The Gault is overlaid by a group of sands and sandstones often of a greenish tint from the presence of glauconite grains. Hence the name Upper Greensand which is applied to them. These strata can be traced westwards into Devonshire, and eastwards to the headlands of Kent, but they die out towards the north. Their mineralogical characters and variable thickness seem to point to them as deposits of the shore of the sea in which the chalk was subsequently laid down upon them.

Among their characteristic fossils are the sponges *Siphonia pyriformis* and *S. costata*; urchins of the genera *Cidaris*, *Echinus* and *Salenia*; numerous *Terebratulæ* and *Rhynchonellæ*; many lamellibranchs, particularly of the genera *Exogyra*, *Ostrea*, *Gryphæa*, *Lima*, *Pecten*, and *Trigonia*; and gasteropods of the genera *Natica*, *Turritella*, and others. The cephalopods abound and comprise many forms of *Ammonites* (40 species), *Hamites*, *Scaphites*, *Baculites*, *Nautilus*, and *Belemnites*.

Chalk.—This conspicuous member of the Cretaceous system has at its base a white or pale yellow marl with green grains of glauconite, phosphatic nodules, and iron pyrites (Chloritic Marl), which is succeeded sometimes by a kind of argillaceous chalk (Chalk Marl) forming the base of the true Chalk. It can be traced from Flamborough Head in Yorkshire across the south-eastern counties to the coast of Dorset. Throughout this long course its western edge usually rises somewhat abruptly from the plains as a long winding escarpment, which from a distance often reminds one of an old coast-line. The upper half of the Chalk is generally distinguished by the presence of many nodular layers of flint. With the exception of these enclosures, however, the whole formation is a remarkably pure white pulverulent dull limestone, meagre to the touch, and soiling the fingers. It is composed mainly of crumbled foraminifera, with the mingled debris of urchins, corals, and mollusks. It must have been accumulated in a sea of some depth and tolerably free from sediment, like some of the foraminiferal ooze of the existing sea-bed. There is, however, no evidence that the depth of the water at all approached that of the abysses in which the present Atlantic globigerina-ooze is being laid down. Indeed, the character of the foraminifera, and the variety and association of the other organic remains, are not like those which have been found to obtain now on the deep floor of the Atlantic.

Somewhere about 800 species of fossils are known from the English Chalk. Occasional rare fragments of terrestrial wood occur, perforated by the teredo, and telling of a transport of some distance from land. Sponges are numerous. They have usually been silicified and preserved in the flint nodules. Among the more characteristic genera are *Choanites*, *Cliona*, *Ventriculites*, *Brachiolites*, *Spongia*, and *Siphonia*. Careful preparation of a fragment of chalk usually brings to light remains, sometimes well preserved, of foraminifera (*Rotalina ornata*, *Cristellaria rotulata*, *Globigerina bulloides*). Corals are represented by about 15 species (*Parasmilia*, *Caloamilia*, *Caryophyllia*, &c.). The echini form one of the most conspicuous features among the Chalk fossils, from their individual numbers and their variety of forms. Among the more common genera the following may be named—*Ananchytes*, *Echinoconus* (*Galerites*), *Cardiaster*, *Micraster*, *Cyphosoma*, *Cidaris*, *Pseudodiadema*, *Discoidea*, and *Salenia*. Among other star-fishes the genus *Goniaster* occurs in numerous species in the upper division of the Chalk. The crinoids were represented in the sea of the period by a *Comatula*, one or two *Pentacrinites*, *Marsupites*, and *Bourgueticrinus*. Polyzoa abound in the Upper Chalk (*Hemeseolen*, *Fustulipora*, *Holostoma*, &c.). The brachiopods appear in the form of great numbers of *Rhynchonella*, *Terebratula*, and *Terebratulina*, with *Crania*, *Thecidea*, and *Kingena*. Among the lamellibranchs the genera *Ostrea*, *Pecten*, *Inoceramus*, and *Lima* are particularly frequent. Gasteropods are comparatively few, *Pleurotomaria perspectiva* being one of the few forms found both in the lower and upper division of the Chalk. Cephalopods however, abound; characteristic species are *Belemnitella plena*, *B. mucronata*, *Nautilus Deslongchampsianus*, *Ammonites naviculatis*, *A. varians*, *A. Rothomagensis*, *Turrilites costatus*, *Baculites baculoides*. *Scaphites equalis*, and *Hamites armatus*. Upwards of 80 species of fish have been discovered. These include chimæroids (*Edaphodon*, *Ischyodus*), sharks (*Hybodus*, *Ptychodus*, *Lamna*, *Otodus*), ganoids (*Macropoma*, *Pycnodus*), and teleosteous or bony fishes (*Beryx*, *Enchodus*, *Saurocephalus*). Numerous reptilian remains have been found, more particularly in a bed about 1 foot thick lying at the base of the Chalk of Cambridge, and largely worked for phosphate of lime derived from reptilian coprolites and bones. Among the known forms are several chelonians, the great deinosaur *Acanthopholis*, several species of *Plesiosaurus*, 5 or 6 species of *Ichthyosaurus*, 10 species of *Pterodactylus* from the size of a pigeon upwards, one of them having a spread of wing amounting perhaps to 25 feet, 3 species of *Mosasaurus*, a crocodilian (*Polyptychodon*), and some others. At Cambridge also the bones of one or two species of birds have been found, probably belonging to *Natatores* allied to the living gulls.

