through the intervention first of mice and then of bees, the frequency of certain flowers in that district."

One would almost think, in reading Mr. Darwin's string of sequences, that the ingenious author of *The House that Jack built* had intended to imbue the infant mind with a knowledge of high scientific truths; for the whole of the foregoing extract may be concisely expressed, after the fashion of that immortal legend, in the following brief sentence: "This is the old woman, that kept the cat, that ate the mouse, that killed the humble-bee, that fertilised the clover." And it is obvious that if our country were in the condition of Paraguay, an abundance of wild clover would favour the increase of feral herds of cattle, which, in its turn, would operate extensively in modifying the general flora and fauna of the country.

It is only in a somewhat metaphorical sense that the term "struggle for existence" can be used with respect to plants; but when so understood, it is as applicable to their life as to that of animals. A plant which annually produces a hundred seeds, of which, on an average, only one comes to maturity, may be said to struggle against the other plants which tend to crowd out both itself and its progeny, against the animals which feed upon it in every stage of its development, and against all the physical conditions which are unfavourable to it, whether as to soil or exposure, heat or cold, drought or excessive moisture, or the like. We have many instances of the rapid multiplication and diffusion of particular species, which seem extraordinary only because they are exceptional; the peculiarity depending, not on any unusually rapid production, but simply on the absence of the ordinary repressing agencies. Cases could be given of introduced plants, which have become common throughout whole islands in a period of less than ten years; and in some of the most remarkable of these the extension has not been so much effected by seeds as by the ordinarily slower process of budding. Thus the *Anacharis alsinastrum*,' a water-weed, which was imported into this country a few years ago from Canada, has made its way into almost every one of our rivers

and canals, and into many of our isolated lakes and ponds, which can only be kept from being choked with it by the employment of artificial means for its destruction; yet this plant has never flowered in Britain, and the thousands of tons of its stalks and leaves which might be annually collected from various parts of our island, are really all extensions of the single individual originally imported. We believe that the like may be said of the Indian couch-grass, which is rapidly extending itself through the cultivated pastures of New South Wales, and which will probably ere long displace other grasses in the remoter parts of that colony, whence it will extend over the rest of Australia. Several of the plants now most numerous over the wide plains of La Plata, clothing square leagues of surface, almost to the exclusion of other plants, have been introduced from Europe; and there are plants now ranging in India from Cape Comorin to the Himalaya, which have been imported from America since its discovery. There is no reason whatever to suppose that in such cases (of which many more might be cited) the fertility of the plants has been temporarily increased in any sensible degree. The obvious explanation is, that, on the one hand, the conditions of life have been sufficiently favourable to promote their vigorous growth and reproduction; whilst, on the other, there has been an absence in their new habitats of those checks which previously restrained their exuberance.

Of the nature of these checks we shall cite an illustration or two from Mr. Darwin. Every one knows that an immense destruction of seeds in process of ripening is occasioned by the voracity of granivorous birds; but even when seeds have fallen into a favourable soil, and have begun to germinate, the young plants have from the first to struggle for their lives, partly against the other plants which already thickly stock the ground, partly against the animals to which they serve as food at that stage of their existence. On a piece of ground three feet long and two wide, dug and cleared, in which there could have been no choking from other plants, Mr. Darwin marked all the seedlings of our native weeds as they came up; and out of 357, no fewer than 295 were destroyed, chiefly by slugs and insects. If turf which has long been mown, or turf which has been closely browsed by quadrupeds, be let to grow, the more vigorous plants gradually kill the less vigorous though fully grown plants; thus out of twenty species growing on a little plot of turf (three feet by four), nine species perished from the other species being allowed to grow up freely.

The competition which it has to sustain with other tribes of plants, is considered by Mr. Darwin to be an agency at least as important as climate in determining the geographical range

of any particular species. If we look at a plant in the midst of its range, we see that it is not climate that restrains it from doubling or quadrupling its numbers; for we know that it can perfectly withstand a little more heat or cold, a little more dampness or dryness, since elsewhere it ranges into slightly hotter or colder, damper or drier districts. But towards the confines of its climatic range it will be subject to the competition of other plants, whether of its own kind or of some other, for the spots most favourable to it in regard to warmth or coolness, exposure or protection, dryness or moisture. And thus it seems probable that few plants (and the same will be true also of animals) range so far that they are destroyed by the rigour of the climate alone. It is from this circumstance that so large a proportion of the plants which have been introduced into this country from foreign sources, and which have become perfectly acclimatised, are still restricted to our gardens; being incapable of perfect naturalisation, since they cannot compete with our native plants, nor resist destruction by our native animals.

