CHAPTER XX.

JURASSIC GROUP. — PURBECK BEDS AND OOLITE.

The Purbeck beds a member of the Jurassic group — Subdivisions of that group — Physical geography of the Oolite in England and France — Upper Oolite — Purbeck beds — New fossil Mammifer found at Swanage — Dirt-bed or ancient soil — Fossils of the Purbeck beds — Portland stone and fossils — Lithographic stone of Solenhofen — Middle Oolite — Coral rag — Zoophytes — Nerinæan limestone — Diceras limestone — Oxford clay, Ammonites and Belemnites — Lower Oolite, Crinoideans — Great Oolite and Bradford clay — Stonesfield slate — Fossil mammalia, placental and marsupial — Resemblance to an Australian fauna — Northamptonshire slates — Yorkshire Oolitic coal-field — Brora coal — Fuller's earth — Inferior Oolite and fossils.

Immediately below the Hastings Sands (the inferior member of the Wealden, as defined in the 18th chapter), we find in Dorsetshire another remarkable freshwater formation, called *the Purbeck*, because it was first studied in the sea-cliffs of the peninsula of Purbeck in Dorsetshire. These beds were formerly grouped with the Wealden, but some organic remains recently discovered in certain intercalated marine beds show that the Purbeck series has a close affinity to the Oolitic group, of which it may be considered as the newest or uppermost member.

In England generally, and in the greater part of Europe, both the Wealden and Purbeck beds are wanting, and the marine cretaceous group is followed immediately, in the descending order, by another series called the Jurassic. In this term, the formations commonly designated as "the Oolite and Lias" are included, both being found in the Jura Mountains. The Oolite was so named because in the countries where it was first examined, the limestones belonging to it had an oolitic structure (see p. 12.). These rocks occupy in England a zone which is nearly 30 miles in average breadth, and extends across the island, from Yorkshire in the north-east, to Dorsetshire in the south-west. Their mineral characters are not uniform throughout this region; but the following are the names of the principal subdivisions observed in the central and south-eastern parts of England:—

OOLITE.

Upper	*a.*	Purbeck beds.
	b.	Portland stone and sand.
	c.	Kimmeridge clay.
Middle	*d.*	Coral rag.
	e.	Oxford clay.
Lower	*f.*	Cornbrash and Forest marble.
	g.	Great Oolite and Stonesfield slate.
	h.	Fuller's earth.
	i.	Inferior Oolite.

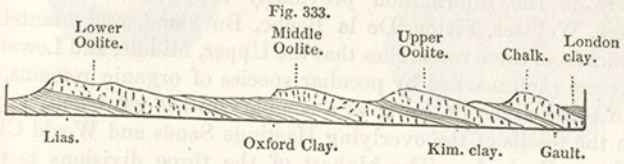
The Lias then succeeds to the Inferior Oolite.

The Upper oolitic system of the above table has usually the Kimmeridge clay for its base; the Middle oolitic system, the Oxford clay. The Lower system reposes on the Lias, an argillo-calcareous formation, which some include in the Lower Oolite, but which will be treated of separately in the next chapter. Many of these subdivisions are distinguished by peculiar organic remains; and, though varying in thickness, may be traced in certain directions for great distances, especially if we compare the part of England to which the above-mentioned type refers with the north-east of France and the Jura mountains adjoining. In that country, distant above 400 geographical miles, the analogy to the accepted English type, notwithstanding the thinness or occasional absence of the clays, is more perfect than in Yorkshire or Normandy.

Physical geography. — The alternation, on a grand scale, of distinct formations of clay and limestone has caused the oolitic and liassic series to give rise to some marked features in the physical outline of parts of England and France. Wide valleys can usually be traced throughout the long bands of country where the argillaceous strata crop out; and between these valleys the limestones are observed, composing ranges of hills or more elevated grounds. These ranges terminate abruptly on the side on which the several clays rise up from beneath the calcareous strata.

The annexed cut will give the reader an idea of the configuration of the surface now alluded to, such as may be seen in passing from London to Cheltenham, or in other parallel lines, from east to west, in the southern part of England. It has been necessary, however,

Fig. 333.



in this drawing, greatly to exaggerate the inclination of the beds, and the height of the several formations, as compared to their horizontal extent. It will be remarked, that the lines of cliff, or escarpment, face towards the west in the great calcareous eminences formed by the Chalk and the Upper, Middle, and Lower Oolites; and at the base of which we have respectively the Gault, Kimmeridge clay, Oxford clay, and Lias. This last forms, generally, a broad vale at the foot of the escarpment of inferior oolite, but where it acquires considerable thickness, and contains solid beds of marlstone, it occupies the lower part of the escarpment.

The external outline of the country which the geologist observes in travelling eastward from Paris to Metz is precisely analogous, and is caused by a similar succession of rocks intervening between the tertiary strata and the Lias; with this difference, however, that the escarpments of Chalk, Upper, Middle, and Lower Oolites face towards the east instead of the west.