CONTINENTAL EUROPE.—The Cretaceous system in many detached areas covers a large extent of the Continent. From the south of England it spreads southward across the north of France up to the base of the ancient central plateau of that country. Eastwards it ranges beneath the Tertiary and post-Tertiary deposits of the great plain, appearing on the north side at the southern end of Scandinavia and in Denmark, on the south side in Belgium and Hanover, round the flanks of the Harz, in Bohemia and Poland, eastwards into Russia, where it covers many thousand square miles up to the southern end of the Ural chain. To the south of the central axis in France, it underlies the great basin of the Garonne, flanks the chain of the Pyrenees on both sides, spreads out largely over the eastern side of the Spanish table-land, and reappears on the west side of the crystalline axis of that region along the coast of Portugal. It is seen at intervals along the north and south fronts of the Alps, extending down the valley of the Rhone to the Mediterranean, ranging along the chain of the Apennines into Sicily and the north of Africa, and widening out from the eastern shores of the Adriatic through Greece, and along the northern base of the Balkans to the Black Sea, round the southern shores of which it ranges in its progress into Asia, where it again covers an enormous area.

A series of rocks covering so vast an extent of surface must needs present many differences of type, alike in their lithological characters and in their organic contents. They bring before us the records of a time when one continuous sea stretched over all the centre with most of the south of Europe, covered the north of Africa, and swept eastwards to the far east of Asia. There were doubtless many islands and ridges in this wide expanse of water, whereby its area of deposit and biological provinces must have been more or less sharply defined. Some of these barriers can still be traced, as will be immediately pointed out.

The accompanying table contains the subdivisions of the Cretaceous system which have been adopted in a few of the more important areas of Continental Europe.

It will be seen from this table that while there is sufficient palæontological similarity to allow a general parallelism to be drawn among the Cretaceous rocks of western Europe, there are yet strongly marked differences pointing to very distinct conditions of life, and probably, in many cases, to disconnected areas of deposit. Nowhere can these contrasts be more strikingly seen than in crossing from the Cretaceous basin of the Loire to that of the Garonne. In the north of France the Upper Cretaceous beds are precisely like those of England, the soft white Chalk forming a conspicuous feature in both countries; but on the south side of the great axis of crystalline rocks, the soft chalk is replaced by hard limestones. There is a prevalence of calcareous matter, often sparry, throughout the whole series of formations, with comparatively few sandy or clayey beds. This mass of limestone attains its greatest development in the southern part of the department of the Dordogne, where it is said to be about 800 feet thick. But the lithological differences are not greater than those of the fossils. In the north of France, Belgium, and England, the singular molluscan family of the *Hippuritidæ* or *Rudistes* appears only occasionally and sporadically in the Cretaceous rocks, as if a stray individual had from time to time found its way into the region, but without being able to establish a colony there. In the south of France, however, the hippurites occur in prodigious quantity. They often mainly compose the limestones, hence called hippurite limestones (Rudisten-Kalke). They attained a great size, and seem to have grown on immense banks like our modern oyster. They appear in successive species on the different stages of the Cretaceous system, and can be used for marking palæontological horizons, as the cephalopods are elsewhere. But while these lamellibranchs played so important a part throughout the Cretaceous period in the south of France, the numerous ammonites and belemnites, so characteristic of the Chalk in England, were absent from that region. This very distinctive type of hippurite limestone has so