It is impossible now to pursue the inquiry as to this system of checks and counter-checks in any further detail, so countless are its ramifications, and so complex are its interlacements. And it is far better for our present purpose to fix our minds upon the general fact, about which there can be no kind of doubt or dispute, that each organic being is striving to increase in a geometrical ratio; but that, either through the whole of its life or at particular periods of it, either during each generation or at frequently-recurring intervals, it is subject to heavy destruction, by which its multiplication is so restrained that its numbers are merely kept up to a certain average, without more than temporary excess or diminution, so long as the conditions remain the same. Lighten any check, mitigate the destruction ever so little, and the number of the species will almost instantaneously increase to any amount; as we see in the increase of cockchafer-grubs and wire-worms that ensues on the foolish destruction of a rookery. Where, on the other hand, the excessive multiplication of a newly-introduced species becomes (as in the case of the *Anacharis*) a serious inconvenience, it is obvious that the only effectual check is to be found in the encouragement of its natural enemies, the species of animals (whatever they may be) to which it serves as food.

But how will this constant struggle for existence tend to the modification of specific types? We shall let Mr. Darwin answer this question in his own words, since these words convey, not only with scientific conciseness, but with philosophical caution, the fundamental idea of his whole treatise:

"Let it be borne in mind in what an endless number of strange peculiarities our domestic productions, and in a lesser degree those under nature, vary, and how strong the hereditary tendency is. Under domestication it may be truly said that the whole organisation becomes in some degree plastic. Let it be borne in mind how infinitely complex and close-fitting are the mutual relations of all organic beings to each other, and to their physical conditions of life. Can it, then, be thought improbable, seeing that variations useful to man have undoubtedly occurred, that other variations, useful in some way to each being in the great and complex battle of life, should sometimes occur in the course of thousands of generations? If such do occur, can we doubt (remembering that many more individuals are born than can possibly survive) that individuals having any advantage, however slight, over others, would have the best chance of surviving, and of propagating their kind? On the other hand, we may feel sure that any variation in the least degree injurious would be rigidly destroyed. This preservation of favourable variations, and the rejection of injurious variations, I call Natural Selection. Variations neither useful nor injurious would not be affected by natural selection, and would be left a fluctuating element, as perhaps we see in the species called polymorphic."

Now by so much the more diversified the descendants from any one species become in structure, constitution, and habits, by so much will they be better enabled to seize on many and widely diversified places in the polity of nature, and so be enabled to increase in numbers. It is easily shown that the advantage of diversification among the inhabitants of the same region, is really the same as that of the physiological division of labour in the animal body; a greater number of plants and animals of different kinds being able to subsist within a limited area, than could find support if they were all of one type. It is obvious, then, that natural selection will favour divergence of character, and that the tendency of each specific type will be not only to diffuse itself over as wide an area as it is capable of occupying, but to undergo as many diversified modifications as its constitution may permit, in conformity with the diversities of climate, locality, food, and the countless other conditions with which it comes into relation; those diversified forms establishing themselves permanently as *new races*, which are best fitted to fight their way in the struggle for existence. Even a very limited experience affords many instances of natural specialisation of habit, which often bear an obvious relation to specialisation of structure. It is well known that one Cat is prone to catch rats rather than mice, and that this tendency is often inherited; other cats exhibit sporting propensities of different kinds, one bringing home winged game, another hares or rabbits, while another hunts on marshy ground, and almost nightly catches woodcocks or snipes. Recent observations on the Cuckoo have

shown that this bird deposits its eggs in the nests of no fewer than twenty-eight different species, and that the cuckoo's egg almost invariably agrees so closely in colour with the eggs among which it is laid, as only to be distinguished from them by a practised eye. This curious fact has been accounted for on the hypothesis that the sight of the eggs amongst which she is about to lay her own, operates through the consciousness of the parent in determining the colour of its shell. But as observation shows that the same individual cuckoo always lays eggs of the same colour; that the cuckoo's eggs are laid upon the ground in the first instance, and are afterwards conveyed in its mouth to the nest of the foster parent upon whose charge the young cuckoo is forced; and that when a nest with eggs of the corresponding colour is not accessible, the egg is deposited in that of some other species,—it seems clear that the colour of the egg is predetermined in the organisation of the parent, and that it is connected with an instinct which leads different individuals constantly to resort to different nests.

