II. *The Corallian Rocks of Oxford, Berks and North Wilts.*

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(Plates 1 and 2 and Map.)

Contents.

I.—Introduction.

The rocks described in this paper strike roughly E.N.E.-W.S.W., from Wheatley, near Oxford, to the neighbourhood of Wootton Bassett and Tockenham in Wiltshire, a distance of about forty miles. They are mapped on the Old Series 1-inch Geological Survey Maps, sheets 13 and 34, and those portions east of Kingston Bagpuize also on the New Series 1-inch Oxford Special Sheet. The extreme south-westerly portions have also been recently re-mapped by the Survey on the new Marlborough sheet.

This strip of rocks, of which the average breadth is about two and a half miles, varying from five miles to nothing, has resisted subaerial denudation to a greater extent than the Oxford and Kimeridge Clays below and above it. In consequence it forms a conspicuous ridge, roughly parallel to the Chalk escarpment, dividing the Vale of the White Horse (in its broadest sense) into the valley of the Isis on the north and the valley of the Ock on the south. Near Wootton Bassett is the water-parting between the Bristol

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Avon and the Thames, of which the Isis is the upper portion, above Abingdon, the point of confluence with the Ock. All the formations within this area have an *apparent* dip to the north-east.

The Corallian formation in the district with which this paper deals is considered to comprise five divisions [3 and 4]* :—

5. Upper Calcareous Grit.
[4. *Trigonia clavellata* Beds ; doubtfully represented.]
3. Osmington Oolite Series.
2. Berkshire Oolite Series.
1. Lower Calcareous Grit.

These rocks are described, the various exposures are correlated, and an attempt is made to show the position which they occupy in the Corallian formation as a whole, both in other parts of England and on the Continent. It is endeavoured, by means of detailed analysis, to throw some light on the conditions under which the rocks were formed, and to account for the apparently meaningless variability which, to a casual visitor to only a few of the exposures, seems to characterise the formation, both palæontologically and lithologically.

It is shown that it is only by detailed work, carried out in conjunction with a broad survey, that we can hope to understand such questions as the distribution of land and sea, the location of coast-lines and of rivers controlling the sedimentation and the growth of corals, or the tectonic movements which repeatedly modified the Jurassic landscape. It is contended that such problems can best be solved by a comparison of the facies changes and faunal associations preserved in the rocks with their modern analogues in the coral seas at the present day. Such considerations have been kept constantly in view in the course of the work.

The paper concludes with a revision of the fauna, some new species being described, and with a geological Map of an important area in the centre of the district, where the relations and surface features of the stratigraphical subdivisions established are best shown.

Before proceeding the writer is anxious to express his thanks to the following, who have been of great assistance in various branches of the work : Prof. W. J. Sollas and Dr. J. A. Douglas for much valuable help in the field, the laboratory and the library ; Mr. R. C. Spiller for examining the pebbles ; Mr. H. S. Straw for help with the corals ; Mr. J. Pringle for his invaluable collaboration while engaged on the Corallian section of the recently published Geological Survey Memoir of the Oxford district, during the preparation of which opportunities arose for discussion of problems in the field ; Dr. A. Morley Davies for putting at the writer's disposal his notes and collections from the Ampthill Clay ; Prof. H. L. Hawkins for the latest information concerning the

* Figures in square brackets refer to the list of works at end of the next section.

Echinoderms; Mr. S. S. BUCKMAN and Dr. L. F. SPATH for fruitful discussions on the subject of the ammonites; Mr. L. R. COX for help in the British Museum; Mr. A. D. PASSMORE for his valuable photographic assistance.

II.—FORMER WORK.

The earliest work published on the Corallian in this area was of a purely descriptive nature. In 1832 LONSDALE described the quarries at Highworth and carried out the detailed investigation of the sequence around Calne, eight miles south of our area [19]. Later, in 1858, E. HULL, working for the Survey, mapped much of the central parts and re-described the Highworth quarries and others, but from his mapping and his accompanying short memoir it appears that he did not understand the succession so well as LONSDALE [14].

The first attempt at a faunal list from the formation was published in 1861 by J. F. WHITEAVES. This formed a basis for PHILLIPS' list of ten years later, but naturally it must not be too much relied upon, for a great many Lower Jurassic fossils were supposed to reappear in the Corallian on the ground of what would now be considered purely superficial similarity. WHITEAVES described and figured four new species from the local rocks [46]. JOHN PHILLIPS, in his 'Geology of Oxford and the Valley of the Thames,' 1871, gave a brief account of the formation, with some excellent drawings of local fossils and a revised list containing many others [29].

It was left for Messrs. BLAKE and HUDLESTON in 1877 to give a thorough and coherent description in their famous paper on "The Corallian Rocks of England" [6]. Their work was so thorough and so accurate, so far as it went, that it will always be the starting point for any study of the Corallian in this country. Indeed, most of their descriptions of exposures are so lucid that every bed can still be immediately recognised, and this part of their work cannot be too highly praised.

The wide extent of country which they covered, however, and the time in which they covered it, did not admit of their visiting more than a tenth of the exposures, of paying anything but a superficial attention to palæontology, or of lingering long enough in any locality to think out the special local problems. Their work is further open to more general criticism on the grounds mentioned by Mr. BUCKMAN [9]. Correlations, where not omitted altogether, are generally implied in the text instead of being separately and clearly tabulated, and conclusions are obscured by detail. The work suffers much from the lack of any adequate palæontological time-scale, a necessary result of the unsatisfactory state of palæontological knowledge obtaining at the time.

In 'The Jurassic Rocks of Britain' [47], 1895, H. B. WOODWARD gathered together much material of mixed value. In most respects little advance was made on BLAKE and HUDLESTON's paper of 18 years earlier, though some additional sections were described for the first time. What would have been valuable fossil-lists are rendered practically useless by failure to state from which beds the fossils were obtained.

In the Memoir accompanying the Oxford Special Sheet, published by the Geological Survey in 1908, are embodied the results of the surveyors' work in the field in the extreme eastern part of the area. The most important contribution is the mapping of the Wheatley and Stanton St. John district by Mr. H. B. WOODWARD [30].

Until 1913 the exceedingly primitive and clumsy zoning still prevailed, in accordance with which the Corallian rocks of this part of England were divided into a lower zone of *Ammonites perarmatus* and an upper zone of *Ammonites plicatilis*. The name "*perarmatus*" was scarcely more diagnostic than "*Aspidoceras*" at the present day, though even BLAKE and HUDLESTON remark that "the group of Ammonites passing under this name presents three well-marked forms, varieties or species." Similarly "*Ammonites plicatilis*" included practically all the Corallian Perisphinctids. The unsatisfactory nature of this system of zoning was apparent when Plicatiloid Perisphinctids were found in the Lower Calcareous Grit and Aspidocerates high up in the Berkshire Oolites In 1913 Dr. SALFELD published his classic paper "Die Gliederung des Oberen Jura in Nordwest-Europa" [38]. In this work six zones were assigned to the Corallian, from the Lower Calcareous Grit to the top of the Sandsfoot Grits, Ammonites being chosen as index fossils, and figured in a contemporary paper. But the state of knowledge of our local rocks at that time is indicated by the only mention of them in Dr. SALFELD's tables; the "Calc. Grits of Highworth and Coral Rag of Wiltshire" are bracketed together and assigned to the zone of *Perisphinctes wartæ*, the whole being correlated with the Sandsfoot Clay!

Eleven years elapsed after the appearance of Dr. SALFELD's papers before the publication of the results of any further work in the district. In 1919 Mr. BUCKMAN began to figure Corallian Ammonites in 'Type Ammonites,' and in 1924 to describe representative sections and hemeral sequences. Some of the old and many new forms received new generic and specific names, and by 1925 the Corallian had been divided into 3 Ages and 38 Hemeræ, of which 26 were said to be represented in the Oxford district [9, p. 67]. It has been one of the principal objects of the palæontological part of the present work to examine these hemeræ in the field and to test how far they are of value.

The most recent work on the district is by Mr. PRINGLE, in the new edition of the Geological Survey Memoir accompanying the new edition of the Oxford Special Sheet. The opposite extremity of the area was also touched upon in Mr. O. WHITE's memoir accompanying the new Marlborough Sheet, published in 1925 [45]. The greater part of the area dealt with in this paper, however, the most important central region, has remained virtually unexplored since 1877.

Since the days of Dr. BUCKLAND members of Oxford University have collected fossils from the Corallian of Headington, Marcham, and other famous quarries in the neighbourhood, and have deposited them in the museum. In the large collections so formed fine specimens and rare species abound, but their value, in most instances, is seriously impaired by the lack of labels, obliging investigators to rely solely on matrix as a guide to identifying the horizons from which they were collected.

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(Excluding purely palæontological works mentioned only in Appendix I.)

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[2] *Idem* (1926). "Studies in the Corallian Lamellibranch Fauna of Oxford, Berks and Wilts. Parts I and II," 'Geol. Mag.,' vol. 63, pp. 193–210 and pp. 534–555.

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[21] *Idem* (1907). "Excursion to Dorton, Brill and Arngrove," 'Proc. Geol. Assoc.,' vol. 20, Part 3, p. 185.
[22] *Idem* (1909). "Excursion to Wheatley and Arngrove," 'Proc. Geol. Assoc.,' vol. 21, Part 4, p. 234.
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III.—The Lower Calcareous Grit Period.

(*a*) *The Sands and Sandstones.*

Between Wheatley and Wootton Bassett the Oxford Clay is usually succeeded by calcareous sands, often cemented in the form of doggers or large lenticles into very hard blue-centred or iron-stained sandstone, known collectively as the Lower Calcareous Grit. Details are so variable from place to place that no useful purpose is served by minute description of particular exposures or subdivision of the series into numbered beds. Near Oxford extensive false-bedding makes this impossible. Not the least variable feature of the Lower Calcareous Grit is its thickness. In some places it is absent altogether, while in others it attains a thickness greater than is anywhere attained by the whole of the rest of the formation together—nearly 80 ft.

Although the Lower Calcareous Grit possesses all the irregular features of a sandbank, with great differences in magnitude in short distances, certain interesting points are revealed by a consideration of the average thicknesses throughout the district. In the east, about Oxford, the maximum thickness proved in wells is 50 ft., at Littlemore and Chawley. The areas in which such a thickness is attained are only local, and the usual thickness is from 20 ft. to 40 ft. In some places it is less, as in the little valley the bottom of which is filled with bog, which runs from Southfield Golf-links to the south of Wingfield Hospital. The thickness here cannot be much more than 12 ft. In the boring at Wootton it was proved to be 11 ft., the boring passing from Coral Rag through the Lower Calcareous Grit straight into 34 ft. of " soft, soapy " Oxford Clay [5, p. 102].

Passing south-westward from Wootton the thickness is much less erratic and increases steadily. In a mile and a quarter, at Cothill, it has become at least 35 ft. At the Frilford boring, two miles farther, it has reached over 50 ft.—$52\frac{1}{2}$ ft. being proved [5].

The next deep borings, at Faringdon, Goosey and Shrivenham, proved 70 ft., 79 ft. and 76 ft. respectively. These three borings are situated approximately in the centre of our area, and record the greatest known thicknesses of Lower Calcareous Grit in the district [5].

Passing westward a progressive thinning is indicated by all the borings. In about three miles, at Highworth, the greatest thickness has become 30 ft., and three other wells and borings proved 26 ft., 22 ft. and 21 ft. respectively [44]. Four miles farther, on the slopes of Blundson Hill, it is easy to see that more than 20 ft. cannot be present and that the usual thickness is from 10 ft. to 15 ft. In yet another mile the Lower Calcareous Grit dwindles to a parting of sand scarcely capable of being mapped, and finally disappears altogether. Then for eleven miles the Oxford Clay and Upper Corallian are nearly everywhere in contact, after which, outside the confines of our district, the normal sands reappear, forming a prominent feature from Spirthill through Bremhill to Calne and beyond.

There are two exceptions, however, in the area where the Lower Calcareous Grit is usually absent. A small " pocket " of the sands exists at Tockenham Wick and extends to the outlier forming Grittenham Hill. A second, even more local patch, forms Paven Hill, Purton, and the bluff on which Ringsbury Camp is cut. This " pocket " was penetrated by a well at Paven Hill, which proved 50 ft. of sands with hard bands. A well at the neighbouring Purton Vicarage passed through 20 ft. of Coral Rag straight into Oxford Clay. This great variability of thickness is reminiscent of the Oxford district, at the opposite extremity of our area. Part of the stratum mapped as Lower Calcareous Grit at Purton consists of non-calcareous Rhaxella chert, similar to the Arngrove Stone at the north-eastern extremity of the district. This will be alluded to on p. 79.

Concerning the palæontology of the Lower Calcareous Grit, regrettably little can be said of any but the upper parts. It was these sands that comprised the old zone of *Ammonites perarmatus*. The finest and most productive exposures are at Marcham, where the enormous excavations testify to the length of time during which they have been exploited and explain the rich collections of fossils which have found their way from Marcham to most of the museums in England.

The commonest Ammonites are *Aspidoceras catena*, Sow. and *Aspidoceras faustum*, BAYLE. The former was so called on account of the loose chain-like way in which the internal casts of the gas chambers are linked together, the septa and shell having been dissolved away. Other ammonites occur in the same condition; particularly *Cardioceras excavatum*, Sow. (*Anacardioceras excavatum*, S.S.B.) of many varieties, ranging in thickness (expressed as a percentage of diameter) from 28 per cent. to 41 per cent. Varieties of *Cardioceras vertebrale* (*Vertebriceras* spp.) and *Cardioceras cordatum* (*Anacardioceras cordatiforme* S.S.B.) also occur.

In the northern quarry near Sheepstead Farm is an impersistent marly band, containing very large specimens of *Nautilus hexagonus*, and *Belemnites abbreviatus*. Careful search on the weathered surfaces of the sandstone reveals innumerable finely broken Lamellibranchs, and *Exogyra nana*, *Ostrea gregaria*; other small oysters, *Chlamys fibrosus*, *Natica arguta* and *Serpulæ* may easily be recognised. A band near the top is composed almost entirely of the first three species. I have also obtained *Bourguetia striata*, *Natica felina*, indications of a Plicatiloid Perisphinctid, a vertebra of *Teleosaurus*, fruits of *Carpolithes plenus* and much drifted wood.

Innumerable pebbles of so-called "lydite" form a conspicuous feature of the Lower Calcareous Grit at Marcham. They are here far more abundant and larger than anywhere else, often attaining a length of as much as 25 mm. They are thoroughly smoothed and rounded and, being very hard, they must have been subjected for a long time to water action. As we pass westward these pebbles become less and less a feature of the Lower Calcareous Grit, dwindling both in numbers and in size.

The Marcham quarries, which expose about 30 ft., are typical of several in the vicinity. They show the present top of the Lower Calcareous Grit, though much that is preserved elsewhere has here been removed by erosion. Two quarries in Tubney Wood expose lower beds. The lower parts, at depths of from 10 ft. to 30 ft., are practically unfossiliferous and devoid of pebbles, while the highest 10 ft. contain numerous fragments of the Marcham oysters and are crowded with lydite pebbles, so that they probably correspond to the base of the sands in the Marcham quarries.

Another feature of the Lower Calcareous Grit of Marcham and Tubney is the fantastic false-bedding, which is here more marked than at any other locality. Here the sandbank appears to have been heaped up rapidly by changing currents. The dip of the false-bedding gives no indication of the direction of the prevailing current, for dips in all directions may be seen in the same quarry. False-bedding in general, however, diminishes westward progressively as the pebbles become scarcer and smaller, and by the time Highworth is reached even-bedding is practically universal.

West of Marcham the Lower Calcereous Grit is exposed at Fyfield Wick, Draycot Moor, Kingston Bagpuize, Pusey, Littleworth, Shellingford, Stanford in the Vale and in many other quarries worked primarily for the overlying Berkshire Oolite limestones. In most of these places it is unfossiliferous. In many the top shows an eroded surface, and in most of them it has been indurated into an intensely hard band on which the hammer sparks.

In the Hangman's Elm Quarry, Highworth, fossils occur in this indurated topmost band. The most characteristic are beautiful casts of *Natica arguta* in highly polished or opalescent calcite. I have also obtained a large inflated, smooth, keelless Cardiocerate of the *excavatum* type (thickness, $58\frac{1}{2}$ per cent. at 196 mm.), and *Nautilus hexagonus*. The eroded surface is here very marked.

The deepest exposure in the west is at Highworth Railway Station, where about 16 ft. of even-bedded yellow sands are seen. In a dogger about $3\frac{1}{2}$ ft. below the top in another sandpit, south of Highworth, I obtained *Aspidoceras* sp., *Cardioceras dorsale*, S.S.B. and casts of *Natica arguta* and *Pleuromya tellina*. All the other exposures have proved unfossiliferous.

Returning to the eastern extremity of the district; in certain places we find beds which appear to be newer than the greater part of the ordinary Lower Calcareous Grit. Such occur at Cumnor, Cowley and probably Littlemore. At Bradley Farm Quarry, near Cumnor, the false-bedded sands of Tubney and Marcham are overlain by a remarkable stratum widely known as the Natica Band.

The Natica Band is a course of hard grit, 6 ft. thick, lying horizontally upon false-bedded sands. It consists of two harder courses enclosing a central, irregular, softer band, composed almost entirely of the casts of Gastropods. The commonest is *Natica arguta*, Phil., but the following is the complete list:—*

Cylindrites polygyrus.
Ceritella costata.
Pseudomelania condensata.
Pseudomelania heddingtonensis.
Pleurotomaria bicarinata.
Pleurotomaria reticulata.
Natica (Ampullina) arguta.
Natica (A.) clio.
Natica (A.) clytia.
Natica felina.
Nerinea goodhalli.

The casts of *Natica arguta* are reminiscent of those in the indurated topmost bed at Hangmans Elm Quarry, Highworth. Besides these Gastropods I have seen *Velopecten velatus*, impressions of Plicatiloid Perisphinctids, and *Cardioceras cordatiforme*, S.S.B. (typical). The typical form of the last fossil also occurs in the extreme top of the sands at Headington, but still associated with *C. excavatum*.

Upon the Natica Bed lie 6 ft. of even-bedded interlaminated sand and clay. This bed is suggestive of similar sand and clay separating the Trigonia Beds of Marcham,

* To save constant repetition, the sense in which the name of each fossil is to be interpreted throughout the paper is set forth in Appendix I (pp. 162–178).

belonging to the Berkshire Oolites ; but that it is really a part of the Lower Calcareous Grit becomes apparent on closer inspection. It is overlain by a particularly fine specimen of the Pebble Bed which always forms the base of the Berkshire Oolites, above which is the Shell Bed with *Trigonia*, *Astarte ovata*, etc. It is itself full of small Lower Calcareous Grit lydite and quartz pebbles, but it contains no trace of the large pebbles of grey limestone and indurated grit so characteristic of the Pebble Bed at the base of the Berkshire Oolites.

I have obtained *Cardioceras* cf. *tenuistriatum* from this bed and BLAKE and HUDLESTON mention that it contains " nodules surrounding *Ammonites cordatus*, or enclosing a nest of shells in which *Cylindrites* [*polygyrus*] is abundant. It also contains *Natica clytia*, *Gervillia aviculoides*, *Ostrea* [*gregaria*] and *Serpula tricarinata* " [6, p. 307].

BRADLEY FARM QUARRY, CUMNOR.