much wider an extension than the English type of the Cretaceous system that it should be regarded as really the normal development. It ranges through the Alps into Dalmatia, and round the great Mediterranean basin far into Asia. Gümbel has proposed to group the European Cretaceous rocks into three great regions:—(1) the northern province, or area of white chalk with *Belemnitella*,

Table showing the Subdivisions of the Cretaceous System in the West of Europe.

		England.	Northern France.	North-West Germany and Denmark.	Southern France.
Senonian.		Upper Chalk with flints.	Danien, Craie supérieure et calcaire pisolitique (p. 360). Craie blanche (*Belemnitella mucronata*).	Faxoe chalk. Maestricht chalk (p. 360).	
		Lower Chalk without flints.	Craie (*Micraster cor-anguinum*).	Oberquadersandstein (*Micraster cor-anguinum*).	Calcaires à rudistes (*Radiolites*)
Turonian.		Chalk Marl.	Craie marneuse.	Mittelquader. Mittelplaner (*Inoceramus Cuvieri* and *I. labiatus*)	Calcaires à *Hippurites cornu-vaccinum*, et à *Radiolites cornu-pastoris*.
		Chloritic Marl	Craie glauconieuse		Calcaires marneux (*Inoceramus labiatus*).
Cenomanian.		Upper Greensand.	Grès vert supérieur	Unterquader, Unterplaner (*Ammonites Rotomagensis*, *A. varians*).	Calcaires à *Caprotina triangularis*, et à *Ammonites Rotomagensis*
Gault.		Gault.	Albien, argile marneuse ou sableuse.	Flammenmergel (*Arcacula gryphæoides*). Clay (*Belemnites minimus*).	Albien, sables et grès verts ou ferrugineux à *Turrilites*.
			Aptien, argiles à plicatules.	Marls, &c. *Ammonites tardefurcatus*, *Belemnites Escaldi*)	Aptien (*Orbitulina lenticularis*).
			Urgonien.	Clays (*Belemnites Brunsvicensis*). *Ancyloceras* beds.	Calcaire à caprotines
Neocomian or Hils.		Lower Greensand.	Argiles ostréennes (*Exogyra subpilicata*, *Ostrea Leymerii*).	Hils clay (Hilsthon) with *Ammonites Noricus*, &c.	Neocomien supérieur (*Toxoceras complanatus*) calcaire à *Spatangus*.
	Wealden	Purbeck and Tealby beds and middle part of Speeton Clay.	Calcaires néocomiens et marnes bleues (*Toxoceras complanatus*).	Hils conglomerate (*Toxoceras complanatus*, *Rhynchonella depressa*).	Weald clay (*Melania*, *Cyrena*).	Néocomien inférieur (*Toxoceras Castelnaui*).
		Lower part of Speeton Clay.	Sable blanc et ferrugineux.		Deistersandstein with coal seams.	

comprising England, northern France, Belgium, Denmark, Westphalia; (2) the Hercynian province, or area of *Exogyra columba*, embracing Bohemia, Moravia, Saxony, Silesia, and central Bavaria; and (3) the southern province, or area of hippurites, including the regions south of the crystalline axis of France, the Alps, and southern Europe.