The Chalk crops out from beneath the tertiary sands and clays of the Paris basin, near Epernay, and the Gault from beneath the Chalk and Upper Greensand at Clermont-en-Argonne; and passing from this place by Verdun and Etain to Metz, we find two limestone ranges, with intervening vales of clay, precisely resembling those of southern and central England, until we reach the great plain of Lias at the base of the Inferior Oolite at Metz.

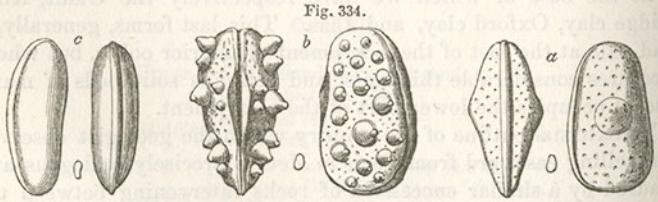
It is evident, therefore, that the denuding causes have acted similarly over an area several hundred miles in diameter, sweeping away the softer clays more extensively than the limestones, and undermining these last so as to cause them to form steep cliffs wherever the harder calcareous rock was based upon a more yielding and destructible clay.

UPPER OOLITE.

Purbeck beds (*a.* Tab. p. 292.).—These strata, which we class as the uppermost member of the Oolite, are of limited geographical extent in Europe, as already stated, but they acquire importance, when we consider the succession of three distinct sets of fossil remains which they contain. Such repeated changes in organic life must have reference to the history of a vast lapse of ages. The Purbeck beds are finely exposed to view in Durdlestone Bay, near Swanage, Dorsetshire, and at Lulworth Cove and the neighbouring bays between Weymouth and Swanage. At Meup's Bay, in particular, Prof. E. Forbes examined minutely in 1850 the organic remains of this group, displayed in a continuous, sea-cliff section; and he added largely to the information previously supplied in the works of Messrs. Webster, Fitton, De la Beche, Buckland, and Mantell. It appears from these researches that the Upper, Middle, and Lower Purbecks are each marked by peculiar species of organic remains, these again being different, so far as a comparison has yet been instituted, from the fossils of the overlying Hastings Sands and Weald Clay.*

Upper Purbeck.—The highest of the three divisions is purely freshwater, the strata, about 50 feet in thickness, containing shells of the genera *Paludina*, *Physa*, *Limnæus*, *Planorbis*, *Valvata*, *Cyclas*, and *Unio*, with *Cyprides* and fish. All the species seem peculiar, and among these the *Cyprides* are very abundant and characteristic. (See figs. 334. *a*, *b*, *c*.)

Fig. 334.



Cyprides from the Upper Purbecks.

a. Cypris gibbosa, E. Forbes. *b. Cypris tuberculata*, E. Forbes. *c. Cypris leguminella*, E. Forbes.

* "On the Dorsetshire Purbecks," by Prof. E. Forbes, Brit. Assoc. Edinb. 1850.

The stone called "Purbeck marble," formerly much used in ornamental architecture in the old English cathedrals of the southern counties, is exclusively procured from this division.

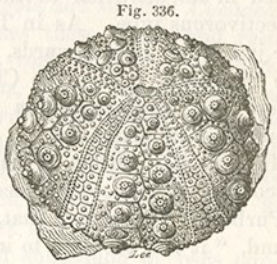
Middle Purbeck.—Next in succession is the Middle Purbeck, about 30 feet thick, the uppermost part of which consists of freshwater limestone, with cyprides, turtles, and fish, of different species from those in the preceding strata. Below the limestone are brackish-water beds full of *Cyrena*, and traversed by bands abounding in *Corbula* and *Melania*. These are based on a purely marine deposit, with *Pecten*, *Modiola*, *Avicula*, *Thracia*, all undescribed shells. Below this, again, come limestones and shales, partly of brackish and partly of freshwater origin, in which many fish, especially species of *Lepidotus* and *Microdon radiatus*, are found, and a crocodilian reptile named *Macrorhyncus*. Among the mollusks, a remarkable ribbed *Melania*, of the section *Chilira*, occurs.

Immediately below is the great and conspicuous stratum, 12 feet thick, long familiar to geologists under the local name of "Cinder-bed," formed of a vast accumulation of shells of *Ostrea distorta* (fig. 335.). In the uppermost part of this bed Prof. Forbes discovered the first echinoderm (fig. 336.) as yet known in the Purbeck series, a species of *Hemicidaris*, a genus characteristic of the Oolitic period, and scarcely, if at all, distinguishable from a previously known oolitic species. It was accompanied by a species of *Perna*.

Fig. 335.

Ostrea distorta.
Cinder-bed, Middle Purbeck.

Fig. 336.



Hemicidaris Purbeckensis, E. Forbes.
Middle Purbeck.

Below the Cinder-bed freshwater strata are again seen, filled in many places with species of *Cypris* (fig. 337. *a*, *b*, *c*), and with *Valvata*,

Fig. 337.

Cyprides from the Middle Purbecks.
a. Cypris striato-punctata, E. Forbes. *b. Cypris fasciculata*, E. Forbes. *c. Cypris granulata*, Sow.

Paludina, *Planorbis*, *Limnæus*, *Physa* (fig. 338.), and *Cyclas*, all different from any occurring higher in the series. It will be seen