ERA OF THE OOLITE.

COMMENCEMENT OF MAMMALIA.

THE chronicles of this period consist of a series of beds, mostly calcareous, taking their general name (*Oolite System*) from a conspicuous member of them—the oolite—a limestone composed of an aggregation of small round grains or spherules, and so called from its fancied resemblance to a cluster of eggs, or the roe of a fish. This texture of stone is novel and striking. It is supposed to be of chemical origin, each spherule being an aggregation of particles round a central nucleus. The oolite system is largely developed in England, France, Westphalia, and Northern Italy; it appears in Northern India and Africa, and patches of it exist in Scotland, and in the vale of the Mississippi. It may of course be yet discovered in many other parts of the world.

The series, as shewn in the neighbourhood of Bath, is (beginning with the lowest) as follows:—1. Lias, a set of strata variously composed of limestone, clay, marl, and shale, clay being predominant; 2. Lower oolitic formation, including, besides the great oolite bed of central England, fullers' earth beds, forest marble, and cornbrash; 3. Middle oolitic formation, composed of two subgroups, the Oxford clay and coral rag, the latter being a mere layer of the works of the coral polype; 4. Upper oolitic formation, including what are called Kimmeridge clay and Portland oolite. In Yorkshire there is an additional group above the lias, and in Sutherlandshire there is another group above that again. In the wealds (moorlands) of Kent and Sussex, there is, in like manner, above the fourth of the Bath series, another additional group, to which the name of the *Wealden* has been given, from its situation, and which, composed of sandstones and clays, is subdivided into Purbeck beds, Hastings sand, and Weald clay.

There are no particular appearances of disturbance between the close of the new red sandstone and the beginning of the oolite system, as far as

has been observed in England. Yet there is a great change in the materials of the rocks of the two formations, shewing that while the bottoms of the seas of the one period had been chiefly arenaceous, those of the other were chiefly clayey and limy. And there is an equal difference between the two periods in respect of both botany and zoology. While the new red sandstone shews comparatively scanty traces of organic creation, those in the oolite are extremely abundant, particularly in the department of animals, and more particularly still of sea mollusca, which, it has been observed, are always the more conspicuous in proportion to the predominance of calcareous rocks. It is also remarkable that the animals of the oolitic system are entirely different in species from those of the preceding age, and that these species cease before the next. In this system we likewise find that uniformity over great space which has been remarked of the Faunas of earlier formations. "In the equivalent deposits in the Himalaya Mountains, at Fernando Po, in the region north of the Cape of Good Hope, and in the Run of Cutch, and other parts of Hindostan, fossils have been discovered, which, as far as En-

glish naturalists who have seen them can determine, are undistinguishable from certain oolite and lias fossils of Europe."*

The dry land of this age presented cycadeæ, "a beautiful class of plants between the palms and conifers, having a tall, straight trunk, terminating in a magnificent crown of foliage."† There were tree ferns, but in smaller proportion than in former ages; also equisetaceæ, lilia, and conifers. The vegetation was generally analogous to that of the Cape of Good Hope and Australia, which seems to argue a climate (we must remember, a universal climate) between the tropical and temperate. It was, however, sufficiently luxuriant in some instances to produce thin seams of coal, for such are found in the oolite formation of both Yorkshire and Sutherland. The sea, as for ages before, contained algæ, of which, however, only a few species have been preserved to our day. The lower classes of the inhabitants of the ocean were unprecedentedly abundant. The polypiaria were in such abundance as to form whole strata of themselves. The crinoidea and echinites were also extremely numerous. Shell mollusks, in hundreds of new species, oc-

* Murchison's Silurian System, p. 583.

† Buckland.

cupied the bottoms of the seas of those ages, while of the swimming shell-fish, ammonites and belemnites, there were also many scores of varieties. The belemnite here calls for some particular notice. It commences in the oolite, and terminates in the next formation. It is an elongated, conical shell, terminating in a point, and having, at the larger end, a cavity for the residence of the animal, with a series of air-chambers below. The animal, placed in the upper cavity, could raise or depress itself in the water at pleasure by a pneumatic operation upon the entral air tube pervading its shell. Its tentacula, sent abroad over the summit of the shell, searched the sea for prey. The creature had an ink-bag, with which it could muddle the water around it, to protect itself from more powerful animals, and, strange to say, this has been found so well preserved that an artist has used it in one instance as a paint, wherewith to delineate the belemnite itself.

The crustacea discovered in this formation are less numerous. There are many fishes, some of which (*acrodus*, *psammodus*, &c.,) are presumed from remains of their palatal bones, to have been of the gigantic cartilaginous class, now represented by such as the cestraceon. It has been considered

by Professor Owen as worthy of notice, that, the cestraceon being an inhabitant of the Australian seas, we have, in both the botany and ichthyology of this period, an analogy to that continent. The pycnodontes, (thick-toothed,) and lepidoides, (having thick scales,) are other families described by M. Agassiz as extensively prevalent. In the shallow waters of the oolitic formation, the ichthyosaurus, plesiosaurus, and other huge saurian carnivora of the preceding age, plied, in increased numbers, their destructive vocation.* To them were added new genera, the cetiosaurus, mososaurus, and some others, all of similar character and habits.