The Wealden beds, with the Hastings Sands and Weald Clay, are found in north-west Germany. They contain abundant remains of terrestrial vegetation, which is sometimes aggregated into thin seams of black glancing coal, occasionally even as much as 6½ feet thick. The marine or typical Neocomian series attains a great development among the eastern Alps, where it consists mainly of massive white and grey limestones, divided into zones according to their characteristic fossils. Some geologists place in it a part of the massive Vienna sandstone (Wiener Sandstein) which enters so largely into the structure of the outer Alps. The massive arenaceous formation formerly massed together under the general name of Quader-sandstein, but now found to be the equivalent of the calcareous bands of other regions, and capable of subdivision into the chief normal groups, forms a conspicuous feature in Saxony and Bohemia, as in the great gorge of the Elbe and the picturesque crags and pinnacles of Saxon Switzerland. From the Upper Cretaceous beds, in the neighbourhood of Aix-la-Chapelle, consisting of white sands and laminated clays 400 feet thick, a large number of terrestrial plants have been obtained. The number of species is estimated at more than 400. Of these 70 or 80 are cryptogams, chiefly ferns (*Gleichenia*, *Lygodium*, *Asplenium*, &c.); there are numerous conifers (some akin to *Sequoia*), and three or four kinds of screw-pine (*Pandanus*). This flora has a much more modern aspect than any other yet found in Secondary formations. But its most important feature is the occurrence of numerous true exogenous plants—the earliest yet found in Europe. The prevalent forms are *Proteaceæ*, many of them being referred to genera still living in Australia or at the Cape of Good Hope. There occur also species of oak, bog-myrtle, &c. These interesting fragments serve to indicate the modern character of the flora of Europe towards the close of the Cretaceous period, and to show that the climate, doubtless greatly warmer than that which now prevails, nourished a vegetation like that of some parts of Australia or the Cape. Further information has been afforded regarding the extension of this flora by the discovery in North Greenland of a remarkable series of fossil plants. From certain Lower Cretaceous beds of that Arctic region Heer has described 30 species of ferns, 9 cycads, and 17 conifers while, from the Upper Cretaceous rocks of Noursoak, he enumerates species of poplar, fig, sassafras, credneria, and magnolia.

NORTH AMERICA.—The recent surveys of the western territories of the United States have greatly increased our knowledge of the Cretaceous system on the American continent, where it is now known to cover a vast expanse of surface, and to reach a thickness of sometimes 10,000 feet. Sparingly developed in the eastern States, from New Jersey into South Carolina, it spreads out over a wide area in the south, stretching round the end of the long Palæozoic ridge from Georgia through Alabama and Tennessee to the Ohio; and reappearing from under the Tertiary formations on the west side of the Mississippi over a large space in Texas and the south-west. Its maximum development is reached in the western States and Territories of the Rocky Mountain region—Wyoming, Utah, and Colorado. Cretaceous rocks have likewise been detected in Arctic America near the mouth of the Mackenzie River.

Much controversy has been carried on among American geologists regarding the upper limit of the Cretaceous system, some maintaining, from the character of the plants and of the shells, that the great plant-bearing series termed the Lignitic is of Tertiary age, others insisting, from the occurrence of true Cretaceous shells in and above the Lignitic series, that it must belong to the Cretaceous system. To the Upper Missouri region Hayden and Meek established the following subdivisions:—

5. Fox Hills group.—Sandstones and sandy clays (*Belemnitella*, *Nautilus*, *Ammonites*, *Baculites*, *Mosasaurus*, &c.) ..... 500 ft.
4. Fort Pierre group.—Plastic clays (*Ammonites*, *Scaphites*, *Inoceramus*, &c.) ..... 700 ,,
3. Niobrara group.—Calcareous marl (*Ostrea congesta*, *Inoceramus problematicus*, fish remains), ... 200 ,,
2. Fort Benton group.—Clays and limestones (*Scaphites*, *Ammonites*, *Pholadomya*, &c.) ..... 800 ,,
1. Dakotah group.—Sandstones, clays, and seams of lignite, with vast numbers of dicotyledonous leaves; a few marine shells. This is the great repository of the Cretaceous flora ..... 400 ,,