Again, the Catskill mountains of the United States are inhabited by two varieties of the Wolf: one with a light greyhound-like form, which pursues deer; and the other more bulky, with shorter legs, which more frequently attacks shepherds' flocks. Here we can readily see how very divergent varieties might originate from a common stock, and be perpetuated by the operation of natural selection. Wolves inhabiting a mountainous district, and those frequenting the lowlands, would naturally be forced to hunt different prey; any slight change of organisation that might specially adapt an individual wolf to either mode of life would give it the advantage in the struggle for existence, and would favour not only the prolongation of its own life, but its chance of leaving offspring; some of its young would probably inherit the same peculiarities, and would in like manner transmit them to their descendants; and thus, from the preferential preservation of the individuals best fitted to the requirements of each locality, two types distinct in structure and habits, not merely from each other, but also from their common progenitor, would gradually be evolved. Supposing, again, that the conditions of the country changed in such a manner as to affect the supply of food,—the deer, for example, increasing in numbers, and the other prey decreasing in abundance,—during the season of the year when the wolf is most hardly pressed for subsistence; it is quite obvious that a large proportion of the lowland variety must soon perish from starvation, through the failure of their ordinary means of support, the greater abundance of deer being of no use to animals which had lost the capability of profiting by it; whilst, under the

same circumstances, the mountain variety would both increase in numbers and would improve in swiftness. And conversely, if the supply of deer were to diminish, and the wolves were obliged to depend upon prey which it requires strength rather than swiftness to master, the mountain variety would be reduced in numbers; whilst the more bulky lowlanders would both increase in population, and would improve in special adaptation to the requirements of their mode of life.

A number of very marked examples of the influence of natural selection in the establishment and perpetuation of races having special adaptations to particular climatic conditions would be found, we have reason to believe, among the feral descendants of the domesticated quadrupeds first introduced into South America by the Spaniards; and we anticipate that much novel information on the subject will be made public in Mr. Darwin's more detailed treatise. But the following instance, recorded by M. Roulin, seems to us to be so peculiarly apposite to the present inquiry as to deserve special mention. In some of the hottest provinces of South America, a race of oxen has spontaneously sprung up, distinguished by the peculiar clothing of its hide, which consists of a fine but extremely scanty fur. This race is incapable of maintaining itself elsewhere, the "pelones" (as these oxen are termed) being too delicate in constitution to bear the cold of the Cordilleras, to which the cattle are driven for the provision of the towns situated upon them; and the breed is therefore not encouraged by human agency. On the other hand, when oxen of other breeds are driven into the provinces inhabited by these "pelones," they either speedily die out, or they become gradually and with difficulty acclimatised. In the same hot provinces another curious variety of oxen presents itself, characterised by the entire absence of hair; these naked-skinned oxen, termed "calougos," are even more delicate in constitution than the "pelones," being utterly unable to bear a climate colder than their own. Here, then, we have the spontaneous establishment, within a limited area, of breeds of oxen distinguished by peculiarities quite striking enough to be elsewhere accounted characteristic of different species. These peculiarities, whilst such as adapt them to a set of circumstances which are highly unfavourable to the continued existence of the type from which they sprang, on the other hand render them incapable of maintaining their ground under conditions which are eminently favourable to their ancestral race. And it seems impossible to account for the phenomenon upon any other principle than that of *natural selection*, as advocated by Mr. Darwin and Mr. Wallace.