		Ft.	ins.
OSMINGTON OOLITE SERIES.			
9. Typical Coral Rag with fine reef corals in situ ; *Lima zonata*, *Chlamys nattheimensis*, *Littorina muricata*, *Lithodomus inclusus*, etc.	0 to	4	0
On the N.E. of the quarry this rests directly on Bed 6, and appears to have grown out over Beds 7 and 8, expanding towards the top.			
8. Broken and ground up corals and shells, non-oolitic ; few whole fossils but *Exogyra nana*	0 to	2	0
7. Consolidated ditto, forming a hard white limestone	0 to	1	10
BERKSHIRE OOLITE SERIES.			
6. Shell-cum-Pebble Bed. Cream-coloured limestone with pebbles at the base and many shells, particularly *Trigonia perlata*, *Astarte ovata*, *Gervillia aviculoides*, *Chlamys fibrosus*, *C. splendens*, *Lima rigida*, *Natica* casts, *Pleurotomaria* casts, *Exogyra nana*, *Serpulæ*	3 in. to	1	10
LOWER CALCAREOUS GRIT.			
5. Interlaminated sand and clay with chert and quartz pebbles. *Cardioceras* cf. *tenuistriatum*	2 ft. 6 in. to	5	6
4, 3, 2. The Natica Band		6	0
4. Intensely hard calcareous grit with cherts.			
3. Porous mass of Gastropod casts ; inconstant.			
2. Intensely hard calcareous grit with cherts.			
1. Yellow false-bedded sand, with some seams of clay towards the top ; chert and quartz		9	0

At Cowley the top of the Lower Calcareous Grit is highly fossiliferous in the quarries beside the road to Horspath, but unfortunately these are now no longer worked. Three feet of sands are still exposed, containing *Chlamys fibrosus*, *Pseudomonotis ovalis*, *Exogyra nana* and *Serpulæ*. The sands contain an impersistent hard band, from which Mr. BUCKMAN records *Cardioceras cordatiforme*, *C. excavatum*, *C. ammonoides*, *Cardioceras* cf. *suessi*, *Perisphinctes kranaus*, large " *P.* cf. *triplex* " and casts of *Pleuromya* [9, p. 51].

At Littlemore the Lower Calcareous Grit is seen to be even-bedded for at least 12 ft. from the top. It consists of yellow sand with the usual indurated topmost band, and three rows of doggers, the whole being very unfossiliferous. According to Mr. COBBOLD [10, p. 314] at 14 ft. there is a thicker, more constant hard band, which has been met with at the Sandford sewage farm and elsewhere, and below this sands again. In a neighbouring well the sands had a thickness of 50 ft. In the top part the sands are so pure and of such fine texture that they are sent for moulding to Swindon Works.

All the sections so far described expose only the higher parts of the Lower Calcareous Grit. No permanent sections of the lower portions, or of the junction with the Oxford Clay, have ever been described or now exist, and our only information has perforce to be gleaned from the records of wells and borings and the inspection of the tip-heaps of a few of them. Palæontologically this critical region remains practically unknown.

The highest beds of the Oxford Clay exposed in the district sufficiently well to be available for study are those in the brickyard at Horton-cum-Studley. This clay is characterised by innumerable forms of small Cardiocerates of the "*cordatum*" and *præcordatum* types, as well as by Mr. BUCKMAN's new keelless genus *Hortoniceras*. The *Gryphææ* are broad and flat, unlike those in the Oxford Clay of Wolvercote at lower horizons, and are the counterparts of some to be found in the clay at the top of the Lower Calcareous Grit at Spirthill, Wilts. (The latter, however, occur in association with an extremely incurved form, recalling the Liassic *G. arcuata*.)

Between Studley brickyard and the lowest beds exposed in the Tubney Wood sandpits there is a wide gap. An indication of what may be expected in this gap was given by a well near Pen Hill, north of Swindon, in 1922, which was deepened from Lower Calcareous Grit into Oxford Clay. Near the junction was a fossil band, of unknown thickness, from which I had the opportunity of collecting on the fresh tip-heap. It contained both Cardiocerates of the *cordatum* style and crushed specimens of two species of Plicatiloid Perisphinctids. The bed consisted of shelly, greenish, sandy marl, forming a very characteristic matrix, which was again met with in a shallow well at Gorse Hill, a mile to the south. The most abundant fossil was a small variety of *Chlamys fibrosus*. I also collected *Nucleolites scutatus* (very large and inflated), *Gryphæa dilatata* (typical), *Velopecten velatus*, var. *bonjouri* DE LOR., *Pleuromya recurva* (common), *Goniomya v-scripta*, *Pholadomya lineata*, *P.* cf. *canaliculata*, casts of *Tancredia* cf. *similis*, *Anatina* sp., and several uncertain casts of Lamellibranchs in poor condition.

In the winter of 1924 a well was sunk through the Lower Calcareous Grit into Oxford Clay at Highworth, and I was able to examine the materials brought to the surface. The only fossils were casts of *Pleuromya tellina* and a kind of tubiform or "fucoidal" markings in one of the hard bands. Near the base was a band of unique sandstone, dark slate-grey in colour and of such fine grain and evenness of texture and lamination that it could be split into plates of paper-shale thinness. All the other material was normal.

(*b*) *The Arngrove Stone.*

It is well known that north-east of Wheatley, Holton and Stanton St. John the Lower Calcareous Grit sandbank suddenly ceases, giving place to a peculiar deposit of non-calcareous chert, composed mainly of the spicules of sponges belonging to the species *Rhaxella perforata* HINDE. For our knowledge of this deposit we are indebted to Dr.

A. MORLEY DAVIES, who has made a careful investigation of the stone, which he has named the Arngrove Stone, revising the fauna and other evidence bearing on its stratigraphical position and mapping its area of outcrop [20, p. 37; and 21, p. 185].

The Arngrove Stone is compared by Dr. MORLEY DAVIES with *Rhaxella* cherts in the Lower Calcareous Grit of Yorkshire, and its fauna, though much richer than that of any exposed part of the neighbouring sandbank, is taken to be indicative of an approximately equivalent age. The commonest fossils are small specimens of *Cardioceras cordatum* Sow. and *C.* cf. *vertebrale* Sow. In stratigraphical position it would seem to represent only the lower part of the Lower Calcareous Grit of Oxford, for near Stanton Great Wood it is seen to be separated from the limestones of the Upper Corallian by an unknown thickness of clay [22, p. 235]. This clay is not exposed, but probably represents the remainder, or part of the remainder, of the Lower Calcareous Grit.

The area of occurrence of the Arngrove Stone is restricted to an ellipse about 7 miles in greatest length and $2\frac{1}{4}$ miles in width, and Dr. MORLEY DAVIES favours the view that this corresponds with its original area of deposition. Less than 4 miles beyond the north-eastern boundary, at Ashendon Junction railway cutting, he found the equivalent of the Upper Corallian limestones resting directly upon clays with earlier forms of Cardiocerates (formerly grouped together under the name *præcordatum*), comparable with those occurring in the clay underlying the Arngrove Stone at Studley brickyard. It would seem, therefore, unless the clay fauna survived where the conditions remained unchanged, that the Lower Calcareous Grit is unrepresented in a north-easterly direction beyond Arngrove.

The existence of a second patch of *Rhaxella* chert to the south-west of Purton has long been known to the writer. A record of this second patch was recently published by Dr. MORLEY DAVIES, and a brief description was given [26, p. 273]. The rock litters the fields on Paven Hill, especially near Ringsbury Camp. Its appearance is rendered very striking by the presence of conspicuous ooliths, which have been limonitised, but the other characters—colour, lightness, etc.—are very similar to those of the Arngrove Stone. The area covered by the chert at Purton measures just over 4 miles in its greatest diameter, but may have extended for some miles farther to the west before removal by denudation. It is accurately mapped as Lower Calcareous Grit on the survey map, Sheet 34. The occurrence of this small patch of *Rhaxella* chert at the south-western extremity of the district is a somewhat striking analogue of that of the type area of Arngrove at the north-eastern extremity. So far no trace of such a rock has been detected in the intervening area.

To summarise: in the centre of the district, about Faringdon, the Lower Calcareous Grit is developed to its greatest thickness. North-east and south-west the thickness steadily diminishes, becoming very variable towards the extremities, where the Grit is sometimes absent altogether. Finally, it is temporarily terminated in both directions by deposits of *Rhaxella* chert. The probable significance of this will be brought out in the following pages.

(c) *Possible Source of the Sands and Pebbles.*

In a work which is now in progress Mr. Spiller is dealing with the heavy minerals of the sands of various ages in the Oxford district, with a view to gaining therefrom some clue as to the source of the deposits. Mr. Spiller has kindly consented to examine some of the pebbles from Marcham and elsewhere, but he informs me that little else can be said about them than that they consist entirely of dark cherts and white vein-quartz, probably Palæozoic, but of quite indefinite origin.

These small pebbles have generally been referred to under the comprehensive term "lydites," and they resemble the majority of the lydites which occur at several horizons in the Upper Kimeridgian and Portlandian of the southern Midlands. It is rather from their distribution and relative abundance along the outcrop than from their composition that we must deduce their source of origin.

Mr. Neaverson points out that the black cherts in the Kimeridge–Portland pebble beds attain their maximum abundance in Buckinghamshire, are rare in Wiltshire, and do not occur in Dorset. From this he deduces that they had a northerly origin [28, p. 253]. Now, a similar distribution is noticed in regard to the cherts of the Lower Calcareous Grit; they become increasingly abundant in a north-easterly direction through Wiltshire and Berkshire, and reach a maximum at Marcham, near Oxford. This north-easterly increase corresponds with an increase in the amount and complexity of the false-bedding of the sands containing the cherts, which also reaches a maximum at Marcham.

The remarkable feature of these deposits, however, is that they do not continue north-eastwards through Buckinghamshire, but cease abruptly at Wheatley, where they give place to *Rhaxella* chert and deeper-water clay sediments of an entirely different character. The only satisfactory explanation of this sudden change of facies seems to be that the sandbank *began* near Wheatley, the material being brought to that point by a river from some neighbouring land-mass and deflected south-westward in the form of a long coastal sandbank, dropping the heavier material as it went.

In view of the evidence given in Section IX for a land-mass under London, the shore of which may have extended approximately to the present Chalk escarpment, this hypothesis is endowed with a high degree of probability. That the delta of a river flowing into the sea from this land-mass would be deflected south-westwards instead of advancing out from the shore, is what we might expect, in view of the current towards the outlet which prevails in landlocked seas in these latitudes, for instance, the Baltic. At the point where the currents met and the deflection took place we might anticipate just such indications of disturbance, in the form of erratic current-bedding and the precipitation of the heavier materials, as we find in the neighbourhood of Marcham and Tubney.

Furthermore, we might expect that the neighbourhood of a river mouth would prove attractive to numerous animals in search of food, whose remains would become entombed together with the plants and pebbles brought down by the river. It is just such an assemblage that characterises the Lower Calcareous Grit of Marcham, where numerous

Cephalopoda and other Mollusca lie side by side with remains of Vertebrata and drifted wood. South-west of Marcham the sands are practically unfossiliferous, until the neighbourhoods of Bremhill and Seend are reached, where the sudden thickening of the deposits indicates a fresh source or sources of supply, and transport by rivers from the same land-mass.

With regard to the composition of the sands, Mr. NEAVERSON states that samples which he examined from the Lamb Inn Quarry, Kingston Bagpuize, contained essentially the same assemblage as the Portland Sands [*ibid.*, p. 255]. The chief constituents were kyanite, staurolite, tourmaline, rutile, zircon, garnet and sphene. In spite of the fact that "the sphene has a yellow colour and is markedly angular, contrasting sharply with the rounded colourless grains from the Upper Kimeridge," Mr. NEAVERSON concludes that the source of the bulk of the two sands was in all probability the same. He considers it likely, in fact, that the sands continued to be derived from the same source from the Kellaways period to the Gault, when for the first time a marked change manifests itself by the presence of large purple-red garnets, and that this source was a northerly one, in part Scottish, "in spite of the great distance between the Scottish Highlands and Buckinghamshire."

Now, in view of how little is known of the Palæozoic rocks underlying the London Basin and the North Sea, it seems unnecessary to seek the source in regions so distant as the Scottish Highlands. To assert that a certain suite of minerals has been brought by a river flowing from a certain land-mass does not, of course, involve the assumption that these minerals were derived directly from the distintegration *in situ* on that land-mass of the rocks of which they are characteristic. If the Lower Calcareous Grit sands were derived from beds of Old Red Sandstone, Millstone Grit or Permo-Trias in that direction, their original home would scarcely enter into the question.

Mr. NEAVERSON's only reason for excluding this easterly land-mass as a possible source of the Kimeridge-Portland sands seems inconclusive ; it is based on the discovery that a meagre and inadequate assemblage of heavy minerals (small grains of tourmaline, zircon, garnet and rutile) characterises the Portlandian sands of the Boulogne district, which "may have been derived from the Old Red Sandstone which presumably formed the Anglo-Belgian land of the Portlandian and Kimeridgian periods" [*ibid.*, p. 254]. But even if it be conceded that the Boulogne deposits were mainly derived from the erosion of the southern border of this land-mass, there seems no reason for assuming that the quantitative distribution of the heavy minerals was the same throughout the Old Red Sandstone forming the whole land area. On the contrary, if the heavy minerals were originally derived in Old Red Sandstone times, as would seem probable, from the disintegration of the Caledonian mountain range to the north, an increasing impoverishment is only to be expected in a southerly direction, just as is observed in the Jurassic sands themselves.

Finally, to bring the heavy minerals of the Lower Calcareous Grit directly from the north in Corallian times introduces anomalies which seem to be inexplicable. It is difficult to picture how the sands, and, therefore, the chert pebbles intimately mixed with them, could have crossed the wide intervening area where pelilithic deposition was proceeding, finally to become deposited in their present position.

Another suggestion as to the immediate source of this material, which we may notice in conclusion, is that it consists of locally rearranged beach deposits of Oxford Clay age. The uniformly small size of the pebbles, in spite of their great hardness, points, however, to a distant origin and to their being river borne. It is more logical to assume that they first reached the sea in Lower Calcareous Grit times, where all the evidence points to river influence and in which they lie side by side with fruits of *Carpolithes* and drifted logs, than to transfer the event to the Oxford Clay period, in which no such evidence exists.

The conclusion, then, to which the facts seem to point is that the sands of the Lower Calcareous Grit, together with the small quartz and lydite pebbles, were brought by a river from the south-east, which entered the sea somewhere south-east of Marcham. They were then distributed along the coast as submarine sandbanks by a long-shore current, incorporating the remains of marine animals and gradually dropping their load of heavier materials.

IV.—The Berkshire Oolite Period.*

(*a*) *The Pebble Bed.*

It has already been remarked that the Berkshire Oolites usually rest upon an eroded surface of the Lower Calcareous Grit. The first stratum to be deposited upon this eroded surface was a pebble bed, consisting of pebbles of quite a different character and much larger than those with which we have hitherto been dealing. Proof of erosion need usually be sought no farther than the Pebble Bed itself, for often many of the pebbles consist of indurated Lower Calcareous Grit indistinguishable from that still *in situ* in the lower part of the quarry. The pebbles are well rounded and indicate a considerable lapse of time, unrepresented by deposition, during which the grits had time to consolidate.

The most remarkable features of the Pebble Bed, however, are neither these pebbles of indurated grit nor the innumerable little chert and quartz pebbles which it also contains, the latter likewise evidently derived from the Lower Calcareous Grit. Those which claim the first attention are large rounded pebbles, up to 3 or 4 in. in diameter, of compact, grey, non-oolitic limestone, almost a mud-stone, and quite unlike anything known to exist *in situ* in the Corallian. Weathering has usually given them a white cortex, and in addition they are often encrusted with *Serpulæ* and bored by *Lithodomi*.

With or without the others these grey limestone pebbles occur with remarkable uniformity almost wherever the base of the Berkshire Oolites has been exposed between

* In 1926 [2, I, p. 194] I referred to these rocks as the "Oxford Oolites," a name which it has since seemed desirable to abandon. Mr. Pringle [33, p. 40] has differently interpreted Buckland's original use of the term. Mr. Buckman's use of Oxford Oolites as synonymous with Corallian is unfortunate and has added unnecessarily to the confusion in Corallian nomenclature [9].

Headington and Lyneham, a distance of 40 miles. There is only one genuine exception; on the northern side of Highworth Hill, where the formation is exposed in quarries farther to the north-west than usual, the Pebble Bed is absent. In addition, in one of the quarries south of Wingfield Hospital, Headington, the Pebble Bed is missing; but this is because the whole of the representatives of the Berkshire Oolites, if ever deposited there, have been removed, and rocks of Osmington Oolite age rest directly upon the Lower Calcareous Grit. At Lyneham the Pebble Bed is not observed to cease, but farther south-west there are no more exposures of the Berkshire Oolites, which show signs of thinning out to a few inches in that direction, and all the quarries are opened in poorly fossiliferous white oolites and pisolites of a younger age, or in Coral Rag.

I cracked open some scores of these curious grey compact limestone pebbles in many localities before I obtained any palæontological clue to their origin, though no one could fail to be struck by the unmistakable resemblance which they bear to the hard concretionary "crackers" common in the Oxford Clay. Eventually Mr. SPILLER pointed out, among a collection of various pebbles I had submitted to him from Littleworth, Berks, a small rolled derived fossil resembling the smallest of the limestone pebbles. This proved to be *Nucula elliptica*, a fossil characteristic of the Oxford Clay and not found in the Corallian.

All doubt, then, seems to be removed that these pebbles result from the denudation of beds of Oxford Clay, of which they represent the only hard parts, the former crackers. The territory of Oxford Clay destroyed to supply such a sheet of pebbles, over 40 miles long and of unknown breadth, must have been considerable. The question at once arises, whence came they?

The Oxford Clay pebbles are very hard, but they are not so hard as the much smaller pebbles of chert and quartz found in the Lower Calcareous Grit. The inference is that they have not travelled so far. On the other hand, they have probably been transported a longer distance than the pebbles of Lower Calcareous Grit found in the same bed. Rounded blocks of the latter occur at Marcham, measuring over a foot in diameter, and presumably they cannot be far from their place of origin.

That the source of the Oxford Clay pebbles is to be found in a land-mass to the south-east is suggested by the following considerations:—

First, the pebbles themselves suggest that they are beach pebbles, as opposed to pebbles of fluviatile origin, and the nearest beach lay, we know, to the south-east (see Section IX). They are riddled by the borings of *Lithodomus inclusus*, and sometimes bear *Serpulæ* attached. Further, they are not likely to have been brought by the river that brought the chert and quartz, for (i) none are found with the latter in the Lower Calcareous Grit, and (ii) being softer, they would have been worn down smaller.

Secondly, if the base of the Lower Calcareous Grit, penetrated in the Wootton boring, be produced northwards to Cumnor, it will be found to rise 100 ft., or 50 ft. per mile. If this slope be continued at the same rate for 17 miles, the base of the Corallian will be found to lie 400 ft. above the present surface one mile east of Chipping Norton, at the point of junction of the Inferior Oolite and Great Oolite. Allowing 100 ft. for the Great Oolite, Forest Marble and Cornbrash, this leaves 300 ft. for the Oxford Clay, a figure which makes it probable that in this direction the Corallian was conformable to the Oxford Clay.

Thirdly, the absence of the Pebble Bed at Highworth in the most north-westerly exposures on the outcrop, where the rest of the Berkshire Oolites are fully developed, is significant when coupled with its presence a mile to the south-east, in the Hangman's Elm Quarry. If we conceive the pebbles as derived from the erosion of a cliff, we must suppose them to have been spread out on the sea bottom by means of an undertow, or else swept from the shore by a river or rivers and spread out evenly by a long-shore current. In either case, in view of the even distribution of the pebbles elsewhere, it is more likely that they never reached Highworth than that they came over it or round it from the north.

We seem, then, driven to adopt the view that one of the results of the earth-movements preceding the formation of the Pebble Bed was the elevation of the north-western border of the London *massif* and that part of the trough adjacent to it, and the production of a range of cliffs of Oxford Clay. The coast was now probably north-west of its position in Lower Calcareous Grit times. This conclusion is based on the fact that in the exposure farthest down the dip-slope, that at Stanford in the Vale, the whole of the Berkshire Oolites and Osmington Oolites together are only 6 ft. thick, while in the Goosey boring, two miles farther south-east, they appear to be only 3 ft. thick. The Lower Calcareous Grit at Goosey shows no such signs of thinning out [5, p. 45].