American Cretaceous fossils include the earliest dicotyledonous plants yet found on this continent, upwards of 100 species having been found, of which one-half were allied to living American forms. Among them are species of oak, willow, poplar, beech, maple, hickory, fig, tulip-tree, sassafras, sequoia, American palm (*Sabal*), and cycads. The more characteristic molluscs are species of *Terebratula*, *Ostrea*, *Gryphæa*, *Inoceramus*, *Hippurites*, *Radiolites*, *Ammonites*, *Scaphites*, *Hamites*, *Baculites*, *Belemnites*, *Ancyloceras*, and *Turrilites*. Of the fishes of the Cretaceous seas 97 species are known, comprising large prelacean representatives of modern or osseous types like the salmon and saury, though cestracionts and ganoids still flourished. But the most remarkable feature in the American Cretaceous fauna, as at present known, is the great number, variety, and size of the reptiles. According to the enumeration of Cope, who includes, however, in his list the Lignitic group here placed among the Tertiary formations, there are known at present 18 species of deinosaurs, 4 pterosaurs, 14 crocodilians, 13 sauropterygians or sea-saurians, 48 testudinates (turtles, &c.), and 50 pythonomorphs or sea-serpents. One of the most extraordinary of these reptilian forms was the *Elasmosaurus*—a huge snake-like form 40 feet long, with slim arrow-shaped head on a swan-like neck rising 20 feet out of the water. This formidable sea-monster "probably often swam many feet below the surface, raising the head to the distant air for a breath, then withdrawing it and exploring the

depths 40 feet below without altering the position of its body. It must have wandered far from land, and that many kinds of fishes formed its food is shown by the teeth and scales found in the position of its stomach" (Cope). But the real rulers of the American Cretaceous waters were the pythonomorphic saurians or sea-serpents. Some of them attained a length of 75 feet or more. They possessed a remarkable elongation of form, particularly in the tail; their heads were large, flat, and conic, with eyes directed partly upwards. They swam by means of two pairs of paddles, like the flippers of the whale, and the eel-like strokes of their flattened tail. Like snakes they had four rows of formidable teeth on the roof of the mouth, which served as weapons for seizing their prey. But the most remarkable feature in these creatures was the unique arrangement for permitting them to swallow their prey entire, in the manner of snakes. Each half of the lower jaw was articulated at a point nearly midway between the ear and the chin, so as greatly to widen the space between the jaws, and the throat must, consequently, have been loose and baggy like a pelican's. Nine species of birds have been obtained from the American Cretaceous rocks. Three of these belonged to the order of Natatores or swimmers, which includes our modern gulls, ducks, and geese; four were *Grallæ* or waders; while two belonged to a long extinct order, and united certain ichthyic and reptilian characters with those of birds. (See Cope, *Report of U.S. Geol. Surv. of Territories*, vol. ii., 1875; Marsh, *American Journ. Science*, 3d ser., i. to iv.; Leidy, *Smithsonian Contributions*, 1865, No. 192; Lesquereux, *Cretaceous Flora*, *Report of U.S. Geol. Surv. of Territories*, vol. vi.)

IV. TERTIARY OR CAINOZOIC.

The close of the Secondary periods was marked in the west of Europe by great geographical changes, during which the floor of the Cretaceous sea was raised partly into land and partly into shallow marine and estuarine waters. These events must have occupied a vast period of time, so that, when sedimentation once more began in the region, the organic remains of the Secondary ages had (save in a few low forms of life) entirely disappeared and given place to others of a distinctly more modern type. In England, the interval between the Cretaceous and the next geological period represented there by sedimentary formations is marked by the abrupt line which separates the top of the Chalk from all later accumulations, and by the evidence that the Chalk seems to have been in some places extensively denuded before even the oldest of what are called the Tertiary beds were deposited upon its surface. There is evidently here a considerable gap in the geological record. We have no data for ascertaining what was the general march of events in the south of England between the eras chronicled respectively by the Upper Chalk and the overlying Thanet beds.