This case further illustrates the marked difference in the

conditions and results of *natural* and *artificial* selection; a difference which prevents the deduction as to the permanence of species, which has been drawn from the instability of the peculiarities impressed on domesticated races by the agency of man, from being in the least applicable to divergent forms that have developed themselves in conformity with the peculiarities of their natural conditions. As Mr. Darwin has justly remarked, "man selects only for his own food, nature for that of the being which she tends." Many of the qualities which are most valued in the state of domesticity, are such as would render the animal utterly unfit to maintain its ground in the struggle for life when left to its own resources. The sleek-coated London carriage-horse, and the stall-fed dairy-cow that gives her twenty or even thirty quarts of milk per day, can only be kept up to such an artificial standard of perfection by a treatment that seriously impairs their constitutional stamina; so that they succumb to depressing influences which would have no effect upon hardy Dartmoor ponies or vigorous Ayrshire cattle: just as the massive bulk and vast strength of the brewer's drayman are often suddenly laid low by the results of an injury which in a truly healthy countryman would be too slight to require attention. Our breeds of quickly-fattening pigs, short-legged sheep, poodle-dogs, pouter-pigeons, and the like, never could have established themselves in a state of nature, because the very first step towards such inferior forms would have led to the rapid extinction of the race; still less could they now maintain a competition with their wild allies. The great speed but slight endurance of the race-horse, the unwieldy strength of the ploughman's team, would both be useless in a state of nature; so that, if turned wild upon the pampas, such animals would either soon become extinct, or, if placed in circumstances sufficiently favourable for their maintenance, would lose in successive generations those extreme qualities that are rather detrimental than beneficial to them, and would revert to that common type in which the various powers and faculties are so proportioned to each other as to be best adapted to procure food and secure safety. Thus, then, as Mr. Wallace justly remarks, "domestic varieties, when turned wild, *must* return to something near the type of the original wild stock, or *become altogether extinct.*"

It will not be only on the more important features of the organisation, that Natural Selection will exert its modifying influence; it will often affect characters which we are accustomed to regard as trivial—for instance, *colour*. Among insects and birds we may trace a marked relation between the hue of different tribes and the tints of the spots they respectively fre-

quent, which is obviously a means of passive defence to them against their enemies. Thus leaf-eating insects are green, and bark-feeders mottled gray; the larvæ of the Phasmidæ (or spectre-insects) can scarcely be distinguished in appearance from the dead sticks on which they are commonly found; and the Mantis derives its common name of "walking-leaf" from a resemblance to that object, so close as to deceive any but a near inspection. So, again, the red grouse has very much the colour of heather; the black grouse, that of peaty earth; and the ptarmigan in winter that of snow. These birds would multiply very rapidly if they were not kept under by birds of prey, which are known to be guided chiefly by eyesight; and any deviation from the hue most favourable to escape from their notice would almost certainly ensure the early destruction of the individual that presented it: so that as complete and constant a uniformity would be maintained by natural agencies, as the breeder of white sheep maintains among his flock by the jealous destruction of every lamb that exhibits the faintest trace of black. So among plants, although the down on the fruit, and the colour of its flesh, are considered by botanists as characters of the most trifling importance, yet there is good evidence that in the United States smooth-skinned fruits suffer far more than those with down from the attacks of the curculio-beetle; that purple plums are more liable than yellow plums to a particular disease; whilst another disease attacks yellow-fleshed peaches far more than those with other-coloured flesh. If, with all the aids of art, such slight diversities make a great difference in the success with which the several varieties can be cultivated, assuredly in a state of nature, where the trees would have to struggle with other trees and with a host of enemies, such differences would effectually settle which variety, whether a smooth or a downy, a yellow or a purple-fleshed fruit, should continue to flourish.

The modifying tendency of Natural Selection, then, will be twofold: on the one hand, to the origination and maintenance of races diverging in various directions and degrees from the original type; on the other, to the extinction of all such as are overmastered in the struggle for existence by the greater energy or more perfect adaptation of other races. And we think Mr. Darwin quite justified in the conclusion, that "whatever the cause may be of each slight difference in the offspring from their parents,—and a cause for each must exist,—it is the steady accumulation, through Natural Selection, of such differences, when beneficial to the individual, that gives rise to all the more important modifications of structure, by which the innumerable beings on the face of this earth are