We must now turn to a consideration of the rest of the Berkshire Oolites, of which the Pebble Bed is the basal member.

(*b*) *Traverse of the Outcrop of the Berkshire Oolites from East to West.*

1. *The Eastern Shell-cum-Pebble Bed of Headington, etc.*

One of the results of the earth-movements of which the Pebble Bed is evidence was a complete change in the type of deposition prevailing in our area. From now onwards shelly limestones alternating with marls, clays and false-bedded oolites, with only subordinate grits, tell of unstable conditions. Sedimentation, except in the south-eastern corner, was no longer dominated by the river of Lower Calcareous Grit times, which formerly swamped molluscan life by its continued inpourings of sand and pebbles.

The varied succession of rocks forming the normal sequence of the Berkshire Oolites attains its maximum thickness at Red Down, near Highworth, where it is 34 ft. thick. In the east, around Oxford, and in the west, under Blunsdon, Purton and Wootton Bassett, it thins out to mere shell-beds from 1 ft. to 2 ft. thick. These beds also contain the same pebbles as everywhere form the base of the normal Berkshire Oolites, and hereafter they will be referred to as the eastern and western Shell-cum-Pebble Beds.

In the Headington quarries the Shell-cum-Pebble Bed is the only constant and horizontal feature capable of correlation from one quarry to another, everything above it having a false dip on a large scale, or being structureless, such as the Coral Rag. It is also characterised by its highly fossiliferous nature; it is the source of nearly all the rich collections of fossils—Ammonites, Lamellibranchs and Gastropods—which have been obtained in the past from Headington, Cowley and Bullingdon.

The fauna, of which the following is a list, is chiefly a condensation of that of all the Berkshire Oolites of Berkshire and North Wiltshire. There are certain elements, particularly among the Cephalopoda, however, which probably have more affinity with the north-east.

List of Fossils from the Shell-cum-Pebble Bed of Headington, Cowley, Bullingdon, Littlemore and Cumnor. (By no means exhaustive.) Cephalopoda are excluded; see Appendix I. Specially common or characteristic species are marked *.

Lamellibranchia.

*_Astarte ovata._
Camptonectes giganteus.
* ,, _lens._
Chlamys (Æquipecten) inæquicostatus.
* ,, ,, _fibrosus._
* ,, _splendens._
*_Corbicella lævis._
Ctenostreon proboscideum.
*_Cucullæa contracta._
Cyprina corallina.
,, _tancrediformis._
Entolium solidum.
Exogyra nana.
*_Gervillia aviculoides._
Goniomya v-scripta.
Gryphæa dilatata.
Isocyprina cyreniformis.
Lima (Plagiostoma) læviuscula.
* ,, ,, _mutabilis._
* ,, ,, _rigida._
,, _(Limatula) elliptica._
Lithodomus inclusus.
Modiola bipartita.
Mytilus ungulatus.
Myoconcha radiata.
Opis phillipsi.
Ostrea (Lopha) gregaria.
Perna mytiloides.
Pholadomya æqualis.
,, _canaliculata._
Pinna lanceolata.
Pleuromya tellina.
*_Pseudomonotis ovalis._
*_Pteria (Oxytoma) expansa._
,, _pteropernoides._
Quenstedtia lævigata.
Sowerbya triangularis.
*_Trichites giganteus._
,, _granulatus._
Trigonia meriani.
* ,, _perlata_ incl. var. _hudlestoni._
Unicardium apicilabratum.
,, _excentricum._
*_Velopecten velatus._

GASTROPODA.

Alaria seminuda.
**Cerithium muricatum.*
Littorina muricata.
Natica arguta.
,, *clytia.*
**Pseudomelania heddingtonensis.*
Nerinea goodhalli.
Bourguetia striata.
Pleurotomaria bicarinata.
* ,, *munsteri.*
* ,, *reticulata.*
Trochotoma tornatilis.

ECHINODERMATA.

Cidaris smithi.
Nucleolites dimidiatus.
* ,, *scutatus.*
**Pygaster semisulcatus.*
Pygurus pentagonalis.
,, *costatus.*
Astropecten rectus.

MISCELLANEOUS.

Megalosaurus.
Asteracanthus ornatissimus.
Glyphæa rostrata.
Teleosaurus.
Hybodus obtusus.
Thecosmilia annularis.
Serpulæ.

With regard to the mode of formation of the Shell-cum-Pebble Bed, we can only conjecture. It is not a *remanié* in the ordinary sense of the word, for the fossils are in magnificent condition and unrolled. Rather it would seem to have been formed during the lapse of a long period of time by the gradual accumulation of shells in a gentle current, just sufficient to prevent their becoming entombed in sediment.

The two best-known and most productive quarries near Oxford, still actively worked, are the Vicarage and Magdalen or Workhouse Quarries, Headington. In these the sands of the Lower Calcareous Grit are overlain by a horizontal band of hard limestone, about 2 ft. thick, which separates them (in the Vicarage Quarry) from 20 ft. of slightly false-dipping nodular rubble of Osmington Oolite age. These quarries are typical of many in the district, though the Osmington Oolite rocks overlying the hard band are not quite the same in the two sections and vary from quarry to quarry; they are always poorly fossiliferous, however, and sharply contrasted from the underlying hard band, the Shell-cum-Pebble Bed.

In the Vicarage Quarry the hard band is found on closer inspection to consist of three parts, only the middle third being the true Shell-cum-Pebble Bed. The following is a description of the quarry (see fig. 1, p. 88):—

Vicarage Quarry, Headington.

	Ft.	ins.
Osmington Oolite Series.		
6. "Pendle"; yellow, sandy, false-bedded, broken-shell marl and flaggy white limestone, disturbed by solution	3	6
5. Nodular rubble and hard bands ("Headington Hard") with *Exogyra nana* and *Cidaris florigemma* spines much in evidence	20	0
Also *Pygaster* sp.; *Chlamys nattheimensis*; *Ostrea gregaria*; *Serpulæ*; *Pseudomelania heddingtonensis*; *Bourguetia striata*; *Thecosmilia annularis*.		
4. Transitional bed from Berkshire Oolites to Osmington Oolites, probably referable rather to the latter than to the former. Brown limestone full of *Thecosmilia annularis*, also containing immense *Cardioceras* cf. *rotundatum*, Nikitin, and some of the fossils from the underlying bed including *P.* cf. *antecedens*	0	8
Berkshire Oolites.		
3. Shell-cum-Pebble Bed. Blue limestone full of "lydite" and grey limestone pebbles, fossils, and carbonaceous and pyritic matter. The most characteristic fossils are Cardiocerates of the *excavatum* and *vertebralis* types, Perisphinctids of the *martelli*, *antecedens* and *plicatilis* types, *P. apolypon*, *Camptonectes lens*, *Chlamys splendens*, *C. fibrosus*, *Entolium solidum*, *Velopecten velatus*, *Astarte ovata*, *Pseudomonotis ovalis*, *Pteria expansa*, *Lima rigida*, *L. mutabilis*, *Gervillia aviculoides*, *Perna mytiloides*, etc.	0	8
Lower Calcareous Grit.		
2. Indurated topmost bed, welded to bed above	0	8
1. Yellow sand, usually exposed to about	2	0

Beds 2, 3, 4 are welded together and form the conspicuous hard band.

In the Workhouse or Magdalen Quarry the Shell-cum-Pebble Bed is about 1 ft. thick. The pebbles are scarcer and smaller and the bed is less carbonaceous than in the Vicarage Quarry, but it is equally fossiliferous, and in respect of ammonites even richer. Huge examples of *Perisphinctes parandieri* and allied forms, *P. martelli* and allied forms, *P. antecedens* and many allied forms are very common. The quarry will be described later in connection with the overlying rocks (see p. 128).

In many of the old quarries at and near Headington the Shell-cum-Pebble Bed presents the same features, and the broken ends of the innumerable shells may be seen protruding from the weathered surface. In a quarry near the Roman road on the way to Garsington it is 5 ft. thick and gritty, resembling very closely the *Trigonia perlata* Limestone of the Dorset coast. West of the river it reappears in the quarries at Bagley Wood, Kennington, Ferry Hinksey, and Bradley Farm, near Cumnor.

At Ferry Hinksey it is discontinuous, having been in places apparently worn through prior to the formation of the Coral Rag. It is, however, unmistakable lithologically, and contains amongst other fossils *Isocyprina cyreniformis* and *Trichites giganteus*.

At Bradley Farm the pebbles tend to segregate in the basal part of the bed and the shells in the upper, thereby showing a transition to the more normal conditions farther west. The fossils include *Trigonia perlata* and *Astarte ovata*.

As we pass down the dip-slope southward from the typical Headington district we find in all the quarries that the Shell-cum-Pebble Bed is sandy, the admixture of sand often "diluting" it to a greater thickness. Sometimes it is overlain by up to 3 ft. of sand and sandstone, indistinguishable from the underlying Lower Calcareous Grit, and certainly not capable of correlation with any of the normal divisions of the Berkshire Oolites farther west. Such quarries may be seen at Cowley and Littlemore and in Bagley Wood.

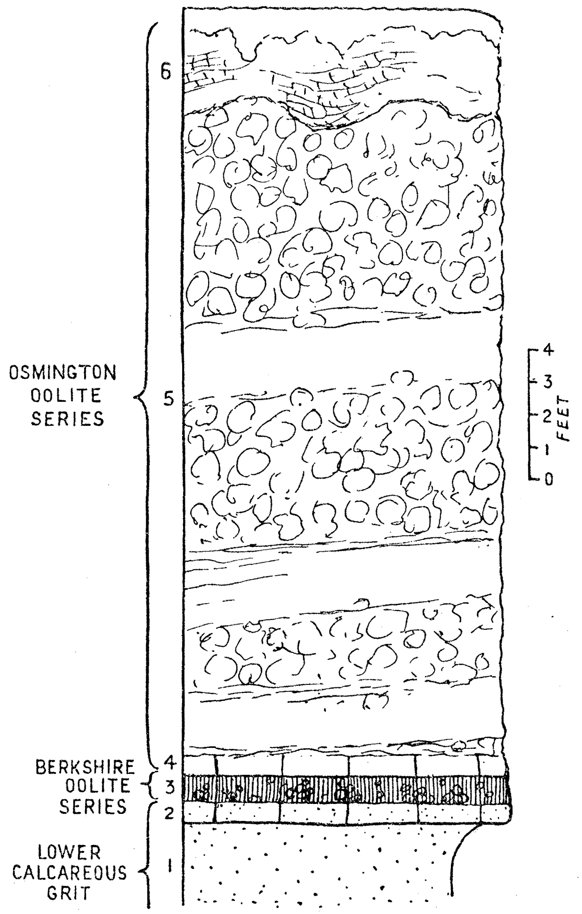


Fig. 1.—Section at Vicarage Quarry, Headington.

These quarries are situated in the area within which we should expect to find the Berkshire Oolites represented by nothing but the Shell-cum-Pebble Bed, but it is evident that sand continued to enter this corner of the district from the south-east after the cessation of the Lower Calcareous Grit conditions to the west and north. The inference is that the river, which supplied the sand of the Lower Calcareous Grit, was not entirely in abeyance after the earth-movements preceding the formation of the Pebble Bed, but continued active in a reduced form throughout the Berkshire Oolite period. We shall see that there is evidence of its influence in the Osmington Oolite period also. The distribution of the sandy material in the Berkshire Oolites accords with the view adopted on p. 82 as to the source of the Lower Calcareous Grit.

The finest section showing the Shell-cum-Pebble Bed overlain by sands and sandy marls is the large quarry beside and west of the road from Cowley to Horspath.

Roadside Quarry West of Road from Cowley to Horspath.

Osmington Oolite Series. Ft. ins.

6. Broken Coral Rag, the lowest foot consisting of bands of tabular masses of corals, separated by sand and rubble, and passing up into the typical argillaceous type 6 0

Isastræa explanata.	*Lima zonata.*
Thamnastræa spp.	*Ctenostreon proboscideum.*
Thecosmilia annularis.	*Lithodomus inclusus.*
Belemnites oxyrrhynchus.	*Exogyra nana.*
Chlamys fibrosus.	*Ostrea gregaria.*
,, *nattheimensis.*	*Littorina muricata.*
Velopecten velatus.	*Cidaris florigemma.*

		Ft.	ins.
BERKSHIRE OOLITE SERIES.			
5. Persistent course of hard gritty limestone 6 ins. to		0	8
Littorina muricata.	*Chlamys fibrosus.*		
Pleurotomaria reticulata.	*Exogyra nana.*		
Nucleolites scutatus.			
4. Shelly sand, rich in beautifully preserved specimens of *Chlamys fibrosus,* with *Nucleolites scutatus* and *Exogyra nana,* and an impersistent band of small concretions about the middle	1 ft. on west to	1	6
3. Poorly fossiliferous, gritty, concretionary limestone, impersistent on west but expanding north-eastwards from a few inches to		1	0
2. Shell-cum-Pebble Bed. A compacted mass of fossils in a matrix of gritty limestone, containing "lydites" and limestone pebbles; in two courses separated by sandy marl parting		2	0
On the west this bed thins to 1 ft. 6 ins.			
Perisphinctes sp.	*Gervillia aviculoides.*		
Trigonia perlata.	*Lima mutabilis.*		
,, *meriani.*	*Exogyra nana.*		
Chlamys fibrosus.	*Natica* sp.		
Entolium solidum.	*Pseudomelania heddingtonensis.*		
Velopecten velatus.	*Littorina muricata.*		
Astarte ovata.	*Pygaster semisulcatus.*		
Tancredia nigra.	*Pygurus pentagonalis.*		
Unicardium apicilabratum.			
LOWER CALCAREOUS GRIT.			
1. Sands with an impersistent hard band. About		2	0
From the sand may be obtained very perfect specimens of *Chlamys fibrosus, Pseudomonotis ovalis* and *Exogyra nana.*			

In Brittleton Barn Quarry, 100 yards to the east, on the opposite side of the road, all the sandy beds 3–5 have disappeared, and in one end of the quarry most of the Shell-cum-Pebble Bed is also missing, leaving the Coral Rag resting only a few inches above the Lower Calcareous Grit. The same condition obtains one hundred yards to the north-west, in the Cowley Industrial School Quarry.

COWLEY INDUSTRIAL SCHOOL QUARRY.

	Ft.	ins.
OSMINGTON OOLITE SERIES.		
3. Typical broken, argillaceous Coral Rag, forming a hard band at base, and resting upon an eroded surface of Bed 2, in which are pockets filled with marl	7	0
BERKSHIRE OOLITE SERIES.		
2. Shell-cum-Pebble Bed, crowded with large Lamellibranchs; also a large Perisphinctid	1	0
LOWER CALCAREOUS GRIT.		
1. Sand with a band of doggers about 1 ft. down	2	0

Half a mile to the north, in the quarry close to Cowley Barracks, we find an almost exact repetition of the sequence west of the Cowley-Horspath road. This section is so rapidly being filled up by rubbish that it seems worth while putting a short description of it on record.

Cowley Barracks Quarry.

	Ft.	ins.
Osmington Oolite Series.		
6. Broken rubbly rag, tending towards the condition of the Nodular Rubble in the Vicarage Quarry	9	0
Berkshire Oolites.		
5. Hard band of gritty limestone. (This may or may not correspond to Bed 5 in the Horspath Road Quarry, which is assigned only tentatively to the Berkshire Oolites; it is a matter of opinion where the boundary should be drawn)	1	0
4. Sandy non-oolitic marl, passing down into the bed below	1	0
3. Hard, gritty limestone below, softer above, like consolidated form of Bed 4	0	9
2. Shell-cum-Pebble Bed; gritty; full of large Lamellibranchs	0	9
Lower Calcareous Grit.		
1. Yellow sand	1	0

The famous section in Littlemore railway cutting shows beds corresponding closely to these. The Shell-cum-Pebble Bed contains a high proportion of grit, and is welded to an indurated grit layer at the top of the Lower Calcareous Grit, the two together forming a very prominent hard band, about 2 ft. thick. Above it lies shelly sand full of *Chlamys fibrosus* with an impersistent band of arenaceous marly limestone. The section is described in detail on p. 142. A corresponding sequence is exposed in Bagley Wood, and a third was formerly quarried, but is now obscured, at Kennington.

2. *The Normal Sequence of the Berkshire Oolites from Marcham to Faringdon.*

It was pointed out in noticing the Bradley Farm Quarry, Cumnor, that the Shell-cum-Pebble Bed showed a tendency to separate into two beds, the pebbles being commonest in the lower half, and the shells, *Trigoniæ*, etc., commonest in the upper. This change also takes place beneath the younger rocks of Boars Hill as we pass south-westward from Bagley Wood and Kennington to Marcham; for at Marcham the Pebble Bed and Trigonia Bed are separate, and are overlain by higher beds of fossiliferous oolite. As we travel farther westward still higher beds make their appearance and the lower beds expand, until at Kingston Bagpuize the Lower Calcareous Grit and the Osmington Oolite coral rag are separated by 16 ft. of strata. They attain their maximum thickness, as has been said, near Highworth in Wiltshire, where in the Red Down boring they were proved to be 34 ft. thick.

In this little province, between Highworth and Marcham, where the rocks attain their full development, five distinct components can be separated. These are marked by constant lithological and palæontological characters, and there is no difficulty in correlating them from quarry to quarry. Their importance in relation to the surface configuration may be seen by a glance at the map of the Highworth district, which will be found at the end of the paper (p. 180).

The names of the subdivisions established were first published, by the kind invitation of Mr. S. S. Buckman, in 'Type Ammonites' [1], but they are here fully described for the first time.

Normal Sequence of the Berkshire Oolites between Marcham and Highworth.

	Max. Thickness. Ft.
5. Pusey Flags. Strongly false-bedded fissile flags of sandy oolite, of very characteristic appearance, generally poorly fossiliferous: occasional micromorphic fauna	15
4. Highworth Grit and Clay. Yellow sand closely resembling the Lower Calcareous Grit, with varying amounts of race and ferruginous seams, passing down into and to some extent alternating with soft grey clay	11
3. Urchin Marls. Even-bedded, drab-coloured marly oolites crowded with Echinoderms (considered for mapping and other practical purposes with 2)	6
2. Trigonia Perlata Bed and equivalent Trigonia Perlata Limestones. A highly fossiliferous series of shelly limestones, with occasional local coral reefs in the west, the former always characterised by numerous ammonites and certain Lamellibranchs, the most important of which are the *Trigoniæ, Cucullæa contracta, Corbicella lævis, Trichites giganteus* and *Astarte ovata*	10–12
1. Basal Pebble Bed, already described	2

This succession is broken locally by non-sequences and erosions and by the thinning-out of some of the subdivisions. Happily quarries in the Berkshire Oolites are numerous and enable us to follow out these changes on the ground, and detailed work of this sort yields very interesting results. In order to illustrate, we will traverse the outcrop from east to west, examining some of the best exposures.

Beginning at Marcham, the first section is the magnificent quarry at Sheepstead Farm. The southern end of the quarry shows the best section of the Berkshire Oolites, for towards the north they thin out. The Pebble Bed contains rounded blocks of Lower Calcareous Grit over 1 ft. in diameter, as well as the familiar grey mud-stone pebbles. The Trigonia Bed is divided into two by interlaminated sand and clay, a feature not met with again as we proceed westward, and no doubt attributable to the same cause as the swamping of the Shell-cum-Pebble Bed with sand in this corner of the district. The richness of the Lamellibranch fauna and the beauty of the specimens, especially of the upper band, are scarcely surpassed. The Clavellate *Trigoniæ*, which can be obtained as perfect as recent shells, show a great range of variation, linking up the species.