Here and there on the Continent a few scraps of evidence are obtainable which help to fill up this gap. Thus, on the banks of the Meuse at Maestricht, a series of shelly and polyzoan limestones with a conglomeratic base (*Système Maestrichtien* of Dumont, who places it above his Senonian system in the Upper Cretaceous series) contains a mingling of true Cretaceous organisms with others which are characteristic of the older Tertiary formations. It contains, for example, the characteristic Upper Chalk crinoid, *Bourgeticrinus ellipticus*, in great numbers; also *Ostrea vesicularis*, *Baculites Faujasii*, *Belemnitella mucronata*, and the great reptile *Mosasaurus*; but with these occur such Tertiary genera as *Voluta*, *Fasciolaria*, and others. At Faxoe, on the Danish island of Seeland, the uppermost member of the Senonian series contains in like manner a blending of well-known Upper Chalk organisms with the Tertiary genera *Cypræa*, *Oliva*, and *Mitra*. In the neighbourhood of Paris also, and in scattered patches over the north of France, a formation known as the pisolitic limestone occurs, which was formerly classed with the Tertiary formations, seeing that its fossils had more affinities with later than with older rocks. But the discovery in it of numerous distinctively Upper Cretaceous forms has led to its being placed at the top of the Senonian series, from which, however, it is marked off by a decided unconformability, for it rests on a denuded surface of the White Chalk. These fragmentary formations are interesting, in so far as they help to show that, though in western Europe there is a tolerably abrupt separation between Cretaceous and Tertiary deposits, there was nevertheless no real break between the two periods. The one merged insensibly into the other; but the chronicles of the intervening ages have been in great measure destroyed.

In entering upon the Tertiary series of formations, we find ourselves upon the threshold of the modern type of life. The ages of lycopods, ferns, cycads, and yew-like conifers have passed away, and that of the dicotyledonous angiosperms—the hard-wood trees and evergreens of to-day—now succeeds them, but not by any sudden extinction and recreation, for, as we have seen (*ante*, p. 359), some of these trees had already begun to make their appearance even in Cretaceous times. The ammonites, baculites, and other cephalopods, which had played so large a part in the molluscan life of the Secondary periods, now cease. The great reptiles, too, which in such wonderful variety of type were the dominant animals of the earth's surface, alike on land and sea, ever since the commencement of the Lias, now wane before the increase of the mammalia, which advance in ever-augmenting diversity of type until man appears at their head.

The name Tertiary, given in the early days of geology before much was known regarding fossils and their history, has retained its hold on the literature of the science. It is sometimes replaced by the term Cainozoic (*recent life*), which expresses the great fact that it is in the series of strata comprised under this designation that most recent species and genera have their earliest representatives. Taking as the basis of classification the percentage of living species of mollusca found in the different groups of the Tertiary series, Lyell proposed a scheme of arrangement which has been generally adopted. The older Tertiary formations, in which the number of still living species of shells is very small, where, in fact, we seem to see as it were the first beginnings of the modern life, he named *Eocene* (*dawn of the recent*), including under that title those parts of the Tertiary series of the London and Paris basins wherein the proportion of existing species of shells was only 3½ per cent. The middle Tertiary beds in the valleys of the Loire, Garonne, and Dordogne, containing 17 per cent. of living species, were termed *Miocene* (*less recent*). The younger Tertiary formations of Italy were included under the designation *Pliocene* (*more recent*), because they contained a majority or from 35 to 95 per cent. of living species. This newest series, however, was further subdivided into Older Pliocene (35 to 50 per cent. of living species) and Newer Pliocene (90 to 95 per cent.). This classification, with various modifications and amplifications, has been adopted for the Tertiary group not of Europe only but of the whole globe.

As the North American development of the Tertiary series differs in so many respects from that of Europe, it will be most conveniently considered by itself after the European classification has been described.

Eocene.

Great Britain.—The Eocene rocks of Britain are entirely confined to the south-east of the island, where they occupy two great depressions of the chalk, known respectively as the London and Hampshire basins. They have been arranged into the groups shown in the subjoined table.

