Even after the appearance of Lyell's "Principles of Geology," the hypothesis of catastrophes received its special completion by Elie de Beaumont's theory of the structure and genesis of mountain chains. From the first, however, Lyell interposed, and derived the following conclusion from a comparison of the slow but continued and perceptible upheavals and subsidences occurring in historic times, with the various modifications which organisms had meanwhile undergone. "In a word, the movement of the inorganic world is obvious and palpable, and might be likened to the minute-hand of a clock, the progress of which can be seen and heard; whereas the fluctuations of the living creation are nearly invisible, and resemble the motion of the hour-hand of a time-piece. It is only by watching it attentively for some time, and comparing its relative position after an interval, that we can prove the reality of its motion."

Careful observation and logical deduction had thus arrived at conclusions diametrically opposite to the assertions of Cuvier, who inferred the geological catastrophes mainly from the striking difference of successive organisms. While botanists and zoologists prosecuted their studies on Cuvier's system, Geology was being metamorphosed under the hands of Lyell and his adherents. He proceeded from the most tangible basis. That it rained during the era of the coal formation, as it now rains, may be seen by the impress of rain-drops on the levels of that formation. The actions of rivers, the sediments of deltas, previously neglected, were now studied, and likewise the colossal mud deposits, such as are exhibited by the Nile and the Amazon, and also the

destructive work of the irregular motions of the sea, and the partly destructive, partly formative work of its regular currents. Calculations were made of the ploughing, grating, and grinding of glaciers, of the substances which mineral springs dissolve and deposit, of the displacements of material effected by existing agencies, of the manner in which the outlines of land and sea are altered by elevation and subsidence. Similarly, the comparison of ancient and modern coral reefs and oyster banks showed that these silent builders have not changed their habits. In short, the hypothesis of extraordinary events and forces, unheard of in our present era, seemed quite unnecessary; time only, and the continuous development of the earth's crust, were rendered evident.

The stage for reiterated acts of new creation of organisms had thus collapsed, and the hypothesis of such miraculous new creations became an anachronism, for which a well-merited end was inevitably prepared by the appearance of Darwin. With Darwinism, the doctrine of Descent is an historical necessity.

Charles Darwin was born in 1809, and, as the Naturalist attached to the *Beagle* in her voyage round the world, under Captain Fitzroy, in 1831-7, he enjoyed an opportunity of accumulating rich experiences. His important work on Coral Reefs gave the first adequate explanation of the phenomena resulting from the co-operation of geological movements, and the organic agency of the coral animal; his Monograph on Cirripedes bears witness to the exemplary care with which he can observe and systematically work out the relations of the minutest details. We make this remark, as the

opponents of the great inquirer endeavour to suppress his merits and authority by maintaining that he is properly a mere dilettante, dealing with general abstractions,[38] a stranger to the keen observation which takes full account of facts. How Darwin arrived at the idea which has made an epoch in science, he has himself made known in the introduction to his first work on the doctrine of Descent, namely, the "Origin of Species;"[39] and in more detail in a letter to Haeckel, published by the latter in his "History of Creation" (Natürlichen Schöpfungsgeschichte).

"Having reflected much on the foregoing facts, it seemed to me probable that allied species were descended from a common ancestor. But during several years I could not conceive how each form could have been modified so as to become admirably adapted to its place in nature. I began, therefore, to study domesticated animals and cultivated plants, and after a time perceived that man's power of selecting and breeding from certain individuals was the most powerful of all means in the production of new races. Having attended to the habits of animals and their relations to the surrounding conditions, I was able to realize the severe struggle for existence to which all organisms are subjected; and my geological observations had allowed me to appreciate to a certain extent the duration of past geological periods. With my mind thus prepared I fortunately happened to read Malthus's "Essay on Population;" and the idea of natural selection through the struggle for existence at once occurred to me. Of all the subordinate points in the theory, the last which I understood was the cause of the tendency in the