The 5 ft. of drab-coloured oolitic marls which overlie the Trigonia Bed in this quarry afford the type section of the Urchin Marls. As the name implies, they are crowded with *Nucleolites scutatus; Pygaster semisulcatus* is also much more abundant than elsewhere in the district, and in one visit to the quarry since work was stopped the writer has obtained as many as 14 examples *in situ* from these marls.

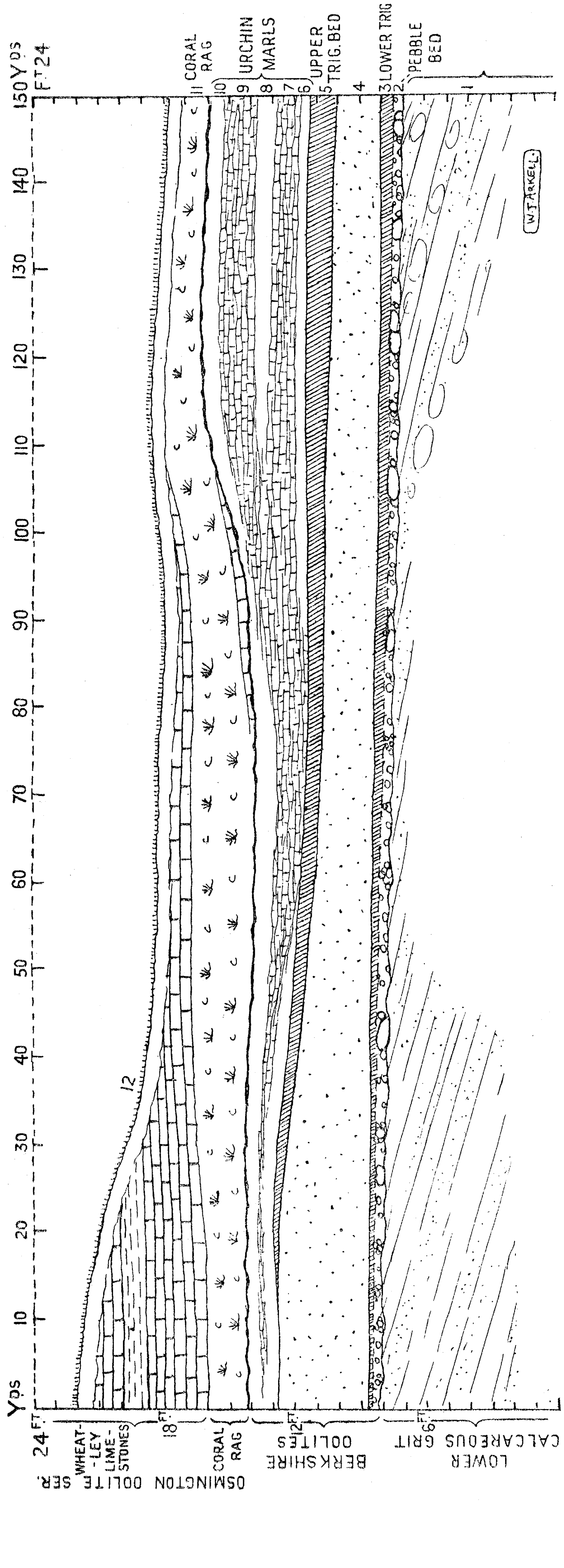


Fig. 2.—Section at Sheepstead Farm Quarry, Marcham.

Sheepstead Farm Quarry, Marcham.

	Ft.	ins.
Osmington Oolite Series.		
12. Wheatley limestones. Poorly fossiliferous white limestone, weathering flaggy	5	0
11. Coral rag; rubbly bed of broken corals	2	0

Thecosmilia annularis.
Isastræa explanata.
Cidaris florigemma.
Perisphinctid fragment.
Serpulæ.
Exogyra nana.
Chlamys nattheimensis.
Ctenostreon proboscideum.
Pholadomya canaliculata.
Lithodomus inclusus.

	Ft.	ins.
Berkshire Oolite Series.—Urchin Marls.		
10. Oolitic marl with race, full of *Nucleolites scutatus*. Also *Pygaster semisulcatus*, *Pleuromya tellina* and *Exogyra nana*	0	8
9. Consolidated ditto. Same fossils plus *Perisphinctes* fragment, *Chlamys fibrosus*, *Gervillia* casts, and *Pseudomelania heddingtonensis*	1	8
8. Oolitic marl. Same fossils as Bed 9 plus *Cerithium muricatum*, *Anisocardia* cast, large *Cyprina corallina*, *Belemnites* sp., *Chlamys splendens*	1	0
7. Consolidated ditto. *Nucleolites scutatus*, *Chlamys fibrosus*, *Perna mytiloides*, *Lima rigida*	1	0
6. Oolitic marl full of *Nucleolites scutatus*. Also *Exogyra nana*, *Lima subantiquata*	0	4

The five beds, 6 to 10, when traced northwards round the quarry, in less than 150 yards lose their identity and thin out to a single bed 1 ft. 4 ins. thick.

	Ft.	ins.
Trigonia Perlata Limestones.		
5. Hard limestone packed with *Trigoniæ* and other fossils	1	0

Trigonia perlata.
,, ,, var. *hudlestoni.*
,, *meriani.*
Corbicella lævis.
Astarte ovata.
Trichites giganteus.
Lima mutabilis.
,, *rigida.*
Limatula elliptica.
Chlamys fibrosus.
Chlamys splendens.
Camptonectes lens.
Gervillia aviculoides.
Isocyprina cyreniformis.
Opis phillipsi.
Tancredia nigra.
Pleuromya tellina.
Pleurotomaria munsteri.
Natica arguta.

	Ft.	ins.
4. Interlaminated sand and clay. *Serpulæ*, *Exogyra nana* (on S. of quarry)	2	0
3. Lower Trigonia Bed. Irregular white limestone, the *Trigoniæ* as casts	1	0

Trigonia meriani.
,, *perlata.*
Trichites giganteus.
Gervillia aviculoides.
Exogyra nana.
Pleurotomaria reticulata.
Serpulæ.

Traced northwards for 150 yards round the quarry both Trigonia Beds disappear, and the bed between them (Bed 4) thickens to 3 ft. 6 ins.

	Ft.	ins.
Pebble Bed.		
2. Irregular seam of débris, welded to the base of Bed 3, consisting of shells (chiefly *Exogyra nana*) *Serpulæ* and pebbles of "lydite," quartz, grey limestone and indurated Calc. Grit about	0	4

Ostrea gregaria.
,, *pseudocallifera.*
Exogyra nana.
Pleurotomaria reticulata.
Natica arguta.
Serpulæ.

LOWER CALCAREOUS GRIT. Ft. ins.

1. False-bedded sand, sandstone and doggers, with the usual small pebbles of quartz and chert . . . . seen to c. 6 0

Ostrea gregaria. *Exogyra nana.*
Pseudomonotis ovalis. *Natica arguta.*
Serpulæ.

In two similar sections near " Noah's Ark," Garford, the Trigonia Bed is no longer divided by a sandy bed, and it has thinned out together with the Pebble Bed to form a single band only 8 in. thick.

NOAH'S ARK, GARFORD, N.N.W. QUARRY.

	Ft.	ins.
OSMINGTON OOLITE SERIES.		
7. Typical rag, broken and weathered. *Isastræa explanata, Thecosmilia annularis, Cidaris florigemma* (test and spines), *Littorina muricata, Exogyra, Lithodomus*	2	0
BERKSHIRE OOLITE SERIES—URCHIN MARLS.		
6. Rubbly oolitic marl, partly consolidated. *Nucleolites scutatus* v. common, *Pygaster semisulcatus, Pleuromya tellina, Exogyra nana*	2	0
5. Consolidated oolitic marl. *Nucleolites scutatus*	1	0
4. Oolitic marl. *Nucleolites scutatus* v. common	1	0
3. Consolidated ditto. *Nucleolites scutatus, Gervillia* casts, *Perna mytiloides*	1	0
All these beds, 3 to 6, grade vertically into one another and may be considered as one series.		
TRIGONIA BED AND PEBBLE BED.		
2. Hard brown limestone with *Trigoniæ* much in evidence, but pebbles less conspicuous than usual. *Astarte ovata, Gervillia aviculoides, Nucleolites scutatus*	0	8
This bed is full of shells only seen in section, which cannot be identified with certainty.		
LOWER CALCAREOUS GRIT.		
1. Yellow sand with indurated band at top varying from 6 ins. to 2 ft. . . . Now seen to about	2	6

In the old limekiln, $\frac{1}{4}$ mile south of " Noah's Ark," there is a similar section, but the base is becoming concealed. The Urchin Marls have there thickened to 6 ft., and, though identical in fossil content and lithology, the details of Beds 3 to 6 are not recognisable.

In a shallow pit at the cross-roads north of Fyfield Wick, we find the upper part of the Pebble Bed and the base of the Trigonia Bed becoming coarsely pisolitic, a feature anticipating the Lamb Inn section. The Pebble Bed rests upon the eroded, upturned edge of steeply dipping Lower Calcareous Grit. Although the dip is probably only false-bedding, there has undoubtedly been erosion. Many of the characteristic fossils of the *Trigonia perlata* Limestones may be found, including *Trigonia meriani, Astarte ovata, Corbicella lævis* and *Gervillia aviculoides.*

The next section is the famous Lamb Inn Quarry, one mile west of Kingston Bagpuize. Here, for the first time, the upper divisions of the Berkshire Oolites make their appearance, and the whole sequence is represented in an actively worked quarry face, from which it has been possible to carry out detailed collecting extending over a considerable period of time. It was in this quarry, where the designation is so particularly appropriate, that the Trigonia Bed was long ago given its name by BLAKE and HUDLESTON. In a matrix of cream-coloured limestone are embedded thousands of single valves of *Trigonia meriani*, together with a smaller proportion of clavellate forms and many

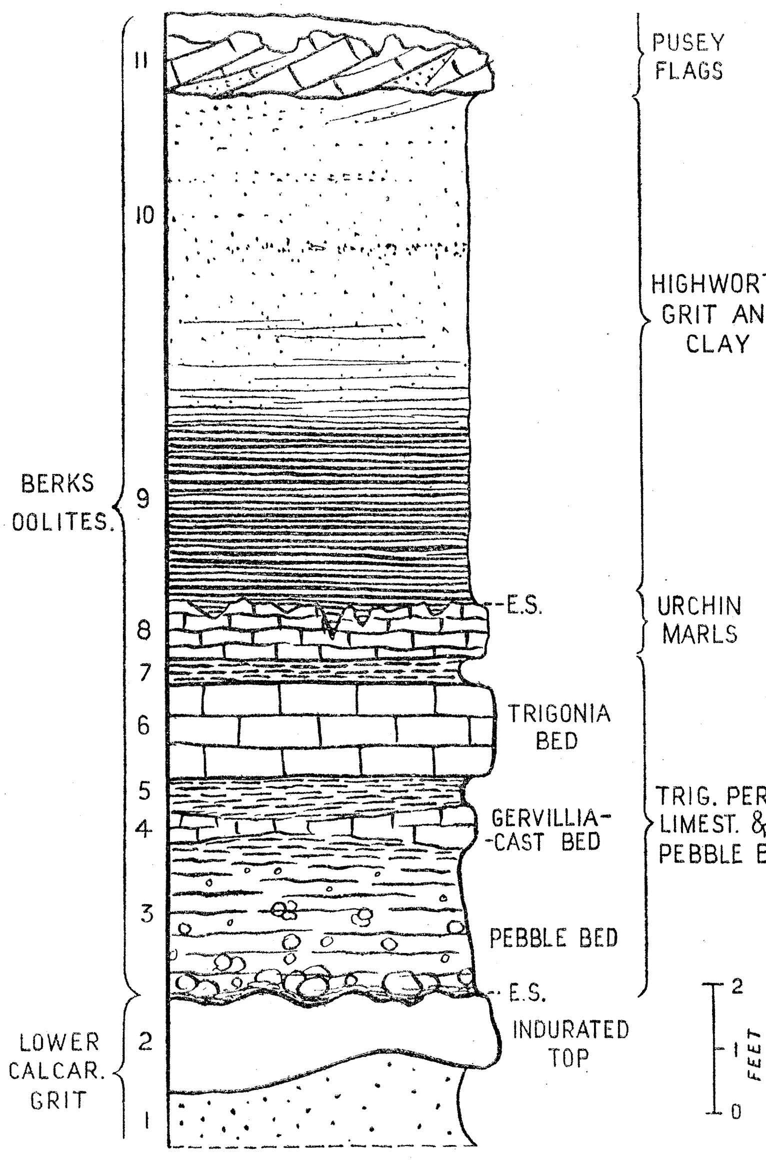


FIG. 3.—Section at Lamb Inn Quarry, Kingston Bagpuize.

other Lamellibranchs, especially *Cucullæa contracta*, *Astarte ovata*, *Trichites giganteus* and *Arca æmula*. Fragments of coral also occur. The profusion of Lamellibranchs is only equalled by the abundance of Perisphinctids, of which a seemingly endless variety occurs, scarcely two being exactly alike.

The Urchin Marls are doubtfully represented, cut by a marked surface of erosion. Upon this rest the Highworth Grit and Clay, now much obscured by scree. With reference to the eroded surface, BLAKE and HUDLESTON remark: "Though it may be partially due to subsequent chemical action on the spot, it is certainly also due to an interval of time between the two deposits" [6, p. 304]. Finally, the highest bed exposed in the quarry, seen just beneath the soil on the south side, is the base of the Pusey Flags. These flags are undoubtedly to be correlated with the important series forming the principal feature of all the exposures for a distance of five miles westward, and attaining their maximum development round Pusey, from which village they take their name.

LAMB INN QUARRY, KINGSTON BAGPUIZE.

	Ft.	ins.
PUSEY FLAGS.		
11. Fissile sandstone flags with white oolite grains. *Littorina muricata, Lima* fragment . .	1	0
HIGHWORTH GRIT AND CLAY		
10. Yellow sand with some oolitic rubbly seams near top and interlaminated clay towards base, passing down into bed below	4	0
9. Brown clay resting on a marked eroded surface	4	0
URCHIN MARLS.		
8. White oolite, weathering flaggy, the upper surface deeply eroded. Maximum about . .	1	2
TRIGONIA PERLATA LIMESTONES.		
7. Grey, non-oolitic marl, full of broken shells	0	4
Perisphinctes helenæ, Chlamys fibrosus, Exogyra nana, Pleuromya tellina, Serpulæ.		
6. TRIGONIA BED. Cream-coloured limestone largely composed of a compacted mass of fossils. The basal 6 ins. in a decayed and ferruginous condition with the ammonites poorly preserved	1	6

Perisphinctes plicatilis and many muts., *P. helenæ, P. aripripes, P. maximus, P.* cf. *subrota*, etc., *Cardioceras* cf. *maltonensis, C. dorsale.*

Trigonia meriani.
,, *perlata.*
,, ,, *var. hudlestoni.*
Trichites giganteus.
Gervillia aviculoides.
Perna mytiloides.
Corbicella lævis.
Astarte ovata.
Cucullæa contracta.
Arca æmula.
Lima subantiquata.
,, *rigida.*
Tancredia nigra.
Velopecten velatus.
Thecosmilia annularis.
Isastræa explanata.
Chlamys fibrosus.
Unicardium excentricum.
Anisocardia damoni.
Isocyprina cyreniformis.
Opis phillipsi.
Sowerbya triangularis.
Ostrea quadrangularis.
Exogyra nana.
Gryphæa dilatata.
Pholadomya paucicosta.
Pleuromya tellina.
Cerithium muricatum.
Pseudomelania heddingtonensis.
Cylindrites polygyrus.
,, *elongatus.*
Pygurus pentagonalis.
Serpulæ.

		Ft.	ins.
5. Marl, with *Perisphinctes* sp., *Chlamys fibrosus*, *Exogyra nana*		0	3
4. GERVILLIA-CAST BED. Impersistent band composed almost entirely of the casts of *Gervillia*	0 to	0	6

Perisphinctes sp.
Gervillia aviculoides.
Cucullæa contracta.
Astarte ovata.
Lima rigida.
Chlamys fibrosus.
Exogyra nana.
Pleuromya tellina.

PEBBLE BED.

		Ft.	ins.
3. Grey pisolitic marl, becoming cemented towards the base into a blue-grey pisolitic limestone, full of "lydites" and larger grey limestone pebbles up to 6 ins. in diameter, the latter bored by *Lithodomus* and encrusted with *Serpulæ;* also rounded pebbles of indurated Lo. Calc. Grit. A band of *Trigonia perlata* about the centre		2	8

Perisphinctids of *cymatophorus-promiscuus* group and many muts.; also of *plicatilis* group. *Cardioceras excavatum*, *Aspidoceras crebricostis*, *Belemnites abbreviatus* and *B. oxyrrhynchus*.

Trigonia perlata.
Chlamys fibrosus.
,, *splendens.*
Camptonectes lens.
Entolium solidum.
Lima mutabilis.
,, *rigida.*
,, *læviuscula.*
Limatula elliptica.
Pseudomelania heddingtonensis.
Pleurotomaria reticulata.
Natica arguta.
Gervillia aviculoides.
Modiola pulchra.
Cucullæa contracta.
Cyprina cautisrufæ.
Unicardium excentricum.
Opis phillipsi.
Ostrea quadrangularis.
Exogyra nana.
Pleuromya tellina.
Nucleolites scutatus.
Serpulæ.

LOWER CALCAREOUS GRIT.

		Ft.	ins.
2. Impersistent indurated topmost bed, the surface eroded and uneven	0 to	1	6
1. Yellow sand with a few doggers		5	0

This section has been described in some detail because it is the most important and complete in the district, and its component parts may be recognised bed for bed in the Highworth area of Wiltshire. The only exposure which showed Coral Rag resting upon Pusey Flags was an old long-disused rag quarry near Lower Lodge Farm. This is now mostly overgrown, but it still shows a few feet of Coral Rag, and fragments of Pusey Flags may be picked up on the floor of the quarry.

Passing westward to Pusey and Buckland, we find many quarries exposing Pusey Flags, these having thickened at the expense of the underlying beds to the extent of 15 ft. or more. They consist of highly false-bedded fissile flagstones with varying concentrations of oolite grains of all sizes, traversed by ramifying seams of sand composed of loose ooliths. The whole of this tract was mapped by the Survey as Lower Calcareous Grit.

At Pusey 12 ft. of brown, false-bedded, oolitic flags are shown, much veined by iron stains, enclosing lenticles of yellow oolite sand and occasional thin seams of clay. The ooliths have generally the size of the eggs in herrings' roe, but vary from fine oolite to coarse pisolite. These flags rest directly upon the sands of the Lower Calcareous Grit, the ooliths ceasing abruptly in a 1-ft. band of coarse iron-sand. There is no trace of a Pebble Bed or of the rest of the Berkshire Oolites, which have here been removed by a local erosion prior to the deposition of the Pusey Flags. Fossils are very meagre, and mostly small and fragmentary. I have been able to detect only the following:—

Littorina muricata.
Exogyra nana.
Chlamys fibrosus.
Camptonectes lens.
Ostrea sp.
Isocyprina cyreniformis.
Opis phillipsi.
Sowerbya triangularis.
Unicardium apicilabratum.
Echinoid spines (undetermined).

Similar good sections may be seen $\frac{1}{4}$ of a mile south of Buckland Cross Roads and at the "Slack Pit" on the Buckland estate, north-west of the Sandhills (formed of an inlier of the Lower Calcareous Grit). At the latter place the Pusey Flags have a thickness of 15 ft.

A much more fossiliferous quarry is worked at Carswell Farm. Here Pusey Flags are quarried to a depth of 10 ft. and overlie a fused Pebble Bed and Trigonia Bed, 2 ft. thick, which once more separates them from the sands of the Lower Calcareous Grit. (This is now usually concealed beneath the base of the quarry.) Lithologically, the Pusey Flags here are the same as at Pusey, but they contain in addition numerous specimens of *Camptonectes lens* lying flat in the bedding planes, and lenticular fossil bands. The latter consist chiefly of hundreds of small Lamellibranchs compacted into a hard ferruginous limestone, and yield a rich diminutive fauna, the commonest member of which is the little *Unicardium apicilabratum*, Etall (see Plate 2, fig. 4, *a* and *b*).