Upper	Upper fresh-water and estuarine series	Hempstead beds	170 ft.
		Bembridge ,,	115 ,,
		Osborne ,,	70 ,,
		Headon ,,	200 ,,

Middle	Middle marine series	Upper Bagshot Sand	250 to 300 ft.
		Middle Bagshot beds, including Barton Clay (300 feet) and Bracklesham beds (100 feet).	
		Lower Bagshot beds	100 ,, 150 ,,
Lower	Lower fresh-water, estuarine, and marine series	London Clay	50 ,, 500 ,,
		Oldhaven beds	20 ,, 30 ,,
		Woolwich and Reading beds	15 ,, 163 ,,
		Thanet Sand	20 ,, 60 ,,

Grouped in relation to the physical changes which they record, these strata naturally stand in three divisions. At the base lies a series of beds laid down in fresh, estuarine, and sea-water, on an upraised denuded surface of Chalk. Then comes a central group bearing witness to the deepening of these shallow waters, and to the advance of the sea far up the former estuary. The upper group brings before us proof of the eventual retreat of the sea, and the conversion of the area once more into fresh-water lakes and rivers. This arrangement does not quite tally with that which is based on a comparison of the fossils with existing forms, and with those of other Tertiary districts, for it places the London Clay in the middle series, though the fossil evidence distinctly shows that formation to belong to the older Eocene groups.

Lower Eocene.—The Thanet Sand at the base of the London Tertiary basin consists of pale yellow and greenish sand, sometimes clayey, and containing at its bottom a layer of green-coated flints resting directly on the Chalk. According to Mr Whitaker, it is doubtful if any proof of actual erosion of the chalk can anywhere be seen under the Tertiary deposits in England, and he states that the Thanet Sands everywhere lie upon an even surface of chalk with no visible unconformability. Professor Philips, on the other hand, describes the chalk at Reading as having been "literally ground down to a plain or undulated surface, as it is this day on some parts of the Yorkshire coast," and having likewise been abundantly bored by lithodomous shells. The fossils of the Thanet Sand comprise about 70 known species (all marine, except a few fragments of terrestrial vegetation). Among them are several foraminifera, numerous lamellibranchs (*Astarte tenera*, *Cyprina Morrisii*, *Ostrea Bellovacina*, &c.), a few species of gasteropods (*Natica subdepressa*, *Aporrhais Sowerbii*, &c.), a nautilus, and the teeth or palatal bones of fishes (*Lamna*, *Pisodus*).

The Woolwich and Reading beds, or Plastic Clay of the older geologists, consist of lenticular sheets of plastic clay, loam, sand, and pebble beds. The organic remains show that the sea of the Thanet Sand era gradually shallowed into an estuary. They amount to more than 100 species, and include a few plants of terrestrial growth such as *Ficus Forbesi*, *Grevillea Heeri*, and *Laurus Hookeri*. The lamellibranchs are partly estuarine or fresh-water (*Cyclas*, *Cyrena*, *Dreissena*, *Unio*), partly marine. Of the latter a characteristic species is *Ostrea Bellovacina*, which forms a thick oyster bed at the base of the series. *Ostrea tenera* is likewise abundant. The gasteropods include a similar mixture of marine with fluviatile species (*Cerithium funatum*, *Melania inquinata*, *Natica subdepressa*, *Fusus latus*, *Paludina lenta*, &c.) The fish are chiefly sharks (*Lamna*). Bones of turtles and scutes of crocodiles have been found. The highest organisms are bones of mammalia, one of which, the *Coryphodon*, was allied to the modern tapir.