descendants from a common progenitor to diverge in character."*

That organisms are variable and not fixed in rigid forms, is a phenomenon so general that variability passes current as a self-evident property of organic existence. In the next chapter we shall inquire how far everything organic is necessarily subject to mutability. On the existence of this property rests the artificial breeding, or selection by man, consciously and unconsciously exercised from the earliest commencement of hunting and agriculture, of which, as Darwin says, "the importance mainly lies in the power of selecting scarcely appreciable differences, which are nevertheless found to be transmissible, and which can be accumulated until the result is made manifest to the eye of every beholder." In the " Origin of Species," as an example of methodic selection in the production of breeds, Darwin has chosen the pigeon, to the breeding of which he zealously devoted himself for many years.

The pigeon is specially adapted to the purpose of scientific observation of the phenomena of breeding, because, owing to its monogamic habits, it is easy to control, because it may be brought in a short time to striking variations, because the records of its breeding are tolerably complete, and, finally, because it is one of the few domestic animals of which the ancestral stock is scarcely open to a doubt.

The chief races produced by the fanciers may be grouped as follows. The Pouter Pigeons have a moderate beak, elongated legs and body, their œso-

* Mr. Darwin has himself been good enough to re-write his letter from the German text. He kept no copy of the original MS.

sages only partially obscure, possess less atrophied optic apparatus. A singular gradation occurs among the burrowing mammals, and Darwin [63] cites an example admirably illustrating the loss of sight in consequence of the mode of life. "In South America a burrowing rodent, the Tuco-tuco, or Ctenomys, is even more subterranean in its habits than the mole; and I was assured by a Spaniard, who had often caught them, that they were frequently blind; one which I kept alive was certainly in this condition, the cause, as appeared on dissection, having been the inflammation of the nictitating membrane. As frequent inflammation of the eyes must be injurious to any animal, and as eyes are certainly not necessary to animals having subterranean habits, a reduction in their size, with the adhesion of the eyelids and growth of fur over them, might in such case be an advantage; and, if so, natural selection would constantly aid the effects of disuse."

In the classes of flying animals, a large number have left off flying; and we find their flying apparatus in an aborted or incomplete condition, which perverse judgment and reasoning alone can regard as a state of progressive development from yet simpler rudiments. If throughout the great family of the Coleoptera, genera and species are to be found with imperfect flying apparatus, consolidated wing covers, &c., if the whole family of Staphylinæ does not possess the power of flight, no one dreams of considering them as arrested forms; but it is conceivable that the mode of life in which they differ from the other members of their order and class, gradually superinduced in their flying ancestry the habit of not flying, and at the same time the atrophy

of the organs of flight. With this was combined, as these beetles show, no degradation of organization, but, on the contrary, a higher and extremely advantageous development of other organs, the manducatory and locomotive apparatus. A general reduction of the power of flight has been shown in the beetle fauna of many islands. Thus in Madeira, of 550 species, over 200 fly imperfectly or not at all, and for this there is no explanation but natural selection. Here the less good and enterprising flyers had the advantage, while the others were blown into the sea and eliminated. The non-application of a previously attained special perfection is advantageous in the "struggle for existence."

In several families of lizards, some genera are serpentine, as they are termed, which, with elongated bodies, possess either fore-legs only (Chirotes), or merely rudimentary hind-legs (Pseudopus), or no vestiges of legs (Anguis). They bear the same relation to the great class of normally four-legged lizards as the non-flying insects to their own class. They have not been arrested in their development, nor are they animals in process of evolving four legs; but, as Fürbringer has demonstrated from the history of development and comparative anatomy, their limbs, and—if these are entirely absent—the remains of the pectoral and pelvic arches and the sternum bear indubitable marks of the abortion of a once complete apparatus. Further comparison shows that this atrophy reaches its climax in the snakes, but that it is compensated for by the ribs and intercostal muscles having undertaken the work of the limbs. Here,