List of Fossils from the Pusey Flags, Carswell Farm Quarry.

Perisphinctes sp.
Belemnites abbreviatus.
Pleurotomaria reticulata.
Littorina muricata.
Pseudomonotis ovalis (both valves).
Exogyra nana.
Camptonectes lens.
Chlamys splendens.
,, *fibrosus.*
Serpulæ.
Nucleolites scutatus.
Lima rigida.
Lima mutabilis.
Limatula elliptica.
Gervillia aviculoides.
Perna mytiloides.
Opis phillipsi.
Sowerbya triangularis.
Unicardium apicilabratum.
Pleuromya tellina.
Gryphæa small sp.
Isocyprina cyreniformis.
Tooth of *Hybodus*.
Wood.

In addition to these I found a fragment of a clavellate *Trigonia* and a fragment of a Cardiocerate of the *excavatum* type, their much-rolled condition and their matrix proving that they had been derived from the Trigonia Bed and the Pebble Bed respectively. There occur also some pebbles of grey limestone and lydites derived from the latter source. We do not need to look far for an explanation of this, in view of the cutting down of the Pusey Flags to the Lower Calcareous Grit at Pusey.

The true relation of the Pusey Flags to the rest of the Berkshire Oolites is again seen in two quarries in the fields north of Hatford Down Cottages, half a mile south of "The Fox and Hounds," Littleworth. Here the base is seen passing down irregularly into a racy marl parting containing lenticular masses of tough unfossiliferous sandstone, which is all that is left to represent the 8 ft. of Highworth Grit and Clay seen at Kingston Bagpuize. The Urchin Marls are unrepresented.

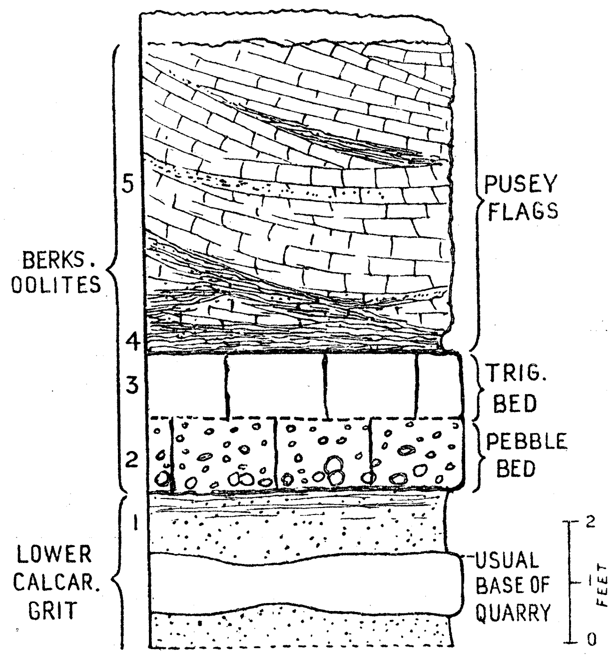


FIG. 4.—Section near Littleworth.

The Trigonia Bed and the Pebble Bed are fused together to form a single limestone band, 2 ft. 3 in. thick, but they nevertheless maintain perfectly their separate identities.

Two Quarries near Hatford Down Cottages, Half-Mile South of the Fox and Hounds, Littleworth.

	Ft.	ins.
PUSEY FLAGS.		
5. False-bedded, fissile, oolite flags, few fossils	4	6
4. Band of marl, tongueing up into the bed above and separating lenticles of it. In the northern quarry this bed contains dogger-like masses of tough, grey, unfossiliferous, non-oolitic, sandy limestone . . . 6 ins. to	1	0

		Ft.	ins.
TRIGONIA BED.			
3. Cream-coloured shelly limestone		1	0

Perisphinctes plicatilis type and muts.

,, *helenæ.*	*Gryphæa dilatata.*
,, *ariprepes* type.	*Gervillia aviculoides.*
Trigonia perlata.	*Perna mytiloides.*
,, *meriani.*	*Lima mutabilis.*
Astarte ovata.	,, *rigida.*
Corbicella lævis.	*Pholadomya protei.*
Camptonectes lens.	*Pleuromya tellina.*
Chlamys fibrosus.	*Modiola bipartita.*
Velopecten velatus.	*Exogyra nana.*
Ostrea quadrangularis.	*Pygurus pentagonalis.*

PEBBLE BED.

2. Grey limestone, somewhat pisolitic, containing many pebbles and "lydites" 1 3

Perisphinctes cymatophorus type and muts. and many others.

Aspidoceras paucituberculata.	*Belemnites oxyrrhynchus.*
Cardioceras cf. *dorsale.*	*Lima mutabilis.*
Pleurotomaria agassizii.	,, *læviuscula*, var. *grandis.*
Trigonia perlata.	*Ctenostreon proboscideum.*
Camptonectes lens.	*Gervillia aviculoides.*
Chlamys fibrosus.	*Exogyra nana.*
Pteria expansa.	*Lithodomus inclusus* (in the pebbles).
Gryphæa dilatata.	*Nucula elliptica* (derived).

LOWER CALCAREOUS GRIT.

1. Yellow sand with interlaminated clay and ferruginous concretions, and a hard grit band about 1 ft. down 2 6

One mile west of Littleworth, in the quarry by the wind pump, close to the high road, Highworth Grit and Clay, with an admixture of carbonaceous matter, once more underlie the Pusey Flags to a thickness of 10 ft.

WINDMILL PIT, ONE AND A HALF MILES EAST OF FARINGDON.

	Ft.	ins.
PUSEY FLAGS.		
4. False-bedded, fissile, calcareous, sandstone flags, containing white oolite grains and penetrated by veins of oolitic sand. The basal few inches contain many detached *Serpulæ* and soft white calcareous pisoliths	4	0

Pygaster semisulcatus.	*Perna mytiloides.*
Lima rigida.	*Chlamys splendens.*
Limatula elliptica.	,, *fibrosus.*
Exogyra nana.	*Serpulæ.*

		Ft.	ins.
HIGHWORTH GRIT.			
	3. Brown and yellow sand, with an increasing amount of interlaminated clay towards the base, passing down very gradually into bed below	5	0
HIGHWORTH CLAY.			
	2. Brown and blue clay with interlaminated sand; blackened by carbonaceous matter	5	0
	1.? TRIGONIA BED probably with PEBBLE BED. No longer exposed. "Solid blue calcareous grit, with large flattened oolite grains rendering it almost an oolite. *Gervillia aviculoides, Pecten lens, Littorina muricata* (base of quarry)." [6, p. 303.]		

In another mile (if I have rightly interpreted Messrs. BLAKE and HUDLESTON'S description of the old Faringdon Workhouse Quarry, now completely obliterated) Pusey Flags, Highworth Grit and Highworth Clay all disappear, and Coral Rag rests once again upon an eroded surface of the Urchin Marls. Owing to the importance of this quarry, I reproduce here BLAKE and HUDLESTON'S very lucid description, with my own interpretations inserted in square brackets.

OLD FARINGDON WORKHOUSE QUARRY [6, pp. 301, 302].

		Ft.	ins.
[OSMINGTON OOLITE SERIES.]			
	8. Coral rag	6	0
	7. Red clay parting and broken rag	0	4
	6. Hard calcitic limestone. Central and lower portions a semicrystalline pisolite. Fossils small. *Thecosmilia*. [This feature occurs also at Shellingford.]	0	6
[BERKSHIRE OOLITE SERIES]—[URCHIN MARLS].			
	5. Oolite of variable hardness, and rather shelly towards the middle, with hard crystalline nodules, and an urchin bed of *Pygaster* and [*Nucleolites*], etc.	2	0
[TRIGONIA BED.]			
	4. Principal Shell Bed. A fawn-coloured limestone, gritty, and only moderately oolitic, with abundance of large shells; *Trigonia meriani, T. perlata,* [*Velopecten*] *velatus, Astarte ovata, Pecten fibrosus, P. lens*	1	1
[PEBBLE BED.]			
	3. Dirty yellowish limestone, partly oolitic, with flattened lumps of marl of smooth surface	0	8
[LOWER CALCAREOUS GRIT]—[INDURATED TOP].			
	2. Building stone. Coarse iron-stained, sandy oolites, blue hearted towards the base, with much wood, and some large fossils; *Pecten lens, Perna mytiloides, Gervillia aviculoides*	3	0
	1. Loose sand, becoming argillaceous lower down.		

A diagrammatic representation of the changes which we have observed in the Berkshire Oolites in following the outcrop from Marcham to Faringdon is given in the accompanying diagram (fig. 5). It will be seen that the Osmington Oolite Coral Rag reposes indiscriminately upon the various subdivisions, and that these in turn show erosions and redepositions among themselves. The chief inference to be drawn from the study of the exposures is that the area was one of instability and rapidly changing sedimentation.

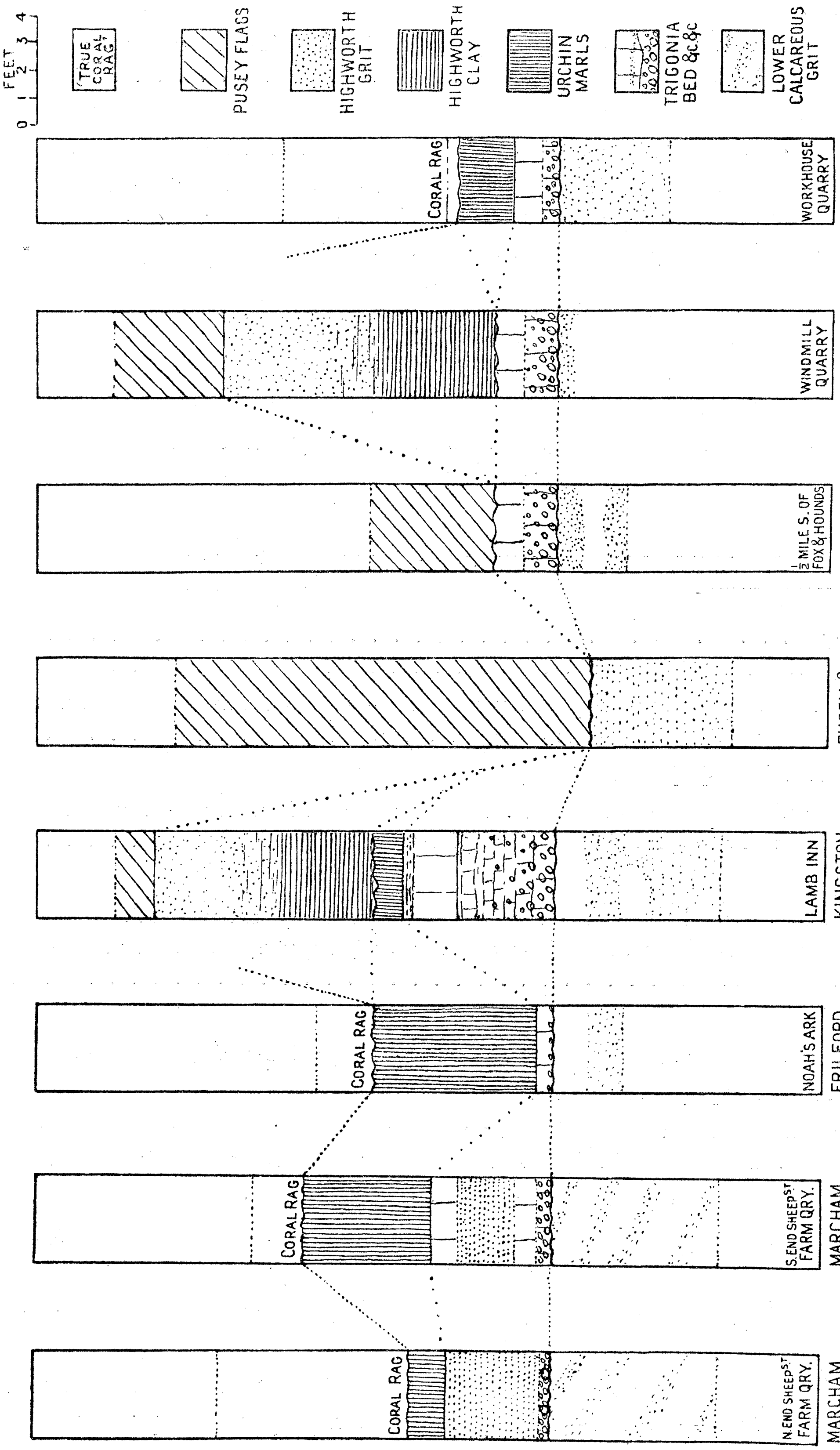


FIG. 5.—Exposures of Berkshire Oolites between Marcham and Faringdon (11 miles) to show intra-oolite erosions. Wavy lines indicate erosion surfaces.

In a southerly direction, 2 miles down the dip-slope, lies the important quarry at Shellingford Cross-Roads. Here the fused Pebble Bed and Trigonia Bed of Littleworth may still be recognised, with their characteristic fossils, overlain by a stratum of nodular oolitic rubble, in which a band of *Nucleolites* and *Pygaster* proclaims the presence of the Urchin Marls.

The quarry has a frontage of about 500 yards, and considerable changes take place from one part to another. In the following description the east side will be described first, then any change that may occur as each bed is traced round to the north and west.

Shellingford Cross-Roads Quarry.*

	Ft.	ins.
7. Red clay soil with (?) *Gryphæa* and flint pebbles. Probably rearranged Upper Calcareous Grit clays . . . . . 6 ins. to	3	0

Osmington Oolite Series.

	Ft.	ins.
6. Very fine reef corals, largely *in situ*. On the west forming a flaggy limestone at the base†	6	0

Isastræa explanata.
Thamnastræa arachnoides.
Thecosmilia annularis.
Cidaris florigemma (test).
Diplopodia versipora (test).
Littorina muricata.
Pseudomelania heddingtonensis.
Lithodomus inclusus.
Lima zonata.
Chlamys nattheimensis.
Camptonectes lens.
Plicatula weymouthiana.
Ctenostreon proboscideum.
Præconia rhomboidalis.
Perna mytiloides.
Exogyra nana.
Serpulæ.

	Ft.	ins.
5. Hard band of calcitic limestone, containing ramifying cavities in the shapes of Thecosmilian corals, lined with calcite crystals. In places there are pockets of pisolite. Towards the west this band gradually dies out, passing into the base of the Coral Rag . . 0 in. to	1	6

Thecosmilia annularis, Perna mytiloides, Exogyra nana.

Berkshire Oolite Series.—Urchin Marls.

	Ft.	ins.
4. Grey nodular, oolitic rubble, hardest on the east, where it is difficult to separate from the bed below . . . . . 1 ft. to	2	0

Nucleolites scutatus.
Pygaster semisulcatus.
Lima subantiquata.
Chlamys splendens.
Exogyra nana.
Perna mytiloides.
Homomya shellingfordensis.
Pleuromya tellina.
Pseudomelania heddingtonensis.
Cerithium muricatum.

* The southerly dip seen in this quarry is probably the southern limit of an anticlinal fold which caused the two Lower Calcareous Grit inliers at Shellingford village and The Sandhills, south of Buckland. The line joining these two inliers is continuous with the dome of Wytham Hill and the Islip anticline.

† The Geologists' Association, who visited this quarry in 1907, record *Thecidium ornatum*, spines of *Cidaris spinosa* and Asteroid ossicles obtained from washing the clay in this bed. They also record two claws of *Goniocheirus cristatus* from the quarry [42].

		Ft.	ins.
TRIGONIA BED.			
3. White oolitic limestone full of *Trigoniæ* and other Lamellibranchs, and yielding many of the characteristic Perisphinctids	1 ft. to	1	6

Trigonia meriani.
,, *perlata.*
Gervillia aviculoides.
Perna mytiloides.
Chlamys fibrosus.
Camptonectes lens.
Plicatula weymouthiana.
Lima mutabilis.
Limatula elliptica.
Exogyra nana.
Velopecten velatus.
Perisphinctes plicatilis type and muts.
Perisphinctes helenæ.

PEBBLE BED.			
2. Hard sub-oolitic limestone, welded to bed above but bluer in colour; containing large pisolitic pellets as at Kingston Bagpuize, and pebbles of grey limestone and "lydite." At the base is a layer of fish teeth		1	0

Gervillia aviculoides.
Perna mytiloides.
Modiola pulchra.
Chlamys fibrosus.
Nautilus hexagonus.
Cardioceras excavatum.
Teeth of *Sphærodus.*
,, *Strophodus.*
,, *Hybodus.*
,, *Teleosaurus.*

LOWER CALCAREOUS GRIT.			
1. Yellow sand with some interlaminated clay	Sometimes dug to	5	0

An almost identical section may be seen in a disused quarry at Hatford, and a third in the extensive quarry at Stanford in the Vale, 2 miles south of Shellingford Cross-Roads. At the latter place the whole of the Berkshire Oolites and Coral Rag have further thinned out, occupying only 2 ft. 9 in. and 3 ft. 4 in. respectively. The Pebble Bed and the Trigonia Bed are still recognisable but inseparable, and are overlain by 1 ft. 4 in. of oolitic rubble, which probably represents the Urchin Marls.* The boring at Goosey, 2 miles farther south-east, shows that the Lower Calcareous Grit does not undergo thinning but rather thickening in this direction [5, p. 49].

3. *The Faringdon Facies.*

The most striking feature of the three quarries last described, and particularly that at Shellingford, is the general tendency to homogeneity which characterises all the Berkshire Oolites. From top to bottom they consist of white, greyish or cream-coloured oolites, not sharply demarcated by sudden changes in lithology as in the other quarries, and barely distinguishable without the aid of the fossils.

As we pass westward this tendency to homogeneity increases, and for six miles west of Shellingford and Faringdon the Lower Calcareous Grit is separated from the Coral Rag by a continuous, indivisible mass of even-bedded white oolites, which become less fossiliferous westwards. The only feature which these oolites retain, besides a meagre

* For description of this quarry, see L. TREACHER [42, p. 115].

fauna, to indicate that they probably represent the Berkshire Oolites just described, is the basal Pebble Bed. This homogeneous, evenly bedded, white oolite facies of the Berkshire Oolites is here designated the "Faringdon Facies"; it occupies the centre of the outcrop traversing our district, and beyond it again, around Highworth, the normal sequence reappears, the same in every detail as east of Faringdon.

The first quarry in the Faringdon facies is at Faringdon Golf-links, barely half a mile from the Workhouse Quarry, where, as we have already seen, the Pebble Bed, Trigonia Bed and Urchin Marls still retain recognisable characters. The condition of the rocks at Shellingford Cross-Roads may be regarded as intermediate between the Workhouse and Golf-links Quarries. For in the Golf-links Quarry, although no lithological differentiation is possible, there is still a rich fauna, from which ammonites, so abundant at Littleworth and scarcer at Shellingford, are, however, conspicuously absent. This fauna, containing the characteristic Lamellibranchs of the *Trigonia perlata* Bed, is distributed to the top of the oolites, which are overlain by Coral Rag; this suggests that, as in the Workhouse Quarry, the horizons of the Pusey Flags and Highworth Grit and Clay are unrepresented.

List of Fossils from the Faringdon Facies, Faringdon Golf-links Quarry.

Pseudomelania heddingtonensis.
Cerithium muricatum.
Trigonia meriani.
,, *perlata.*
Lima mutabilis.
,, *rigida.*
Limatula elliptica.
Camptonectes lens.
Chlamys splendens.
,, *fibrosus.*
Velopecten velatus.
Gervillia aviculoides.
Perna mytiloides.
Astarte ovata.
Pteria pteropernoides.
Corbicella lævis.
Cucullæa contracta.
Modiola bipartita.
Sowerbya triangularis.
Opis phillipsi.
Tancredia nigra.
Ostrea quadrangularis.
Gryphæa dilatata.
Exogyra nana.
Unicardium excentricum.
,, *apicilabratum.*
Pleuromya tellina.
Cidaris smithi (spine).
Nucleolites scutatus.
Belemnites abbreviatus.
,, *oxyrrhynchus.*
Thecosmilia annularis.
Lithodomus inclusus (in the pebbles).
Serpulæ.

