ERA OF THE NEW RED SANDSTONE.

TERRESTRIAL ZOOLOGY COMMENCES WITH REPTILES.

FIRST TRACES OF BIRDS.

THE next volume of the rock series refers to an era distinguished by an event of no less importance than the commencement of land animals. The *New Red Sandstone System* is subdivided into groups, some of which are wanting in some places; they are pretty fully developed in the north of England, in the following ascending order: — 1. Lower red sandstone; 2. Magnesian limestone; 3. Red and white sandstones and conglomerate; 4. Variegated marls. Between the third and fourth there is, in Germany, another group, called the Muschelkalk, a word expressing a limestone full of shells.

The first group, containing the conglomerates already adverted to, seems to have been produced during the time of disturbance which occurred so generally after the carbonigenous era. This new era is distinguished by a paucity of organic remains, as might partly be expected from the appearances of disturbance, and the red tint of the rocks, the latter being communicated by a solution of oxide of iron, a substance unfavourable to animal life.

The second group is a limestone with an infusion of magnesia. It is developed less generally than some others, but occurs conspicuously in England and Germany. Its place, above the red sandstone, shews the recurrence of circumstances favourable to animal life, and we accordingly find in it not only zoophytes, conchifera, and a few tribes of fish, but some faint traces of land plants, and a new and startling appearance—a reptile of saurian (lizard) character, analogous to the now existing family called monitors. Remains of this creature are found in cupriferous (copper-bearing) slate connected with the mountain limestone, at Mansfield and Glucksbrunn, in Germany, which may be taken as evidence that dry land existed in that age near those places. The magnesia lime-

stone is also remarkable as the last rock in which appears the leptæna, or producta, a conchifer of numerous species which makes a conspicuous appearance in all previous seas. It is likewise to be observed, that the fishes of this age, to the genera of which the names palæoniscus, catopterus, platysomus, &c., have been applied, vanish, and henceforth appear no more.

The third group, chiefly sandstones, variously coloured according to the amount and nature of the metallic oxide infused into them, shews a recurrence of agitation, and a consequent diminution of the amount of animal life. In the upper part, however, of this group, there are abundant symptoms of a revival of proper conditions for such life. There are marl beds, the origin of which substance in decomposed shells is obvious; and in Germany, though not in England, here occurs the muschelkalk, containing numerous organic remains, (generally different from those of the magnesian limestone,) and noted for the specimens of land animals, which it is the first to present in any considerable abundance to our notice.

These animals are of the vertebrate sub-kingdom, but of its lowest class next after fishes,—namely, reptiles,—a portion of the terrestrial tribes

whose imperfect respiratory system perhaps fitted them for enduring an atmosphere not yet quite suitable for birds or mammifers.* The specimens found in the muschelkalk are allied to the crocodile and lizard tribes of the present day, but in the latter instance are upon a scale of magnitude as much superior to present forms as the lepidodendron of the coal era was superior to the dwarf club-mosses of our time. These saurians also combine some peculiarities of structure of a most extraordinary character.

The animal to which the name *ichthyosaurus* has been given, was as long as a young whale, and it was fitted for living in the water, though breathing the atmosphere. It had the vertebral column and general bodily form of a fish, but to that were added the head and breast-bone of a lizard, and the paddles of the whale tribes. The beak, moreover, was that of a porpoise, and the teeth were those of a crocodile. It must have been a most destructive creature to the fish of those early seas.

* *The immediate effects of the slow respiration of the reptilia* are, a low temperature in their bodies, and a slow consumption of food. Requiring little oxygen, they could have existed in an atmosphere containing a less proportion of that gas to carbonic acid gas than what now obtains.

The *plesiosaurus* was of similar bulk, with a turtle-like body and paddles, shewing that the sea was its element, but with a long serpent-like neck, terminating in a saurian head, calculated to reach prey at a considerable distance. These two animals, of which many varieties have been discovered, constituting distinct species, are supposed to have lived in the shallow borders of the seas of this and subsequent formations, devouring immense quantities of the finny tribes. It was at first thought that no creatures approaching them in character now inhabit the earth; but latterly Mr. Darwin has discovered, in the reptile-peopled Galapagos Islands, in the South Sea, a marine saurian from three to four feet long.

The *megalosaurus* was an enormous lizard—a land creature, also carnivorous. The *pterodactyle* was another lizard, but furnished with wings to pursue its prey in the air, and varying in size between a cormorant and a snipe. Crocodiles abounded, and some of these were herbivorous. Such was the iguanodon, a creature of the character of the iguana of the Ganges, but reaching a hundred feet in length, or twenty times that of its modern representative.

There were also numerous *tortoises*, some of

them reaching a great size; and Professor Owen has found in Warwickshire some remains of an animal of the batrachian order,* to which, from the peculiar form of the teeth, he has given the name of labyrinthidon. Thus, three of Cuvier's four orders of reptilia (*sauria, chelonia,* and *batrachia*) are represented in this formation, the serpent order (*ophidia*) being alone wanting.

