ERA OF THE CRETACEOUS FORMATION.

THE record of this period consists of a series of strata, in which chalk beds make a conspicuous appearance, and which is therefore called the cretaceous system or formation. In England, a long stripe, extending from Yorkshire to Kent, presents the cretaceous beds upon the surface, generally lying conformably upon the oolite, and in many instances rising into bold escarpments towards the west. The celebrated cliffs of Dover are of this formation. It extends into northern France, and thence north-westward into Germany, whence it is traced into Scandinavia and Russia. The same system exists in North America, and probably in other parts of the earth not yet geologically investigated. Being a marine deposit, it establishes that seas existed at the time of its formation on

the tracts occupied by it, while some of its organic remains prove that, in the neighbourhood of those seas, there were tracts of dry land.

The cretaceous formation in England presents beds chiefly sandy in the lowest part, chiefly clayey in the middle, and chiefly of chalk in the upper part, the chalk beds being never absent, which some of the lower are in several places. In the vale of the Mississippi, again, the true chalk is wholly, or all but wholly absent. In the south of England, the lower beds are, (reckoning from the lowest upwards), 1. *Shankland* or *greensand*, "a triple alternation of sands and sandstones with clay;" 2. *Galt*, "a stiff blue or black clay, abounding in shells, which frequently possess a pearly lustre;" 3. *Hard* chalk; 4. Chalk with flints; these two last being generally white, but in some districts red, and in others yellow. The whole are, in England, about 1200 feet thick, shewing the considerable depths of the ocean in which the deposits were made.

Chalk is a carbonate of lime, and the manner of its production in such vast quantities was long a subject of speculation among geologists. Some light seemed to be thrown upon the subject a few years ago, when it was observed, that the detritus

of coral reefs in the present tropical seas gave a powder, undistinguishable, when dried, from ordinary chalk. It then appeared likely that the chalk beds were the detritus of the corals which were in the oceans of that era. Mr. Darwin, who made some curious inquiries on this point, further suggested, that the matter might have intermediately passed through the bodies of worms and fish, such as feed on the corals of the present day, and in whose stomachs he has found impure chalk. This, however, cannot be a full explanation of the production of chalk, if we admit some more recent discoveries of Professor Ehrenberg. That master of microscopic investigation announces, that chalk is composed partly of "inorganic particles of irregular elliptical structure and granular slaty disposition," and partly of shells of inconceivable minuteness, "varying from the one-twelfth to the two hundred and eighty-eighth part of a line"—a cubic inch of the substance containing above ten millions of them! The chalk of the north of Europe contains, he says, a larger proportion of the inorganic matter; that of the south, a larger proportion of the organic matter, being in some instances almost entirely composed of it. He has been able to classify many of these creatures, some of them being allied

to the nautili, nummuli, cyprides, &c. The shells of some are calcareous, of others siliceous. M. Ehrenberg has likewise detected microscopic sea-plants in the chalk.

The distinctive feature of the uppermost chalk beds in England, is the presence of flint nodules. These are generally disposed in layers parallel to each other. It was readily presumed by geologists that these masses were formed by a chemical aggregation of particles of silica, originally held in solution in the mass of the chalk. But whence the silica in a substance so different from it? Ehrenberg suggests that it is composed of the siliceous coverings of a portion of the microscopic creatures, whose shells he has in other instances detected in their original condition. It is remarkable that the chalk *with* flint abounds in the north of Europe; that *without* flints in the south; while in the northern chalk siliceous animalcules are wanting, and in the southern present in great quantities. The conclusion seems but natural, that in the one case the siliceous exuviæ have been left in their original form; in the other dissolved chemically, and aggregated on the common principle of chemical affinity into nodules of flint, probably concentrating, in every instance, upon a piece of decaying

organic matter, as has been the case with the nodules of ironstone in the earlier rocks, and the spherules of the oolite.