In two quarries south-east of Wicklesham Lodge Farm, the same indeterminate oolites are exposed, but for some reason the rich fauna has practically disappeared and no decisive fossils can be found to correlate them with the normal succession.

The best section of the Faringdon facies oolites is in Cuckoo Piece Wood, Coleshill. Only about 4 ft. of the oolites are usually quarried, beneath $2\frac{1}{2}$ ft. of Coral Rag, but in

December, 1925, the writer had the base of the quarry excavated to the Lower Calcareous Grit, thus providing the only known complete section. As was expected, the same even-bedded, poorly fossiliferous oolites were met with from summit to base, the only discovery being the presence of a few pebbles of the usual grey limestone representing the Pebble Bed at the base. The section was as follows :—

Cuckoo Piece Quarry, Coleshill.

	Ft.	ins.
Osmington Oolite Series.		
3. Coral Rag. Typical Isastræan and Thecosmilian rubble with a few fine *Isastrææ*. In places forming a hard calcitic limestone as at Shellingford	2	6
Cidaris florigemma spines. — *Littorina muricata, Lithodomus.*		
Berkshire Oolites, Faringdon Facies.		
2. Alternate harder and softer bands (none really hard) of brashy, coarse-grained, cream-coloured and white oolites. *Perna mytiloides* common, but other fossils rare. Pebbles of grey limestone, bored by *Lithodomus*, at base. Even bedded throughout	12	0
Perisphinctes (impression). — *Limatula elliptica.*		
Cardioceras excavatum type. — *Astarte ovata.*		
Perna mytiloides. — *Gervillia aviculoides.*		
Chlamys fibrosus. — *Pleuromya tellina.*		
Velopecten velatus. — *Pseudomelania heddingtonensis.*		
Cucullæa contracta. — *Nucleolites* (fragment).		
Lower Calcareous Grit.		
1. Fine yellow sand	0	6

All the fossils here recorded were found in the stone which had been quarried in the ordinary way, and had, therefore, been obtained from the top 4 ft. Thus it seems probable that, as at Faringdon, the whole 12 ft. of oolites represent the *Trigonia perlata* Limestones and Urchin Marls, a thickening which prepares us for the great expansion of the whole series in the direction of Highworth. The absence of the higher members may be due to non-deposition, but it is also probable that they were originally represented by similar oolites which were removed as the result of erosion following earth-movements at the beginning of Osmington Oolite times ; for in a small quarry at the foot of Badbury Hill, a bed of rounded pebbles of white oolite forms the base of the Coral Rag, resting upon an eroded surface of the Faringdon facies oolites, lithologically identical with the pebbles. A similar white oolite, the top of which can still be seen, was formerly quarried at Great Coxwell.

On the whole, it may probably be said that the Faringdon facies oolites indicate more tranquil conditions and rather deeper water during their deposition than prevailed at the same time on either side of them.

4. *The Normal Sequence of the Berkshire Oolites in the Highworth District.*

Between Coleshill and Highworth the Corallian escarpment is cut back so as to form a wide amphitheatre, floored by a lowland of Oxford Clay, which separates the two hills. The only connection is three miles down the dip-slope, where the rocks are thin and badly exposed. Consequently the transition from the Faringdon facies to the normal condition of the Berkshire Oolites on this side cannot be studied.

On Highworth hill, three miles west of Coleshill, the typical succession is again fully developed. The distribution and relations of the rocks in the neighbourhood are shown on the folding geological map at the end of the paper (p. 180), on which quarries are marked Q.

The old quarries which have made Highworth famous, described by LONSDALE, HULL, and BLAKE and HUDLESTON, with varying interpretations, are situated half a mile south of the town, and are rapidly becoming filled up and obscured. Nevertheless, the sequence can still be made out, and the weathering of the hard bands has enabled a rich collection of fossils to be made. The main quarry still shows a fine section of the *Trigonia perlata* Limestones, Urchin Marls and Highworth Clay. The Lower Calcareous Grit, which is now hidden, is overlain by about 8 ft. of hard shelly limestone bands separated by marl partings. The individual bands have evidently changed considerably since the quarry was described by the authors mentioned, and they need only be considered as a single series. A noticeable feature are two beds of rolled corals—*Thecosmilia annularis* and *Montlivaltia dispar*—with spines of *Cidaris smithi*. BLAKE and HUDLESTON record a test of the urchin. The whole of these limestones are extremely fossiliferous, and, although *Trigonia* has never been recorded from this quarry, all the other characteristic fossils of the *Trigonia perlata* Bed occur, and the writer has picked up both *T. perlata* and *T. meriani* on neighbouring ploughed fields. The relations of these limestones to the Lower Calcareous Grit are shown in a sandpit 100 yards to the south, where the Pebble Bed is absent; its absence in the main quarry also was proved by digging.

The Urchin Marls bear a strong resemblance to those of Berkshire, and contain chiefly *Nucleolites scutatus*, *Pseudomelania heddingtonensis* and *Pleuromya tellina* casts.

Above the Highworth Clay the sequence is continued upwards in an old sandpit 100 yards to the south-east (the remains of an old brickyard, where bricks were made from the Highworth Clay mixed with Highworth Grit). Here the Highworth Grit is surmounted by about 2 ft. of false-bedded sandstone flags with white oolite grains, indistinguishable from the Pusey Flags of Berkshire, planed off horizontally by the Osmington Oolite Coral Rag. (Q. 93 on map.)

Combining these three exposures, we arrive at the succession first elucidated by BLAKE and HUDLESTON [6, pp. 297, 298]; but the section is so important that I propose to give a new description, embodying more detailed palæontological researches and my own interpretation.

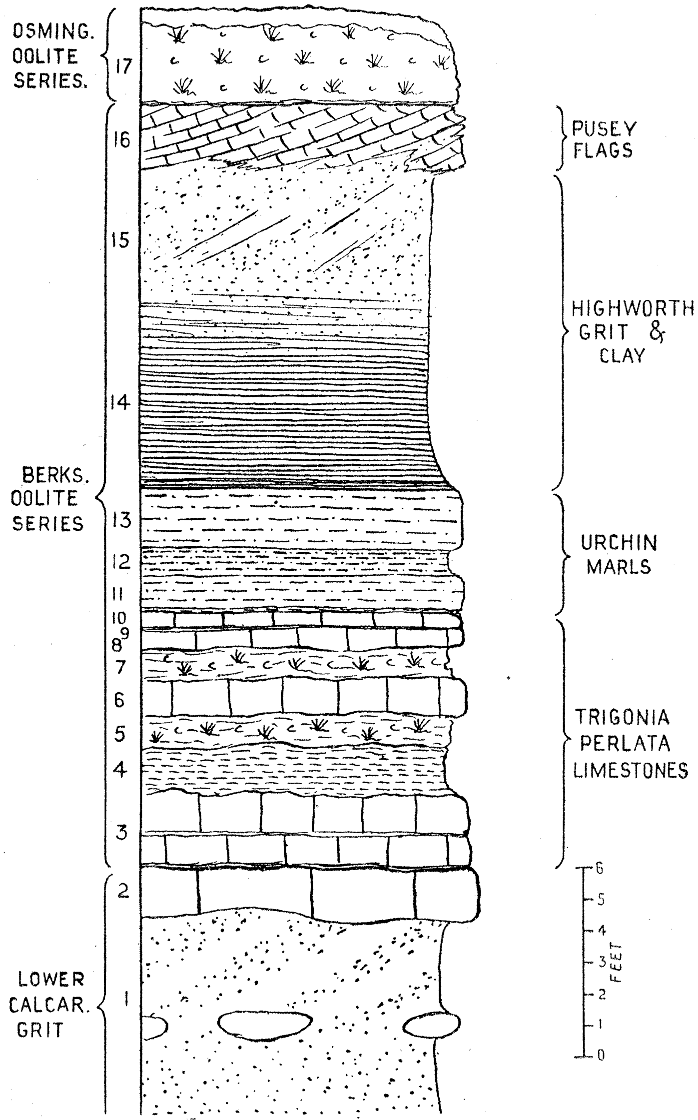


FIG. 6.—Section in Quarries South of Highworth.

OLD QUARRIES SOUTH OF HIGHWORTH. (Q. 92–94.)

	Ft.	ins.
OSMINGTON OOLITE SERIES.		
17. Broken coral rag; *Thecosmilia annularis*, spines of *Cidaris florigemma*	3	0
BERKSHIRE OOLITE SERIES.—PUSEY FLAGS.		
16. False-bedded, fissile sandstone flags with large white oolite grains and finely ground fossil fragments	2	0
HIGHWORTH GRIT AND CLAY.		
15. Yellow sand with streaks of white race and ferruginous coloration, false-bedded towards top, even-bedded below, and passing up from bed below by interlamination	5	0
14. Brown and grey clay with *Chlamys fibrosus* and *Ostrea quadrangularis*	5	0

		Ft.	ins.
URCHIN MARLS.			
13.	Soft, flaggy-weathering oolite; few fossils but *Nucleolites scutatus*	2	0
12.	Oolitic marls with interlaminated clay; *Nucleolites scutatus, Pseudomelania heddingtonensis* and *Pleuromya tellina*	0	9
11.	Consolidated brashy oolite, like 13, passing into basal marly parting	1	3

OTHER FOSSILS FROM BEDS 11–13.

Perisphinctes, fragmentary casts.
Lima rigida.
Chlamys fibrosus.
Exogyra nana.
Anisocardia damoni.
Serpulæ.

		Ft.	ins.
TRIGONIA PERLATA LIMESTONES.			
10.	Hard shelly limestone, only slightly oolitic	0	8
9.	Marl parting, varying in thickness; usually about	0	3
8.	Hard shelly limestone; highly fossiliferous. *Perisphinctes plicatilis* and muts; *Aspidoceras* sp.	1	2
7.	Rolled Coral Bed. Rubble largely composed of rolled *Thecosmiliæ; Astarte ovata, Trichites giganteus*, etc.	1	5
6.	Hard shelly limestone, like Bed 8, becoming more broken up westwards. Perisphinctids of *P. plicatilis* type and other forms. *Cardioceras* cf. *maltonensis*	1	0
5.	Rolled Coral Bed like Bed 7, but corals more numerous, and same fossils. *Cidaris smithi*	0	8
4.	Marl, passing into bed above. Average thickness	0	10
3.	Hard shelly limestone like Bed 6, with a few Thecosmilian corals and a marl parting	2	0
LOWER CALCAREOUS GRIT.			
2.	Indurated topmost bed of very hard blue-centred calcareous grit; not present in southern sandpit	1	9
1.	Yellow sand with (in southern sandpit) a band of doggers $3\frac{1}{2}$ ft. from the top, containing *Aspidoceras perarmatum, Cardioceras* cf. *dorsale, Natica* casts and *Pleuromya* casts. Once dug to	12	6

From the *Trigonia perlata* Limestones considered as a whole (Beds 3–10 = BLAKE and HUDLESTON'S 6, 5, and part of 4), the following fossils (except those marked BL. and H., which are inserted from BLAKE and HUDLESTON'S list) have been obtained by the writer:—

Astarte ovata.
Camptonectes lens.
Chlamys splendens.
Cucullæa sp.
,, *fibrosus.*
Cyprina tancrediformis.
Exogyra nana.
Gervillia aviculoides.
Gryphæa dilatata.
Isocyprina cyreniformis.
Lima mutabilis.
,, *læviuscula.*
,, *rigida.*
,, *subantiquata* (BL. and H.).
Limatula elliptica.
Lithodomus inclusus.
Ostrea gregaria.
Opis phillipsi.
Ostrea quadrangularis.
Pholadomya canaliculata.
,, *æqualis.*
Plicatula weymouthiana.
Pleuromya tellina (many polymorphs).
Pseudomonotis ovalis (BL. and H.).
Quenstedtia lævigata (BL. and H.).
Sowerbya triangularis.
Trichites giganteus.
Unicardium apicilabratum.
,, *excentricum.*

Cerithium muricatum.	*Bourguetia striata.*
Pseudomelania heddingtonensis.	*Pleurotomaria munsteri.*
Natica arguta.	,, *reticulata.*
Littorina muricata.	*Trochus dædalus* (Bl. and H.).
Belemnites oxyrrhynchus. (Bl. and H., recorded as *B. oweni*).	*Ammonoidea* (mentioned in the description).
Cidaris smithi.	*Nucleolites scutatus.*
Thecosmilia annularis.	*Montlivaltia dispar.*

Until the beginning of the present century there existed a rival combination of brickworks and stone quarry in the same strata on the north side of the town. Although these workings have been increasingly obliterated in recent years, enough may still be made out to see that while the Highworth Grit and Clay increase in thickness in this direction, the underlying limestones tend to become thinner.* (Q. 96.)

A quarry, north-east of the town, shows the base of the *Trigonia perlata* Limestones; the Pebble Bed is again absent.

North-East Quarry, Highworth. (Q. 95.)

	Ft.	ins.
Trigonia Perlata Limestones.		
4. Rubbly limestone, full of *Thecosmilia annularis*	3	0
Perisphinctes plicatilis type. *Belemnites oxyrrhynchus.* *Littorina muricata.* *Lima rigida.* ,, *mutabilis.* *Chlamys fibrosus.* *Serpulæ.* *Pteria expansa.* *Unicardium excentricum.* *Exogyra nana.* *Ostrea,* sp. *Lithodomus inclusus.* *Cidaris smithi.* *Nucleolites scutatus.*		
3. Brightly coloured ferruginous marl, containing some soft ferruginous concretions and broken shells; tongueing up into above; *Natica arguta, Serpulæ.* Resting on marked eroded surface of bed below. 6 in. to	1	10
Lower Calcareous Grit.		
2. Indurated topmost bed. 1 ft. to	1	6
1. Yellow sand	4	0

The same highly ferruginous type of the base of the limestones, without any Pebble Bed, is also exposed in a road cutting near the railway station. In the neighbouring sand-pit is a section almost identical with that in the N.E. Quarry, the Lower Calcareous Grit being excavated for about 16 ft. (allowing for a small fault which traverses the quarry). The same horizon is shown in an old quarry in the railway cutting near Byde Mill, where the base of the limestones consists of a mass of Thecosmilian rubble. (Q. 97, 99.)

* At this particular place the beds are all mapped as Lower Calcareous Grit by the Survey (Sheet 34, 1859), though over wide areas to the S.E. they figure on the same map as Coral Rag.

The "Section at Highworth Turnpike," mentioned by BLAKE and HUDLESTON (*ibid.*, p. 300), is almost obliterated, the house known as "The Quarry" having been built in it (Q. 98). Enough can still be seen, however, to show that Beds 1–4 in the descriptions of those authors belong to the *Trigonia perlata* Limestones, and Beds 5–6 to the Lower Calcareous Grit. The location of their "East Quarry, Highworth" (*ibid.*, p. 300), is less certain, but it may have been near the eastern entrance gate of Eastrop Grange. In it the Urchin Marls (Bed 2) seem to have thinned to 1 ft. 8 in., and the record of *Trigonia meriani* from the underlying limestones is confirmatory of our correlations in this district.

Down the dip-slope, at a distance of 1½ miles south-east of Highworth, a fine new quarry was opened in 1923, at the spot known as Hangman's Elm, near Highmoor Wood. (Q. 88.) The Perisphinctids here proved to be almost as numerous as at Kingston Bagpuize, but although all the same groups or types are represented, it is difficult to find two specimens which exactly agree from the two localities. The chief features to be revealed were the return of the Pebble Bed and the first appearance of an early Coral Rag.

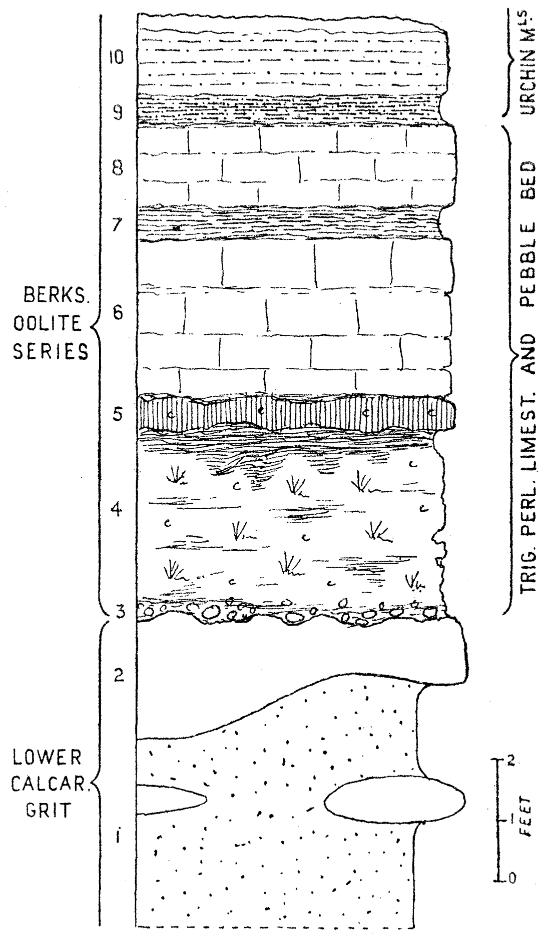


FIG. 7.—Hangman's Elm Quarry, Highworth, showing a coral rag at base of Berks Oolites.

HANGMAN'S ELM OR HIGHMOOR QUARRY, NEAR HIGHWORTH. (Q. 88.)

	Ft.	ins.
URCHIN MARLS.		
10. Coarse-grained, drab-coloured, compacted marly oolite, weathering flaggy	1	0
9. Same as 10 but softer	0	6

From 9 and 10 :—

Perisphinctid fragments.
Pseudomelania heddingtonensis.
Nucleolites scutatus.
Ostrea gregaria.
Pleuromya tellina.

	Ft.	ins.
TRIGONIA PERLATA LIMESTONES.		
8. Shelly, slightly oolitic limestone, containing many ammonites and other fossils, including *Trigonia* casts	1	4
7. Marl parting	0	6

	Ft.	ins.
6. Shelly, slightly oolitic limestone, like Bed 8, rich in Ammonites and other fossils, the lowest foot becoming more a hard, compact grey marl, with *Thecosmiliæ* and spherical masses of *Thamnastræa arachnoides*, large *Pholadomya protei* and *Aspidoceras paucituberculata* .	2	6
5. Trigonia Bed. Hard, irregular, reddish limestone, containing many *Thecosmiliæ* and most of the fauna of Beds 6 and 8; in particular *Trigonia meriani, Trichites giganteus, Astarte ovata*	0	8

From Beds 5–8;

Perisphinctes plicatilis type and many muts. *Cardioceras* cf. *maltonensis, C. highmoori,*
P. helenæ, P. ariprepes, P. chloroolithicus. Nautilus hexagonus.
P. cf. *martelli* and many undescribed forms. (Most of these from Bed 8.)

	Ft.	ins.
4. Coral Bed, composed chiefly of *Thecosmilia annularis* in fine preservation and unrolled, with much clay; band of clay at top. Also *Montlivaltia dispar, Comoseris* new sp., *Cidaris smithi, Littorina muricata*	2	8

From Beds 4–8:—

Astarte ovata.
Camptonectes lens.
Chlamys splendens.
,, *fibrosus.*
Ctenostreon proboscideum.
Exogyra nana.
Gervillia aviculoides.
Gryphæa dilatata.
Lima mutabilis.
,, *rigida.*
Limatula elliptica.
Pseudomelania heddingtonensis.
Cerithium muricatum.
Nucleolites scutatus.
Cidaris smithi (spines).
Pygaster semisulcatus (a single example).
Lithodomus inclusus.
Ostrea gregaria.
Modiola bipartita.
Opis phillipsi.
Ostrea quadrangularis.
Perna mytiloides.
Pholadomya canaliculata.
,, *paucicosta.*
,, *protei.*
Plicatula weymouthiana.
Pleuromya tellina.
Pteria expansa.
Sowerbya triangularis.
Trichites giganteus.
Trigonia meriani.
Littorina muricata.
Pleurotomaria reticulata.

