

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

phagus is of great size, barely separated from the crop, and is capable of inflation. A second group includes Carriers, Runts, and Barbs, which possess in common a long beak, with the skin over the nostrils swollen and often carunculated or wattled, and the skin round the eyes bare and likewise carunculated. To another group, with shorter beak, and the skin round the eyes only slightly developed, belongs the Fantail, in which the normal number of twelve tail feathers may rise to forty-two with aborted oil-gland; also the Tumbler, in which the beak becomes extremely short, and a sickly disposition of the brain, produced and exaggerated by selection, and manifesting itself by tumbling, has been transmitted for more than 250 years, and has become established as the characteristic of a race. In the fourth group, the Trumpeter occupies a prominent position, on account of its peculiar voice; likewise the Laughing, or Indian turtle-dove, comprising several sub-races scarcely differing in structure from the rock-pigeon (*Columba livia*). The latter is divided into several geographically distinct races, ranging from the coasts of the Faroe Islands and Scotland to the shores of the Mediterranean and to India; and the most minute investigation, whether the incredibly divergent races of domestic pigeons are derived from eight or nine wild species or solely from the wide-spread rock pigeon, results decidedly in favour of the latter alternative. Proportional dimensions, colouring, and parts of the skeletons which differ from one another far more widely in the various races than they do in well marked species of the same genus, or even family, are modified under the hand and according to the will of man; and, more-

over, pre-eminently in the pigeon may be traced the phenomenon which has been termed the "correlation of growth," and consists in the fact that, with the intentional modification of an organ by means of selection, one or more other organs are drawn into sympathy and unintentionally transformed into characteristics of a race.

Darwin's minute researches on the formation of races in the pigeon are recounted in his second work on the theory of Descent, "The Variation of Animals and Plants under Domestication," in which the most detailed investigations respecting other domestic animals are also to be found. Whoever has had occasion to inspect one of the modern exhibitions of poultry, must have been astonished at the diversity of the different races, and the purity and uniformity within each race. Though not quite so positively as in the case of the pigeon, yet with approximate certainty, the domestic fowl appears to be derived from a single ancestral stock, the Indian *Gallus Bankiva*. The cumulative power of selection by man is likewise testified by the various races of pigs bred within the last century by the English farmers from an intermixture of the native and Indian races, differing in general appearance, colouring, size of ears, length of legs, and also partially in fertility. Our attention is, however, more closely drawn to the two races of Southdown sheep and Short-horn cattle, which, as well as the choicest breeds of pigs, have been for some years past particularly esteemed on the continent. These and many other races have been bred with definite purposes, and for certain domestic and commercial advantages, and one and all bear testimony to the plasticity of species.

Artificial selection operates by establishing peculiarities

originally variable, and on their first accidental appearance usually perceived only by the careful eye of a connoisseur. But not a few cases are likewise certified in which an accidental deformity and a new character appearing suddenly even in a single individual have lent themselves to the rapid formation of a race. "Thus," as Darwin relates,⁴¹ "in 1791 a ram lamb was born in Massachusetts, having short, crooked legs and a long back like a turnspit dog. From this one lamb the otter or ancon semi-monstrous breed was raised; as these sheep could not leap over the fences, it was thought that they would be valuable; but they have been supplanted by merinos, and thus exterminated. These sheep are remarkable from transmitting their character so truly, that Colonel Humphreys never heard of but one questionable case of an ancon ram and ewe not producing ancon offspring."—"A more interesting case has been recorded in the Report of the Juries for the Great Exhibition (1851), namely, the production of a merino ram lamb on the Mauchamp farm in 1828, which was remarkable for its long, smooth, straight, and silky wool. By the year 1833, Mr. Graux had raised rams enough to serve his whole flock, and after a few years more he was able to sell stock of his new breed. So peculiar and valuable is the wool, that it sells at 25 per cent. above the best merino wool; even the fleeces of half-bred animals are valuable, and are known in France as the Mauchamp merino. It is interesting, as showing how generally any marked deviation of structure is accompanied by other deviations, that the first ram and his offspring were of small size with large heads, long necks, narrow chests, and long flanks; but these blemishes