enabled to struggle with each other, and the best adapted to survive." And we fully agree with him, that *individual* differences, though hitherto accounted as of small interest to the systematist, are of high importance in any philosophical inquiry into the origin of species, as being the first step towards those slighter varieties which are barely thought worth recording in works on natural history. So varieties which are in any degree more distinct and permanent, are steps in a regular gradation that leads through more strongly-marked and more permanent varieties to sub-species, and thence to species. The permanence of each race will thus depend on the permanence of the conditions in which it is placed. So long as these remain unchanged, the adapted form that has been once established as the best will continue to hold the mastery; and all aberrations from it that unfit the subject of them for maintaining its ground in the battle for life will be borne down in the *mêlée*. But let a change take place in any of the conditions, however trivial they may appear, that either affect the organism directly (as is the case with temperature, hygrometric state, pressure of the air or water), or do so by an alteration in its relation to other organisms (as by affecting its supply of food, or its means of obtaining it, or by subjecting it to attacks which require increased means of resistance or escape), the race must either be capable of adapting itself to that change, or it must succumb. In the one case, the original form will give place to some modification directly proceeding from it by genetic descent; in the other, it will be superseded by some rival form derived from a different ancestry, which presses in and occupies its place; just as we see, in the social battles of life, that the families of our older aristocracy hold their ground, or are displaced by the *parvenus* whom they regard as their natural enemies, in proportion as they either adapt themselves to the spirit of the age and take advantage of its requirements, or as they hold tenaciously to their time-honoured customs, and refuse to profit by any thing that shall lower them in their own artificial scale of dignity.

We are disposed to believe, then, that Mr. Darwin and Mr. Wallace have assigned a *vera causa* for that diversification of original types of structure which has brought into existence vast multitudes of species, sub-species, and varieties, referable to the same generic forms; and we think that the weight of evidence is decidedly in favour of such an extension of this doctrine from the present to the past, as will enable us to account for the modification of specific types which is presented to us as we pass from one geological formation to another. It will probably meet with less opposition among British than among continental palæontologists; for with the former it has

come to be generally admitted that many species really do range through a long succession of formations; whilst with some of the latter it is sufficient for shells or corals to present themselves in two different strata, to establish their specific diversity, however close may be their structural conformity. Are such the men, we would ask, whose opinion should have any weight in a discussion like the present? They are of the same class with the botanists who make new species of our commonest plants, because they find them in remote parts of the globe; and who affirm that an Australian or a New-Zealand species *cannot* be identical with a European, for no other reason, that we can discover, than that they have established in their own minds as a law of nature that the species of the northern and southern hemispheres *must* be dissimilar.

Now the tendency of all modern geological inquiry has been, as has been well stated by Professor Powell,* to substitute the idea of *continuous* for that of *interrupted* succession, of physical change; in breaking up large divisions into smaller; in obliterating sharp lines of demarcation by subordinate gradations; in tracing intermediate deposits in one locality which fill up breaks in another; and in thus connecting more and more closely with each other the successive members of the series of stratified deposits. And though we may be as yet very far from realising this in all instances, yet no one who has followed the progress of geological research for the last quarter of a century, can refuse to admit that the general doctrines originally enunciated by Sir Charles Lyell on this subject have been progressively acquiring a firmer basis and a more extended application. The doctrine of continuous succession, once admitted in physical geology, seems almost to necessitate the admission of the like doctrine as a corollary in regard to the succession of organic life; and such a deduction is fully borne out by our present knowledge of the relation of our existing fauna and flora to that of the later tertiary and post-tertiary epochs. "Throughout all the most recent formations," again to use the language of Professor Powell, "we find a continuous series of allied species, and a succession of organised structures, in a chain absolutely unbroken, and marked only by the minutest specific differences in its successive links, down to forms now existing; and as this is carried backwards through countless ages, by degrees we find fewer features of the present and more of the past, and even come to whole genera and orders of extinct races coexisting with some which have survived them." And though at intervals in the course of this series of close and continual connection, there

* Unity of Worlds, p. 335.