PEBBLE BED.

	Ft.	ins.
3. Grey oolite with grey limestone pebbles up to 4 in. diameter, also pebbles of indurated grit and "lydite." No ammonites, but many *Pectens* and *Limas*. Resting upon a marked eroded surface of Bed 2	0	4

Camptonectes lens.
Chlamys splendens.
,, *fibrosus.*
Lima læviuscula var. *grandis.*
,, *rigida.*
,, *mutabilis.*
Modiola pulchra.
Pleuromya tellina.
Gervillia aviculoides.
Natica arguta.
Serpulæ (abundant).

LOWER CALCAREOUS GRIT.

	Ft.	ins.
2. Intensely hard indurated topmost bed; *Cardioceras* cf. *goliathum* (or thick *C. excavatum ?*), *Nautilus hexagonus, Natica arguta, Pleurotomaria reticulata.* 1 ft.	2	0
1. Yellow sand, with a band of doggers near top, some containing shining calcite casts of *Natica arguta* as in the Natica Bed at Cumnor	6	0

The upward sequence is continued in an old disused quarry on the opposite side of the road, where the Urchin Marls, 2 ft. thick, are overlain by 3 ft. of Highworth Clay. Between here and Friars Hill the Highworth Grit crops out, and on the top of the hill a shallow pit near the cross-roads shows massive Isastræan coral rag of Osmington Oolite age, resting upon a yellow, oolitic, sandy rubble. Descending the southern side of Friars Hill, the road to Watchfield crosses a steep slope formed of the outcrop of the Highworth Grit, then flattens out for a mile across a plateau formed of the *Trigonia perlata* Limestones. Now, in the distance of half a mile, during which the higher rocks of Friars Hill conceal the outcrop, a great change comes over the limestones and, instead of the usual oolitic limestones with *Trigoniæ* and other shells, we find massive Thamnastræan and Isastræan corals littering the fields; the latter bear, in fact, the aspect typical of fields situated upon the Osmington Oolite coral rag. The reef is only a local one, for a small quarry a quarter of a mile due east of West Mill shows the limestones once more in their normal condition.

Several old quarries close to the road N.W. of West Mill penetrate this reef, and, though only a few feet of coralline limestones are now exposed, the neighbourhood of the quarries provides a good collecting ground. The fauna is of peculiar interest, for it is an admixture of many of the shells highly characteristic of the ordinary shelly limestone facies with the true "coral fauna" characteristic of the coral rag; *Lima zonata* and *Chlamys nattheimensis*, everywhere so common in association with the reef-building corals in the later Osmington Oolite coral rag, here make their earliest appearance. At the same time ammonites are conspicuously absent.

FOSSILS FROM OLD QUARRIES N.W. OF WEST MILL, BESIDE HIGHWORTH-WATCHFIELD ROAD.

Astarte ovata (rare).
Camptonectes lens.
Chlamys splendens (v. com.).
,, *nattheimensis* (rare).
,, *fibrosus.*
Ctenostreon proboscideum.
Cucullæa contracta.
Exogyra nana.
Gervillia aviculoides.
Pseudomelania heddingtonensis.
Littorina muricata.
Ostrea gregaria (v. com.).
Nucleolites scutatus.
Cidaris spines (rare).
Isastræa explanata.
Thamnastræa concinna (v. com.).
,, *arachnoides.*
Thecosmilia annularis.
Lima mutabilis (com.).
,, *rigida* (com.).
,, *zonata* (rare).
Limatula elliptica.
Modiola pulchra (rare).
Trichites giganteus (rare).
Montlivaltia dispar.
Comoseris cf. *irradians.*
Serpulæ.

A second local reef or coral island of this age is quarried nearer Highworth, at Upper Farm, S.W. of Eastrop Grange. Here a long shallow opening reveals the actual transition from the structureless reef to normal bedded limestones. The western end of the pit shows massive growths of *Thamnastræa concinna*, with *T. arachnoides*, *Isastræa explanata* and *Thecosmilia annularis* ; the clay pockets among the corals contain hundreds of specimens of *Ostrea gregaria*, of which exceptionally perfect examples may be obtained, also *Littorina muricata*, *Lithodomus inclusus* and other typical rag fossils. Traced in an easterly direction the corals pass into beds of detrital limestone, more flaggy than in the type section, but evenly bedded and containing only minute fragments of coral. The Lamellibranchs in this quarry show less of the normal " shelly " assemblage than in the last, yet we are barely a quarter of a mile from Hangman's Elm Quarry, and *Trigonia*, *Astarte* and *Cucullæa* may be picked up in the ploughed fields round Rag Farm, an even shorter distance away.

LAMELLIBRANCHS FROM UPPER FARM QUARRY, HIGHWORTH. (Q. 91.)

Camptonectes lens.
Chlamys splendens.
,, *nattheimensis.*
,, *fibrosus.*
Ctenostreon proboscideum.
Lithodomus inclusus.
Lima mutabilis.
,, *rigida.*
,, *zonata.*
Limatula elliptica.
Ostrea gregaria (v. com.).
,, *quadrangularis.*
Exogyra nana.

That this reef belongs to the *Trigonia perlata* Limestones and is not faulted Osmington Oolite coral rag can be easily demonstrated ; to the N. it dips normally beneath the Highworth Grit and Clay surmounted by Osmington Oolite coral rag, forming the higher plateau on which the town is built ; to the S. its junction with the Lower Calcareous Grit is exposed in a little sand-pit in the garden of Upper Farm ; and to the E. the normal limestones, the whole Lower Calcareous Grit, and 22 ft. of Oxford Clay were pierced by a well sunk in 1923–4 [44, p. 64, No. 90].

On the northern slope of Red Down lies a small disused quarry in beds which detailed mapping has proved to belong to the horizon of the *Trigonia perlata* Limestones, yet they consist of a typical Thamnastræan and Isastræan reef, containing exclusively the " coral fauna " ; absolutely no internal evidence can be found to distinguish it from the coral rag of Osmington Oolite age.

FOSSILS FROM RED DOWN QUARRY, HIGHWORTH. (Q. 100.)

Isastræa explanata.
Thamnastræa concinna.
Thecosmilia annularis.
Littorina muricata.
Pseudomelania heddingtonensis.
Lithodomus inclusus.
Chlamys splendens.
,, *nattheimensis.*
Lima zonata.
Exogyra nana.
Cidaris florigemma spines.
Serpulæ.

Reef corals occur also on the field adjoining the road to Hannington, at the top of the hill N. of the station, showing that the Red Down reef probably extended on to Staplers Hill. Yet on the N.W. side of Staplers Hill we find again normal shelly limestones, and the same applies to the southern slope of Red Down. At the latter place, close to the footpath to Stanton, innumerable broken Perisphinctids litter the fields, and I have picked up the following fossils: *Trigonia meriani*, *T. perlata*, *Lima rigida*, *Camptonectes lens*, *Pectens*, *Pholadomya canaliculata*, etc. By following up the stream at this point we cross the whole formation, the upward sequence being completed in a quarry (Q. 102) near Red Down Bungalow.

Red Down Bungalow Quarry. (Q. 102.)

	Ft.	ins.
Osmington Oolite Series.		
3. Coral Rag. Masses of Thamnastræan and Thecosmilian corals just below the soil, dropped into the bed below by solution	0	6
Berkshire Oolite Series.		
2. Pusey Flags. Grey current-bedded oolite and pisolite, with streaks of ferruginous colouring; soft and marly. *Velopecten velatus*, *Limatula elliptica*, *Pleuromya tellina*, *Exogyra nana*, *Serpulæ*	2	0
1. Highworth Grit. Yellow sand with some hard concretionary masses	3	0

I have marked the location of these major isolated reefs upon the geological map at the end of the paper, but it is impossible, for obvious reasons, to trace exactly their boundaries. But for the evidence of detailed mapping they would undoubtedly be regarded as of Osmington Oolite age, and we may draw from this a salutary lesson concerning the unreliability of such negative evidence as is afforded by the failure of fossil assemblages when we are dealing with rocks of different facies, even over a region so restricted as this. Then, as now, reef corals carried with them a peculiar fauna, and the company of this assemblage was shunned by certain other organisms, particularly *Cephalopoda* and *Trigoniæ*.

5. *The Western Shell-cum-Pebble Bed from Blunsdon to Tockenham and Lyneham.*

The critical region west of Highworth is as poor in exposures as that between Highworth and Coleshill. The only quarry showing the transition to the western Shell-cum-Pebble Bed is far down the dip-slope at the old Kingsdown Brickyard. Here the Osmington Oolite coral rag and Lower Calcareous Grit are once more only 2 ft. 4 in. apart.

Old Brickyard, Kingsdown.

	Ft.	ins.
Osmington Oolite Series.		
3. Rubbly Coral Rag with very fine *Thecosmiliæ*, in places let down by solution into the underlying marl	3	0

Thecosmilia annularis. *Opis phillipsi.*
Thamnastræa concinna. *Lithodomus inclusus.*
,, *arachnoides.* *Exogyra nana.*
Serpulæ. *Pseudomelania heddingtonensis.*
Spongia floriceps. *Cerithium muricatum.*

	Ft.	ins.
Berkshire Oolite Series.		
2. Grey oolitic marl with the Pebble Bed at base, containing some large grey limestone pebbles up to 4 in. in diameter	2	4

Nucleolites scutatus (common).
Chlamys fibrosus. *Pleuromya tellina.*
Astarte ovata. *Pseudomelania heddingtonensis.*
Exogyra nana. *Serpulæ.*

	Ft.	ins.
Lower Calcareous Grit.		
1. Interlaminated sand and clay, with bright iron colouring in the sand laminæ and ferruginous concretions at top. This passes down into clay which may be Oxford Clay or equivalent to part of the Lower Calcareous Grit	6	6

At Blunsdon, only 3 miles west of the Red Down boring, the Berkshire Oolites have completely disappeared, except for a Pebble Bed. As in the Headington district the Osmington Oolite series here spreads northward in great thickness to the edge of the Corallian outcrop and none of the quarries penetrate beneath it. In 1925, however, a well was dug for some new cottages near the Cold Harbour Inn, and the writer was able to watch the progress of the work and to descend the well. The following section was seen :—

Well near Cold Harbour Inn, Blunsdon.

	Ft.	ins.
Osmington Oolite Series.		
6.–5.–4. Uniform Coral Rag with a 2-ft. band of Wheatley Limestone 8 ft. below the surface	20	6
? Berkshire Oolite Series.		
3. Pebble Bed. Tough grey marl, partly oolitic, with many pebbles of grey limestone and *Thecosmiliæ*	1	6
Lower Calcareous Grit.		
2. Indurated topmost bed of grit	0	6
1. Yellow sand (4 ft.) ; white water-bearing sand (2 ft.)	6	0

This district will be dealt with in greater detail in connection with the Osmington Oolite period. For many miles south-westward nothing can be seen of the Berkshire Oolites. From the great thickness of the former series over this area and the resemblance that the quarries about Purton bear to those in the Wheatley–Headington area, and from the fact that the Osmington Oolite series extends northward to the edge of the escarpment, it may safely be inferred that if any Berkshire Oolites are present they can only consist of a thin Pebble Bed, or Shell-cum-Pebble Bed, as was seen at Blunsdon.

Confirmation of this is found at Tockenham Wick. The best quarry, close to the main Swindon–Chippenham road, has been worked from time to time in recent years, and provides an instructive section. Nine feet of coral rag are seen, passing down into from 15 in. to 2 ft. 10 in. of partly blue-centred, hard oolite and pisolite, containing *Thecosmilia annularis* and spines of *Cidaris florigemma*. This oolite rests upon a lithically rather similar bed, 1 ft. thick, from which it is separated by a soft pisolitic parting. While the upper band seems to belong to the base of the Osmington Oolite series, there can be no doubt that the lower represents the Berkshire Oolites. (A recent description of the exposure by the Geological Survey fails to bring this point out.)

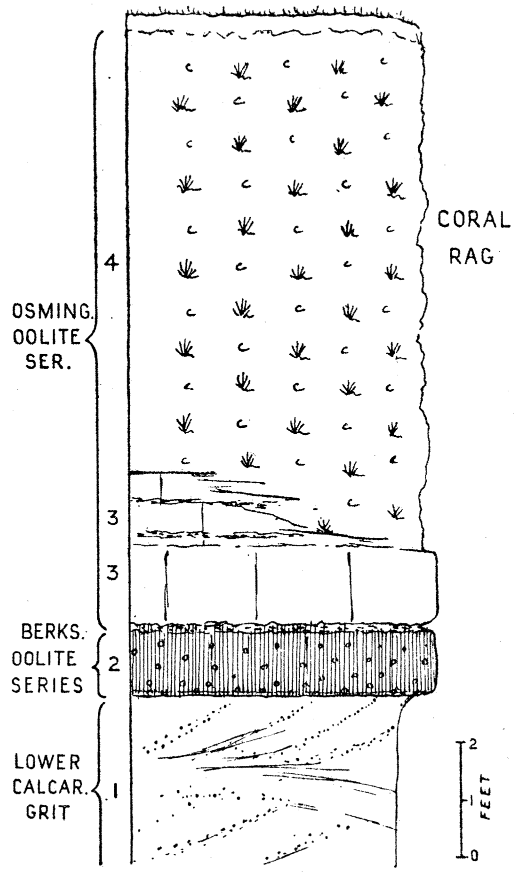


FIG. 8.—Tockenham Wick Quarry, S. of Swindon Road.

QUARRY S. OF SWINDON ROAD, TOCKENHAM WICK.

OSMINGTON OOLITE SERIES.	Ft.	ins.
4. Typical broken Coral Rag with a high proportion of clay; rudely stratified; highly fossiliferous (for a list of the fossils see p. 139)	9	0
3. Partly blue-centred, hard oolite and pisolite. Thickening from 15 in. in one part of the quarry to 2 ft. 10 in. in another, where it lies in several courses. Poorly fossiliferous; separated from bed below by soft pisolitic parting .15 in. to	2	10

Thecosmilia annularis. *Limatula elliptica.*
Cidaris florigemma (spines). *Exogyra nana.*

		Ft.	ins.
BERKSHIRE OOLITE SERIES.			
2. Shell-cum-Pebble Bed; pisolite somewhat resembling bed above but blacker and containing pebbles of "lydite," quartz and grey limestone up to 3 in. in diameter. The basal 2 in. are soft, and comprise a fish-tooth layer analogous with that at Shellingford		1	0

Perisphinctes (fragmentary cast).
Trigonia (clavellate).
Pteria pteropernoides.
Gervillia aviculoides.
Lima rigida.
Chlamys splendens.
,, *fibrosus.*
Trichites granulatus.
Pholadomya canaliculata.
Pleuromya tellina.
Nucleolites scutatus.
Saurian teeth.
Teeth of *Hybodus*.

	Ft.	ins.
LOWER CALCAREOUS GRIT.		
1. False-bedded yellow sand with ferruginous staining and fossil wood	6	0

A similar section may be seen a quarter of a mile to the N.W., beside the road to Dauntsey, where the Shell-cum-Pebble Bed has become softer.

The last quarry is that near Lyneham Folly, three-quarters of a mile S.W. of Tockenham Wick, where the Berkshire Oolites have further dwindled to a mere Pebble Bed 5 in. thick, and show signs of disappearing or losing their identity.

QUARRY NEAR LYNEHAM FOLLY.

	Ft.	ins.
OSMINGTON OOLITE SERIES.		
3. Coral Rag with the usual fossils	2	6
BERKSHIRE OOLITE SERIES.		
2. Pebble Bed. Grey oolitic marl with pebbles	0	5
LOWER CALCAREOUS GRIT.		
1. Yellow sand with ferruginous concretions and interlaminated clay	7	0

This quarry provides the last glimpse that can be seen of the Berkshire Oolites in their familiar form. South-westwards we seem to be entering a partially separated basin of deposition, in which the Berkshire Oolites (as we know them) lose their identity and may be represented by other types of sediment (as by the clays with *Trigonia* in the Westbury boring [31], and the gritty shell-bed above the Lower Calcareous Grit at Seend). All the other quarries, however, are in coral rag or white oolites with *Chlamys qualicosta,* only capable of correlation with the Osmington Oolite series.

(c) *Summary and Conclusions.*

The rocks of the district with which this paper deals form a small province of their own; N.E. of Wheatley the whole formation passes into deeper-water sediments, and we have now seen that a change almost as fundamental takes place S.W. of Lyneham. In the course of our traverse of the outcrop of the Berkshire Oolites across this district it was found that, after passing the centre, the changes which we had observed were repeated in the reverse order, in such a way as might be expected if the different types of rocks were arranged in concentric rings, or on either side of a trough with its axis perpendicular to the strike. Either supposition in itself is as improbable as the other, but by a combination of the two we arrive at the most probable solution of the problem. All the evidence points, in other words, to the existence over the area of a broad shallow bay, of which the shore lay beneath the present outcrop of the Kimeridgian and Cretaceous rocks.

In the centre of the district we find the even-bedded homogeneous oolites of the Faringdon facies. These point to an origin in quieter, deeper water than that in which their variable equivalents were being deposited, eroded and re-deposited east and west of them. The latter, by the rapid changes which they indicate in the type of sedimentation and by the intercalation of eroded surfaces and the piling up of shell-banks, denote distinctly unstable conditions. They have the appearance of having been banked against a rising sea-bed over broad shallow tracts, becoming increasingly shallow towards Headington and Blunsdon, where only the thin Shell-cum-Pebble Beds were laid down.

It is suggestive that the tract occupied by the Faringdon facies of the Berkshire Oolites corresponds with the area proved by borings to be that in which the Lower Calcareous Grit attains its greatest thickness. Thus it would seem that a depression was here initiated in Lower Calcareous Grit times by the beginnings of anticlinal uplifts on either side. For convenience these two uplifts will be spoken of as the Oxford and the Purton anticlines, their axes being considered to run through the centres of the areas occupied respectively by the eastern and western Shell-cum-Pebble Beds.

We shall see that the arrangement and distribution of the rocks of Osmington Oolite age show the same parabola-shaped *motif*. Over the areas occupied by the eastern and western

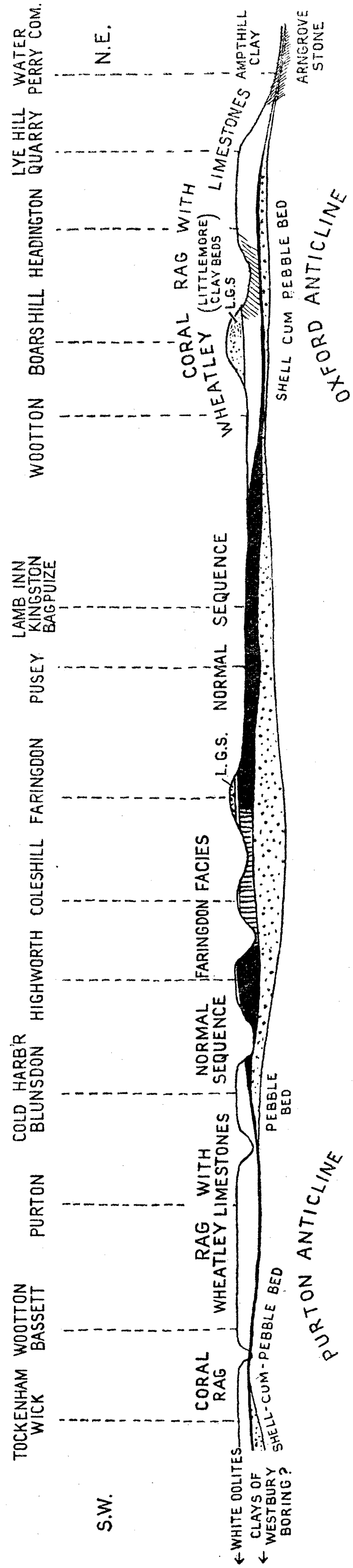


FIG. 9.—Diagram section through district, to show lenticular form of Berkshire Oolites. Distance about 40–45 miles. Lower Calcareous Grit, dotted; Berks Oolites, black and hatched; Osmington Oolites, white and hatched.