The Oldhaven beds forming the base of the London Clay, though of trifling thickness, have yielded upwards of 150 species of fossils. Traces of *Ficus*, *Cinnamomum*, and *Coniferæ* have been obtained from them; but the organisms are chiefly marine and partly estuarine shells, the gasteropods being particularly abundant. The London Clay, as its name implies, is a mass of clay, stiff, brown, or bluish-grey, with septarian nodules. It extends through both the London and Hampshire basins, attaining a maximum thickness in the south of Essex. It has yielded a long and varied suite of organic remains, from which we can see that it must have been laid down in the sea beyond the mouth of a large estuary, into which abundant relics of the vegetation, and even sometimes of the fauna of the adjacent land were swept. Its fossils are mainly marine mollusca, and, taken in connexion with the flora, indicate that the climate was somewhat tropical in character. The plants include the fruits or other remains of palms (*Nipadites*), custard-apple, acacia, gourds, melons, *Proteaceæ*, and *Coniferæ*. Crustacea abound (*Xanthopsis*, *Hoploparia*). Gasteropods are the prevalent mollusks, the common genera being *Pleurotoma* (45 species), *Fusus* (15 species), *Cypræa*, *Murex*, *Cassidaria*, *Pyrula*, and *Voluta*. The cephalopods are represented by 6 or more species of *Nautilus*, by *Belosepia sepioidea*, and *Beloptera Levesquei*. Nearly 100 species of fishes occur in this formation, the rays (*Myliobates*, 14 species) and sharks (*Lamna*, *Otodus*, &c.) being specially numerous. A sword-fish (*Tetrapterus priscus*), and a saw-fish (*Pristis bisulcatus*) about 10 feet long, have been described by Agassiz from the London Clay of Sheppey, whence almost the whole of the fish remains have been obtained. The reptiles were numerous, but markedly unlike, as a whole, to those of Secondary times. Among them are numerous turtles and tortoises, two species of crocodile, and a sea-snake (*Palæophis*), estimated to have been 13 feet long. Remains of birds have also been met with; one of these (*Lithornis vulturinus*) appears to have been allied to the vulture, another (*Halcyornis toliapicus*) to our modern king-fisher, besides waders and other types. The mammals numbered among their species a hog (*Hyracotherium*), several tapirs (*Coryphodon*, &c.), an opossum (*Didelphys*), and a bat. The carcases of these animals must have been borne seawards by the great river which transported so much of the vegetation of the neighbouring land.

Middle.—The Bagshot group consists of sand and bands of clay which, in the Hampshire basin, are tolerably fossiliferous. As developed in the Isle of Wight and at Bournemouth, their lower members have yielded a large number of terrestrial plants, among which the *Proteaceæ* are still numerous, together with species of fig, cinnamon, fan-palm (*Sabal*), oak, yew, cypress, laurel, lime, senna, and many more. Crocodilian forms still haunted the waters, and have left their bones with those of sea-snakes and turtles and of the tapirs and other denizens of the land, which still, as in the time of the London Clay, continued to be washed out to sea. Among these strata we now find one of the most typical organisms of the Eocene rocks of the Mediterranean basin, a foraminifer termed *Nummulites* (*N. lævigata*, *N. scabra*, *N. variolaria*). Characteristic fossils are *Voluta athleta*, *V. luctatrix*, *Murex asper*, *Fusus longævus*, *Cardita planicosta*, and *Chama squamosa*.

Upper.—The strata of this division of the English Eocene formations are entirely confined to Hampshire and the Isle of Wight. They consist of sands, clays, marls, and limestones, in thin-bedded alternations. These strata were accumulated partly in the sea, partly in brackish, and partly in fresh water. They were hence named by Edward Forbes the fluvio-marine series. Among the marine fossils are—*Fusus porrectus*, *Oliva Branderi*, *Natica labellata*, *Ostrea callifera*, and *Nummulites lævigata*. The genera *Cerithium*, *Potamomya*, *Paludina*, *Planorbis*, *Limnæa*, and *Cyclas* are abundant, showing the brackish and fresh-water conditions in which many of the strata were deposited. Remains of turtles, snakes, crocodiles, and alligators continue to occur in these Upper Eocene beds. With these are found the bones of several very characteristic mammals also met with in the Paris basin,—the three-toed *Palæotherium*, resembling the living tapir; *Anoplotherium*, a more graceful