What is more remarkable, M. Ehrenberg has ascertained that at least fifty-seven species of the microscopic animals of the chalk, being infusoria and calcareous-shelled polythalamia, are still found living in various parts of the earth. These species are the most abundant in the rock. Singly they are the most unimportant of all animals, but in the mass, forming as they do such enormous strata over a large part of the earth's surface, they have an importance greatly exceeding that of the largest and noblest of the beasts of the field. Moreover, these species have a peculiar interest, as the only specific types of that early age which are reproduced in the present day. Species of sea mollusks, of reptiles, and of mammifers, have been changed again and again, since the cretaceous era; and it is not till a long subsequent age that we find the first traces of any other of even the humblest species which now exist; but here have these humble infusoria and polythalamia kept their place on earth through all its revolutions since that time, —are we to say, safe in their very humility, which might adapt them to a greater variety of circum-

stances than most other animals, or are we required to look for some other explanation of the phenomenon?

All the ordinary and more observable orders of the inhabitants of the sea, except the cetacea, have been found in the cretaceous formation—zoophytes, radiaria, mollusks, crustacea, (in great variety of species,) and fishes in smaller variety. In Europe, remains of the marine saurians have been found; they may be presumed to have become extinct in that part of the globe before this time, their place and destructive office being perhaps supplied by cartilaginous fishes, of which the teeth are found in great quantities. In America, however, remains of the plesiosaurus have been discovered in this part of the stratified series. The reptiles, too, so numerous in the two preceding periods, appear to have now much diminished in numbers. One, entitled the mosæsaurus, seems to have held an intermediate place between the monitor and iguana, and to have been about twenty-five feet long, with a tail calculated to assist it powerfully in swimming. Crocodiles and turtles existed, and amongst the fishes were some of a saurian character.

Fuci abounded in the seas of this era. Con-

fervæ are found enclosed in flints. Of terrestrial vegetation, as of terrestrial animals, the specimens in the European area are comparatively rare, rendering it probable that there was no dry land near. The remains are chiefly of ferns, conifers, and cycadeæ, but in the two former cases we have only cones and leaves. There have been discovered many pieces of wood, containing holes drilled by the teredo, and thus shewing that they had been long drifted about in the ocean before being entombed at the bottom.

The series in America corresponding to this, entitled the ferruginous sand formation, presents fossils generally identical with those of Europe, not excepting the fragments of drilled wood; shewing that, in this, as in earlier ages, there was a parity of conditions for animal life over a vast tract of the earth's surface. To European reptiles, the American formation adds a gigantic one, styled the saurodon, from the lizard-like character of its teeth.

We have seen that footsteps of birds are considered to have been discovered in America, in the new red sandstone. Some similar isolated phenomena occur in the subsequent formations. Mr. Mantell discovered some bones of birds, apparently

waders, in the Wealden. The immediate connexion of that set of birds with land, may account, of course, for their containing a terrestrial organic relic, which the marine beds above and below did not possess. In the slate of Glarus, in Switzerland, corresponding to the English galt, in the chalk formation, the remains of a bird have been found. From a chalk bed near Maidstone, have likewise been extracted some remains of a bird, supposed to have been of the long-winged swimmer family, and equal in size to the albatross. These, it must be owned, are less strong traces of the birds than we possess of the reptiles and other tribes; but it must be remembered, that the evidence of fossils, as to the absence of any class of animals from a certain period of the earth's history, can never be considered as more than negative. Animals, of which we find no remains in a particular formation, may, nevertheless, have lived at the time, and it may have only been from unfavourable circumstances that their remains have not been preserved for our inspection. The single circumstance of their being little liable to be carried down into seas, might be the cause of their non-appearance in our quarries. There is at the same time a limit to uncertainty on this point. We

see, from what remains have been found in the whole series, a clear progress throughout, from humble to superior types of being. Hence we derive a light as to what animals may have existed at particular times, which is in some measure independent of the specialties of fossilology. The birds are below the mammalia in the animal scale; and therefore they may be supposed to have existed about the time of the new red sandstone and oolite, although we find but slight traces of them in those formations, and, it may be said, till a considerably later period.