are real or apparent interruptions of greater or less magnitude, in which the immediate affinity seems broken off between the species characterising one formation and those most nearly allied to them in the next, yet the only fair inference from such a fact would be that no fossiliferous deposits took place *in that locality* during a long series of ages, through which a progressive change of organic forms was going on elsewhere, that marked itself in the entire change of specific and generic types presenting themselves in the next deposit in the first locality. A geologist who had formed his notions of the succession of strata only from the study of those wide areas in the continent of America over which the palæozoic are immediately overlaid by the tertiary formations, would be justly rebuked by his European brother for ignoring the whole series of secondary strata, and the varied forms of life which they contain; yet there are still geologists in this country who have the presumption to affirm, that because the continuity both of stratification and of organic life seems to have been completely interrupted at the end of the palæozoic period in the limited areas hitherto explored, such interruption must have prevailed universally over that vast proportion of the earth's surface of whose geological history we know absolutely nothing. As regards the supposed break between the latest secondary and the tertiary strata, the tendency of recent inquiries has most unequivocally been to remove the difficulties which have been urged on the strength of it; the study of the strata which intervene between the chalk and the nummulitic limestone of the south of Europe having revealed an unexpected continuity alike in stratification and in the succession of organic forms. And the more carefully the cretaceous, and even the oolitic, as well as the early tertiary fossils are compared with existing types, the more numerous are the instances that are found to present themselves, in which their conformity is so close as fully to sanction the idea of the continuous descent of the latter from the former, with more or less of intervening modification.

Of such modifications, occurring under circumstances which permit both their source and their continuity to be traced out, we may cite a characteristic example in the changes presented by certain univalve shells that occur in three successive beds in the tertiary formations of the Island of Cos, as described by the late Professor E. Forbes. The genera in question (*Paludina* and *Neritina*) are remarkable for their power of sustaining considerable alterations in the nature of the medium they inhabit: for although properly fresh-water mollusks, they are not limited to lakes and rivers, but are often found in estuaries, in which they are either subjected to alternations of salt water with fresh,

or live in water which is pretty constantly brackish. Now the lowest of the beds just referred to is obviously of purely fresh-water formation; for there are embedded in it, with Paludinæ and Neritinæ of their ordinary smooth and unwrinkled type, various species of shells that could not have inhabited any other medium—amongst others, pulmoniferous water-snails. In the second bed, however, these last, with other forms most rigidly limited to fresh water, disappear; whilst the Paludinæ and Neritinæ have their shells belted by a strong fold or corrugation, such as is presented by existing shells of the same tribes inhabiting waters with a slight admixture of brine. And in the third all the fresh-water forms are wanting, save such as are known to be capable of living in brackish estuaries, and are replaced by marine shells, which have a like power of partial adaptation; and the shells of the Paludinæ and Neritinæ are deeply furrowed and surrounded by strong spiral ridges. The subsequent formations, which overlie these unconformably, are undoubtedly of purely marine origin. There seems no room for doubt, then, that the changes in the circumstances under which these successive beds were formed, were such as intermixed progressively increasing proportions of salt water with the stream of fresh water by which the materials of the lowest bed were deposited; and that by this increase was effected such a gradual change of type in the shells of the Paludinæ and Neritinæ, from the forms of the first to those of the third bed, as would, if the intermediate link had not been presented to us in the second bed, or the parallel modifications occurring in these genera at the present time had been unknown, have been held by the conchologist fully to justify him in referring those forms to different species.

From such a case as this, the transition is easy to that presented by the succession of deposits constituting the great chalk formation; through the whole of which there is a strong general resemblance in the organic remains, though the species are for the most part distinct in each stage. As the accumulation of each deposit has often been interrupted, and as long blank intervals have doubtless intervened between successive deposits, we have no right to expect to find in any one or two of them all the intermediate varieties between the species which appear at the commencement and at the close of these periods; but we ought to find after intervals, very long as measured by years, but only moderately long as measured geologically, closely-allied forms, or, as some authors term them, representative species. Now as this is just what we do find, the theory of descent, with modification, is so far conformable

to positive facts, that it must be admitted to have at least as valid a foundation in a broad basis of phenomena as the theory of successive creations.