Land reptiles abounded, including species of the pterodactyle of the preceding age—tortoises, trionyces, crocodilians—and the pliosaurus, a creature which appears to have formed a link between the plesiosaurus and the crocodile. We know of at least six species of the flying saurian, the pterodactyle, in this formation.

* In some instances, these fossils are found with the contents of the stomach faithfully preserved, and even with pieces of the external skin. The pellets ejected by them (*coprolites*) are found in vast numbers, each generally enclosed in a nodule of ironstone, and sometimes shewing remains of the fishes which had formed their food.

Now, for the first time, we find remains of insects, an order of animals not well calculated for fossil preservation, and which are therefore amongst the rarest of the animal tribes found in rocks, though they are the most numerous of all living families. A single libellula (dragon-fly) was found in the Stonesfield slate, a member of the lower oolitic group quarried near Oxford; and this was for several years the only specimen known to exist so early; but now many species have been found in a corresponding rock at Solenhofen, in Germany. It is remarkable that the remains of insects are found most plentifully near the remains of pterodactyles, to which undoubtedly they served as prey.

The first glimpse of the highest class of the vertebrate sub-kingdom—*mammalia*—is obtained from the Stonesfield slate, where there has been found the jaw-bone of a quadruped evidently insectivorous, and inferred, from peculiarities in the structure of that small fragment, to have belonged to the marsupial family, (pouched animals). It may be observed, although no specimens of so high a class of animals as mammalia are found earlier, such may nevertheless have existed: the defect may be in our not having found them; but,

other things considered, the probability is that heretofore there were no mammifers. It is an interesting circumstance that the first mammifers found should have belonged to the marsupialia, when the place of that order in the scale of creation is considered. In the imperfect structure of their brain, deficient in the organs connecting the two hemispheres—and in the mode of gestation, which is only in small part uterine—this family is clearly a link between the oviparous vertebrata (birds, reptiles, and fishes) and the higher mammifers. This is further established by their possessing a faint development of two canals passing from near the anus to the external surface of the viscera, which are fully possessed in reptiles and fishes, for the purpose of supplying aerated water to the blood circulating in particular vessels, but which are unneeded by mammifers. Such rudiments of organs in certain species which do not require them in any degree, are common in both the animal and vegetable kingdoms, but are always most conspicuous in families approaching in character to those classes to which the full organs are proper. This subject will be more particularly adverted to in the sequel.

The highest part of the oolitic formation pre-

sents some phenomena of an unusual and interesting character, which demand special notice. Immediately above the upper oolitic group in Buckinghamshire, in the vicinity of Weymouth, and other situations, there is a thin stratum, usually called by workmen the *dirt-bed*, which appears, from incontestable evidence, to have been a soil, formed, like soils of the present day, in the course of time, upon a surface which had previously been the bottom of the sea. The dirt-bed contains exuviæ of tropical trees, accumulated through time, as the forest shed its honours on the spot where it grew, and became itself decayed. Near Weymouth there is a piece of this stratum, in which stumps of trees remain rooted, mostly erect or slightly inclined, and from one to three feet high; while trunks of the same forest, also silicified, lie imbedded on the surface of the soil in which they grew.

Above this bed lie those which have been called the Wealden, from their full development in the Weald of Sussex; and these as incontestably argue that the dry land forming the dirt-bed had next afterwards become the area of brackish estuaries, or lakes partially connected with the sea; for the Wealden strata contain exuviæ of fresh-water

tribes, besides those of the great saurians and chelonia. The area of this estuary comprehends the whole south-east province of England. A geologist thus confidently narrates the subsequent events: "Much calcareous matter was first deposited [in this estuary], and in it were entombed myriads of shells, apparently analogous to those of the vivipara. Then came a thick envelope of sand, sometimes interstratified with mud; and, finally, muddy matter prevailed. The solid surface beneath the waters would appear to have suffered a long continued and gradual depression, which was as gradually filled, or nearly so, with transported matter; in the end, however, after a depression of several hundred feet, the sea again entered upon the area, not suddenly or violently—for the Wealden rocks pass gradually into the superincumbent cretaceous series—but so quietly, that the mud containing the remains of terrestrial and fresh-water creatures was tranquilly covered up by sands replete with marine exuviæ."* A subsequent depression of the same area, to the depth of at least three hundred fathoms, is believed to have taken place, to admit of the deposition of the cretaceous beds lying above.

* De la Beche's Geological Researches, p. 344.

From the scattered way in which remains of the larger terrestrial animals occur in the Wealden, and the intermixture of pebbles of the special appearance of those worn in rivers, it is also inferred that the estuary which once covered the south-east part of England was the mouth of a river of that far-descending class of which the Mississippi and Amazon are examples. What part of the earth's surface presented the dry land through which that and other similar rivers flowed, no one can tell for certain. It has been surmised, that the particular one here spoken of may have flowed from a point not nearer than the site of the present Newfoundland. Professor Philips has suggested, from the analogy of the mineral composition, that anciently elevated coal strata may have composed the dry land from which the sandy matters of these strata were washed. Such a deposit as the Wealden almost necessarily implies a local, not a general condition; yet it has been thought that similar strata and remains exist in the Pays de Bray, near Beauvais. This leads to the supposition that there may have been, in that age, a series of river-receiving estuaries along the border of some such great ocean as the Atlantic, of which that of modern Sussex is only an example.