The variegated marl beds which constitute the uppermost group of the formation, present two additional genera of huge saurians,—the phytosaurus and mastodonsaurus.

It is in the upper beds of the red sandstone that beds of salt first occur. These are sometimes of such thickness, that the mine from which the material has been excavated looks like a lofty church. We see in the present world no circumstances calculated to produce the formation of a bed of rock salt; yet it is not difficult to understand how such strata were formed in an age marked by ultra-tropical heat and frequent volcanic disturbances. An estuary, cut off by an upthrow of trap, or a change of level, and left to dry up under the heat of the sun, would quickly become

* The order to which frogs and toads belong.

the bed of a dense layer of rock salt. A second shift of level, or some other volcanic disturbance, connecting it again with the sea, would expose this stratum to being covered over with a layer of sand or mud, destined in time to form the next stratum of rock above it.

The plants of this era are few and unobtrusive. Equiseta, calamites, ferns, Voltzia, and a few of the other families found so abundantly in the preceding formation, here present themselves, but in diminished size and quantity.

This seems to be the proper place to advert to certain memorials of a peculiar and unexpected character respecting these early ages in the sandstones. So low as the bottom of the carboniferous system, slabs are found marked over a great extent of surface with that peculiar corrugation or wrinkling which the receding tide leaves upon a sandy beach when the sea is but slightly agitated; and not only are these ripple-marks, as they are called, found on the surfaces, but casts of them are found on the under sides of slabs lying above. The phenomena suggests the time when the sand ultimately formed into these stone slabs, was part of the beach of a sea of the carbonigenous era; when, left wavy by one tide, it was covered over with a

thin layer of fresh sand by the next, and so on, precisely as such circumstances might be expected to take place at the present day. Sandstone surfaces, ripple-marked, are found throughout the subsequent formations: in those of the new red, at more than one place in England, they further bear impressions of rain-drops which have fallen upon them—the rain, of course, of the inconceivably remote age in which the sandstones were formed. In the Greensill sandstone, near Shrewsbury, it has even been possible to tell from what direction the shower came which impressed the sandy surface, the rims of the marks being somewhat raised on one side, exactly as might be expected from a slanting shower falling at this day upon one of our beaches. These facts have the same sort of interest as the season rings of the Craigleith conifers, as speaking of a parity between some of the familiar processes of nature in those early ages and our own.

In the new red sandstone, impressions still more important in the inferences to which they tend, have been observed,—namely, the footmarks of various animals. In a quarry of this formation, at Corncockle Muir, in Dumfriesshire, where the slabs incline at an angle of thirty-eight degrees,

the vestiges of an animal supposed to have been a tortoise are distinctly traced up and down the slope, as if the creature had had occasion to pass backwards and forwards in that direction only, possibly in its daily visits to the sea. Some slabs similarly impressed, in the Stourton quarries in Cheshire, are further marked with a shower of rain which we know must have fallen *afterwards*, for its little hollows are impressed in the footmarks also, though more slightly than on the rest of the surface, the comparative hardness of a trodden place having apparently prevented so deep an impression being made. At Hessberg, in Saxony, the vestiges of four distinct animals have been traced, one of them a web-footed animal of small size, considered as a congener of the crocodile; another, whose footsteps having a resemblance to an impression of a swelled human hand, has caused it to be named the *cheirotherium*. The footsteps of the cheirotherium have been found also in the Stourton quarries above mentioned. Professor Owen, who stands at the head of comparative anatomy in the present day, has expressed his belief that this last animal was the same batrachian of which he has found fragments in the new red sandstone of Warwickshire. At Runcorn, near

Manchester, and elsewhere, have been discovered the tracks of an animal which Mr. Owen calls the rynchosaurus, uniting with the body of a reptile the beak and feet of a bird, and which clearly had been a *link* between these two classes.

If geologists shall ultimately give their approbation to the inferences made from a recent discovery in America, we shall have the addition of perfect birds, though probably of a low type, to the animal forms of this era. It is stated to be in quarries of this rock, in the valley of Connecticut, that footprints have been found, apparently produced by birds of the order grallæ, or waders. "The footsteps appear in regular succession on the continuous track of an animal, in the act of walking or running, with the right and left foot always in their relative places. The distance of the intervals between each footstep on the same track is occasionally varied, but to no greater amount than may be explained by the bird having altered its pace. Many tracks of different individuals and different species are often found crossing each other, and crowded, like impressions of feet upon the shores of a muddy stream, where ducks and geese resort."*

* Dr. Buckland, quoting an article by Professor Hitchcock, in the American Journal of Science and Arts, 1836.

Some of these prints indicate small animals, but others denote birds of what would now be an unusually large size. One animal, having a foot fifteen inches in length, (one-half more than that of the ostrich,) and a stride of from four to six feet, has been appropriately entitled, *ornithichnites giganteus.*