That we should meet with a similar gradational transition in all other cases, is assuredly what we have no right to expect, if we bear in mind *the extreme imperfection of the Geological Record*,—a consideration on which Mr. Darwin dwells very strongly, but not, in our estimation, one whit too strongly. "We are not only ignorant," he pithily says, "but we do not know how ignorant we are." To our minds the great wonder is, that palæontological research should have already yielded so much information as to the past life of the globe, not that it should afford so little. The indications recently afforded in regard to the antiquity of the human race,* taken in connection with the progress of discovery of the air-breathing forms of vertebrata in the earlier formations,† teach a valuable lesson of caution in drawing inferences as to the *non-existence* of any particular type at any period whatever, from the mere *negative* fact that we have not hitherto met with its remains.

A considerable part of Mr. Darwin's treatise is occupied by a discussion of the principal scientific objections (he wisely refrains from taking notice of any others) that can be urged in opposition to his views. Having already noticed by anticipation the geological difficulty, we shall only say, that we think he has conclusively shown that no value whatever can be attached to the "breeding test," on which reliance is commonly placed as a means of discriminating species from varieties; and

* We refer, of course, to the satisfactory evidence lately obtained by Mr. Prestwich, Sir C. Lyell, and other geologists of the highest authority, as to the existence, in gravel-beds elevated a hundred feet above the level of the Somme, of large numbers of flint implements, obviously shaped by the hand of man, in association with the bones of large mammals now extinct. Notwithstanding the ingenious theories which have been invented, either to account for their production by the forces of nature rather than by human art, or, admitting them to be man's handiwork, to account for their presence in these gravel-beds on the hypothesis of the modern origin of the human race, we take upon ourselves to affirm, that no unprejudiced person can carefully examine a large series of these objects without coming to recognise them as the products of a rude handicraft directed by a definite purpose; and further, that it is an inevitable deduction from the circumstances under which they are found, that, whether or not the beings that made them were contemporaneous with the Mammoth, the Tichorhine Rhinoceros, and other great extinct mammals, with whose bones they are associated, the gravel-beds containing them must have been first covered with layers of marl, clay, and sand, in some places forty feet thick, whose slowness of deposit is attested by the perfect preservation of the delicate land-shells they contain, and must have been afterwards upheaved at least a hundred feet; whilst, subsequently to this upheaval, the present valley of the Somme must have been excavated by its stream through the elevated land which now forms its high banks.

† At the last meeting of the Geological Society, the discovery was announced by Dr. Dawson, of Canada, of remains of *six reptiles* in the trunk of one fossil tree in the celebrated section of Carboniferous strata at the "Joggins'" in Nova Scotia.

that the facts of geographical distribution are, when rightly viewed, rather in his favour than otherwise. A greater difficulty than either seems to us to be presented by those cases of extraordinary aberration, whether of structure or habit, whereby particular animals are distinguished from their kind; many of which it is difficult to imagine to have been acquired gradually by any process of consecutive modification.

The history of every science shows that the great epochs of its progress are those not so much of new discoveries of *facts*, as of those new *ideas* which have served for the colligation of facts previously known into general principles, and which have thenceforward given a new direction to inquiry. It is in this point of view that we attach the highest value to Mr. Darwin's work. Naturalists have gone on quite long enough on the doctrine of the "permanence of species." Their catalogues are becoming more and more encumbered with these hypothetical "distinct creations." And the difficulty of distinguishing between true species and varieties increases, instead of diminishing, with the extension of their researches. The doctrine of progressive modification by Natural Selection propounded by Mr. Darwin, will give a new direction to inquiry into the real genetic relationship of species, existing and extinct; and it has a claim to respectful consideration, not merely on account of the high value of Mr. Darwin's previous contributions to zoological science, and the thoroughly philosophical spirit in which it is put forth, but also because it brings into mutual reconciliation the antagonistic doctrines of two great schools—that of Unity of Type, as put forward by Geoffroy St. Hilaire and his followers of the Morphological School, and that of Adaptation to Conditions of Existence, which has been the leading principle of Cuvier and the Teleologists. Nor is it the least of its recommendations that it enables us to look at the War of Nature constantly going on around us as not marked only by suffering and death, but as inevitably tending towards the progressive exaltation of the races engaged in it; just as, in the world of mind, it is only by intellectual collision that Truth can become firmly established, and only by moral conflict, whether in the individual or in society, that Right can obtain an undisputed sway.