Shell-cum-Pebble Beds the coral rag is very thick, contains masses of detrital limestones which separate the areas of actual coral growth into islands, and sweeps some distance north-westward into the Oxford Clay plain to form the prominent hills of Wytham and Purton. Towards the centre the outcrop recedes southward, down the dip-slope, the rocks at the same time thinning out, until they reach only a few feet in thickness at Goosey, Challow and Stanford in the Vale.

Having been led by the evidence to these conclusions as to the tectonic disturbances in this area during Corallian times, it is interesting to speculate as to their causes.

(*d*) *Controlling Factors.*

So long ago as 1901 Mr. Buckman proved that the phenomena connected with the Inferior Oolite in the Northern Cotswolds were due to local anticlinal uplifts within the Inferior Oolite period, resulting in two denudations of the crests of the anticlines, which he termed the Aalenian and Bajocian Denudations [8]. The part of the main gist of his conclusions which concerns us here is the establishment of the existence of anticlinal axes having a roughly N.W.–S.E. strike, and the suggestion that these anticlines probably lay along former lines of weakness. "A line of weakness, once formed, tends to produce subsequent lines of weakness. Therefore, the Jurassic lines of weakness may indicate former lines of weakness, hence former anticlines, hence denudation. There may, then, have been several elevations and several denudations on the same lines." The truth of these suggestions is now no longer doubted, and the idea of recurring anticlines has been elaborated and amplified by many writers, who have, for the most part, tried to apply its principles to the search for hidden coal basins.

A close study of the stratigraphy of almost any part of the Jurassic system reveals the potency of intra-Jurassic movements of one kind or another [11]. In a recent illuminating and suggestive paper on "The Tectonics of the Southern Midlands," Dr. R. H. Rastall [35] has shown that movements continued to be active in Buckinghamshire up to the end of the Upper Jurassic. He has inferred from the distribution of the Lower Greensand that two anticlines with a parallel N.W.–S.E. strike must at that period have arisen, one in the neighbourhood of Sandy and Biggleswade and the other near Leighton Buzzard, 20 miles to the south-west, where the outcrop of the Lower Greensand suddenly terminates. These two anticlines he correlates respectively with the old Charnwood and Nuneaton axes, along the south-eastward continuations of which they lie.

These axes are shown in the same paper to be a part of a system of folds running at approximately equal intervals in a N.W.–S.E. direction across the southern Midlands, crossed at right angles in Wales and the Welsh Border by a second system with a N.E.–S.W. strike, and at an angle of 45° by the Pennine Axis and the line of the Malvern and Abberley Hills, which strike approximately N. and S. Of these axes the ones which concern us here belong to the first-named system, with a strike running N.W.–S.E. From east to west they are designated by Dr. Rastall the Charnwood, Nuneaton, Sedgley–Lickey and Woolhope–May Hill Axes.

If the Sedgley–Lickey line be produced in a S.E. direction it is found to pass close to Oxford, just where we were led to postulate the existence of a rising anticlinal in Berkshire Oolite times. Similarly, the Woolhope–May Hill line, the direction of which is obtained by joining up those two domes—believed to be areas of super-elevation at the points of intersection of anticlinal axes—when continued south-eastward passes near Wootton Bassett. If we continue the slight curve shown on Dr. RASTALL's sketch map, this axis passes somewhere near Purton. Therefore it seems even more probable that it was the recurrence of movements along this old line of weakness which gave rise to the Purton anticline of Berkshire Oolite times. The greater area occupied by the western Shell-cum-Pebble Bed may be connected with its closer proximity to the centre of activity of the corresponding ancient anticlinal.

As detailed investigation progresses, it tends to substantiate the essential correctness of Dr. RASTALL's scheme of old lines of weakness. Some recent work by Dr. J. A. DOUGLAS and the writer, not yet completed, shows that the Cornbrash to the N.E. of Malmesbury, on the line between May Hill and Purton, shows signs of being affected; and Mr. WOOLDRIDGE has recently shown that on the Nuneaton axis the Reading Beds and London Clay are influenced so far away as Middlesex [48]. It need hardly be pointed out to anyone familiar with Oxford geology that the areas occupied by the arenaceous facies of the Kimeridge Clay, at Swindon and Shotover, coincide roughly with the Purton and Oxford anticlines respectively, thus suggesting a continuance of shallow conditions over those axes into Upper Jurassic times.

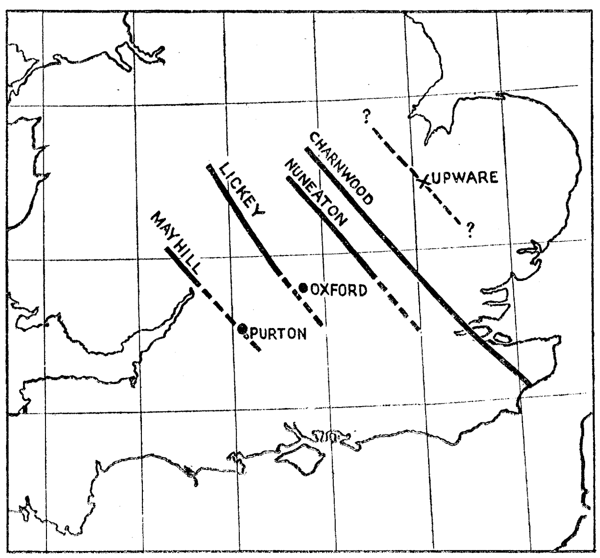


FIG. 10.—N.W.–S.E. trend lines of Southern Midlands. Black lines from RASTALL, 'Geol. Mag.,' vol. 62. Dotted lines added, that passing through Upware wholly conjectural.

Dr. RASTALL mentions in connection with the prolongation of these axes, without insisting on any definite relationship, the coincidence of the Sedgley–Lickey line with the anticline of the Vale of Moreton and with the Goring Gap. I may, therefore, be forgiven for making two further suggestions of a similar nature. First, the continuation of the May Hill Axis to Wootton Bassett or Purton coincides with the water-parting between the Thames and the Bristol Channel, away from which the Middle and Upper Oolites are tilted, as mentioned in the Introduction. Secondly, if a fifth anticlinal axis existed in the Palæozoic floor beneath the Mesozoic rocks of the Fenland, parallel to the other four and about 25 miles beyond the Charnwood axis (that is, at about the average distance separating the visible axes) it would pass beneath the Corallian "reef" of Upware [43]. Thus would be solved one of the greatest problems of the British Corallian, the occurrence of this isolated bank of shallow-water deposits in the midst of the clay area.

V.—The Osmington Oolite Period.

(*a*) *General*.—The Berkshire Oolite Period closed, like the Lower Calcareous Grit Period, with epeirogenic movements. Although at the base of the Coral Rag there is usually no Pebble Bed,* the erosion of the underlying beds and the change in the fauna and the type of deposition testify to these movements. The Coral Rag rests indiscriminately upon eroded surfaces of Pusey Flags, Urchin Marls, Shell-cum-Pebble Bed, and Lower Calcareous Grit. In some of these instances it is not easy to decide whether the missing beds were eroded away or were never deposited, but in others there is no doubt whatever that they were eroded away. The result of these earth-movements was a general levelling of conditions and the establishment of a great belt of coral growth fringing the north-western coast of the London land-mass, from Oxford to mid-Wiltshire. The corals formed a long fringing reef and islands upon the old Lower Calcareous Grit sandbank and its overlying Berkshire Oolites, and like these two preceding formations they terminated suddenly at Wheatley. Beyond this lay the open sea, extending, as before, along the north of the present outcrop. The Coral Rag, more than any other part of the Corallian, is essentially a coastal formation.

The chief participants in this great burst of coral growth were the massive *Thamnastrææ* and *Isastrææ*, accompanied by *Comoseris* and *Thecosmilia*, with several rarer corals. With the spread of the corals most of the familiar molluscs of the Berkshire Oolites became rare or extinct. In particular, practically the whole of the varied Ammonite fauna, together with such important Lamellibranchs as *Trigonia*, *Trichites*, *Cucullæa* and others, disappeared. Instead, the whole district was peopled with the limited "coral fauna," which, as we have seen, was confined in the last period to some small Madreporarian colonies near Highworth. The three most characteristic molluscs of this fauna, almost invariably to be found associated with the corals, are *Lima zonata*, *Chlamys nattheimensis* and *Littorina muricata*. In addition, the corals are generally riddled with the tunnels of the boring Lamellibranch *Lithodomus inclusus*, and strewn with the spines of *Cidaris florigemma*. In some localities Brachiopods made their first appearance in the district. Thus, although some new species appeared in the Coral Rag, such as the Brachiopods, *Hemicidaris intermedia*, *Diplopodia versipora*, *Pecten qualicosta* and some corals, the majority of the fauna had already become established

* Except at Badbury Hill.

in Berkshire Oolite times. Likewise, such unsatisfactory fragments of Ammonites as have been found seem to be of the same general type as those characterising the Berkshire Oolites. There cannot, therefore, be considered to have been any great faunal break, but merely a change of conditions favouring the dispersal and growth of corals.

As already remarked, the outcrop of the Osmington Oolite rag widens over the Oxford and Purton anticlines, and the fringing reef becomes a series of separate islands. Some of the quarries expose ground-up corals, others curious nodular rubble, with only occasional coral seams; in others recognisable fragments of coral are absent altogether, and we find great thicknesses of limestones, as at Wheatley and Holton, in which the only abundant fossils are *Exogyra nana* and spines of *Cidaris florigemma*. In the opinion of the writer the Upper Farm Quarry, near Highworth, with which we have already dealt (see p. 114), records in miniature a general process which provides the key to the interpretation of this somewhat puzzling variety of rocks of post-Berkshire Oolite age, and before we proceed to describe them a few general considerations are desirable.

By its very nature the Coral Rag here cannot have been a continuous deposit. In the channels between the coral islands and on the seaward side of the reefs would have accumulated the débris formed as the product of their reduction by the waves. We should expect the character of this débris to vary according to the distance from the origin, the amount of pounding to which the waves had subjected it, the nature of the prevailing currents and the amount of subsequent cementation. Messrs. BLAKE and HUDLESTON long ago realised these fundamental facts, which are in danger of being overlooked by the more ardent of the modern zoning palæontologists. In 1877 these authors wrote of the old quarry at Stanton St. John [6, p. 310], "We see here the spot where the corals did *not* grow, as at Headington we saw where they did. Here we have the débris of the ground-up, variably hardened reef, along with the Echinoderms that lived in the neighbourhood." In fact, of that part of BLAKE and HUDLESTON's paper devoted to our area, it is the pages dealing with these higher beds near Oxford that are the most valuable, and I shall often quote from them in the following account.

Carried out with this idea in mind, the detailed investigation of all the present sections has led, not to increased complexity, but to remarkable simplification. It has produced the conviction that the recent attempts at complicated interpretations of these rocks are without foundation and misleading. Particularly does this apply to that which, based on doubtful diagnosis of fragmentary and hopelessly uncertain Perisphinctids, introduces non-sequences into those quarries in which the true Coral Rag in its reef form is not present, or again into those from which the limestones of Wheatley are missing [9, pp. 52, 53]. There can be no doubt in the mind of one who carefully traverses the ground and maps the exposures of the various types of coralline deposits about to be described, that (1) the Coral Rag did not begin to grow everywhere simultaneously; (2) it occupied a long time in growing, so that the coarse deposits laid down contemporaneously had time to reach a considerable thickness; (3) extensive as is the area still covered by coral reefs—over 60 miles in length—it must be allowed that a great deal was continually being removed while growth was proceeding, and this must have been deposited somewhere else; (4) it is this débris which forms all the various types of limestone, rubble and "Pendle" overlying the Shell-cum-Pebble Bed in the Oxford and Purton districts, and these can be demonstrated to grade into, and therefore be contemporaneous with, some part of the Coral Rag proper.*

(*b*) *The Oxford District.*—On the Oxfordshire side of the Thames the best exposure of a coral island *in situ* is the Windmill Quarry, Headington. A high proportion of the corals seem to be actually in the position of growth, and the reef was little broken up before fossilisation; we are reminded of the coral islands in the *Trigonia perlata* Limestones near Highworth, and of exposures in the main Osmington Oolite reef at Shellingford, Watchfield and elsewhere. Large tabular masses of *Isastræa explanata* and *Thamnastræa* are conspicuous in a setting of *Thecosmilia annularis*, among which they form hard bands, merging together as solid sheets of coral. The exposure was formerly 20 ft. deep, and at the base the corals were seen to rest directly upon the Shell-cum-Pebble Bed.

This island or reef is nearly continuous with others which occupy most of the plateau south-westwards towards Horspath. Coral Rag, in a more or less broken condition, probably not far from its position of growth, is seen in the quarries from here to Cowley and Bullingdon Green. At the latter place it has yielded Brachiopods. The following is a list of the typical fauna from the Coral Rag of these places:—

Pseudomelania heddingtonensis.
Littorina muricata (comm.).
Bourguetia striata.
Pleurotomaria reticulata.
Lima zonata (comm.).
,, *mutabilis* (rare).
,, *rigida* (rare).
Limatula elliptica.
Ctenostreon proboscideum.
Camptonectes lens (rare).
Chlamys nattheimensis (comm.).
,, *splendens.*
,, *qualicosta.*
,, *fibrosus.*
Isastræa explanata (comm.).
Thamnastræa arachnoides.
,, *concinna.*
Thecosmilia annularis (comm.).
Serpulæ.
Velopecten velatus (rare).
Plicatula weymouthiana.
Ostrea gregaria (comm.).
Exogyra nana (comm.).
Lithodomus inclusus (comm.).
Perna mytiloides.
Gervillia casts.
Many uncertain Lamellibranch casts.
Cidaris florigemma (comm.).
,, *smithi.*
Diplopodia versipora.
Pygaster sp.
Nucleolites scutatus.
Rhabdophyllia phillipsi (rare).
Terebratula boloniensis (rare).
,, *insignis* (rare).
,, *gesneri* (rare).

* Since writing this the author has had the opportunity, in the course of work undertaken for the Oriental Institute of the University of Chicago, of studying the raised and semi-fossil Pleistocene fringing reefs of the west coast of the Red Sea, where the whole of the phenomena described above may be seen, unobscured by soil or vegetation. It has not been found necessary to modify in any way the conclusions previously formed.

Where the Upper Corallian reappears from beneath the Kimeridge Clay, on the eastern side of Shotover Hill, about two miles from this locality, the Coral Rag has entirely disappeared, and its place is taken by the great thickness of limestone in alternating hard and soft bands, which forms so conspicuous a feature at Wheatley and Lye Hill. These massive limestones have been a source of controversy from earliest times. They are devoid of recognisable corals, and the only fossil at all numerous is *Exogyra nana*. On at least one horizon, however, *Nucleolites scutatus* is not uncommon, and the Oxford Museum contains a collection of reptilian bones and fish teeth from Wheatley, including *Pycnodus bucklandi* and *Hybodus obtusus*. I have been able to add only five species to Messrs. BLAKE and HUDLESTON'S list of invertebrates, which now stands as follows:—*Perisphinctes* sp., *Cidaris florigemma*, *Hemicidaris intermedia* (spine), *Nucleolites scutatus*, *Exogyra nana*, *Velopecten velatus*, *Pseudomelania heddingtonensis*, *Pleurotomaria* sp. The Perisphinctids, which occur both at Wheatley and at Lye Hill, are always very poorly preserved and fragmentary, devoid of any trace of suture lines, and quite useless for diagnostic purposes. The best specimens are indistinguishable from the form found in the coral reef at Shrivenham, or from the specimen from the "Headington Hard" of Magdalen Quarry (which will be referred to later). Some of them may, with reasonable certainty, be referred to the group of *P. antecedens* SALFELD.

These remarkable beds are exposed in continuous section for 40 ft. at Lye Hill and 50 ft. at Wheatley, while in the old quarry at the latter place Messrs. BLAKE and HUDLESTON estimated their thickness at 70 ft. Throughout this great thickness the only discernable differences are due to relative degrees of cementation. Hard crystalline bands alternate with softer material, and at the top are some 4 ft. of cream-coloured more flaggy beds, known by the quarrymen as "Pendle." The whole is so tough and compact, however, that none can be quarried without recourse to blasting. Microscopically the whole mass consists of minute calcareous fragments of all shapes, such as might at one time have been fragments of ground-up corals and shells.

Probably the only shells that lived in the vicinity were *Exogyra nana* and the Echinoderms, and the quantity of the former in some of the bands is extraordinary. Now General JOURDY, who has studied the *Exogyræ* on the Continent from their earliest appearance to their extinction, states [16] that it is most noticeable that, wherever these shells occur in great abundance, there is evidence that they lived in the channels among an archipelago, usually an archipelago of coral islands, where the currents and the shallow water appear to have been favourable to their multiplication.

Where, then, was the archipelago whence this mass of detrital matter was derived, and which provided the conditions requisite for these innumerable *Exogyræ* to flourish? It seems most natural to suppose that the group of coral islands around Headington, Cowley, Bullingdon and Horspath provide the answer, as well as the main mass of the reef farther west, where no detrital matter seems to have accumulated. In support of this we notice the pronounced easterly dip of the beds, which, as suggested by BLAKE and HUDLESTON, is probably false dip, such as may be seen in the corresponding beds at Headington, and forms such a remarkable feature in the lower Osmington Oolite at Todber, Dorset. These authors further remark, "We are here presented with the deposits which were formed on the extreme edge, not only of the coral reef, whose thickness would not account for so much false dip (which amounts in the most easterly quarry to 12°, and is even marked 18° at another spot on the map), but probably of the Lower Calcareous Grit sandbank also—a conclusion which is supported by the fact of its sudden termination eastwards." [6, p. 311].

In the northern part of the northern quarry at Wheatley the weathering of a portion of the face fallen into disuse has revealed a significant fact. Here, between the heights of about 10 and 20 ft. below the "Pendle," the softer bands are seen to have a distinctly rubbly and nodular structure, which makes them indistinguishable from the curious "Nodular Rubble" of Headington, about to be described, which can be demonstrated to pass laterally into the Coral Rag.*

We will now return to the coral islands of Headington and follow the passage of the Rag northwards into two other types of detrital deposit, the "Nodular Rubble" and the "Pendle." Three hundred yards north of the Windmill Quarry lies the large quarry close to the cross-roads. In the southern end of this we find the same reef corals as in the Windmill Quarry. The section is continuous for 200 yards in a N.N.E. direction, and when we follow it round we find that the corals are no longer *in situ* but become increasingly broken up, while the tabular masses decrease in number and importance. Moreover, the whole Coral Rag has here a false dip of several degrees in the same direction, away from the reef. Finally, at the northern end of the quarry there is only rubble composed of small coral fragments (see fig. 11).

The next exposure in this direction lies some 300 yards from the last, namely, the Vicarage Quarry. Here the continuation of the same false dip relative to the Shell-cum-Pebble Bed shows that the material was derived from the same source, but recognisable corals are confined to the basal 6 to 12 in. In place of the mass of fragmentary corals seen in the last quarry we find 20 ft. of peculiar nodular rubble, in which all fossils are rare, except *Cidaris florigemma* and *Exogyra nana*. The nodules are of the same composition throughout, consisting of comminuted calcareous fragments, often including *Cidaris* spines. They have hard cores and are compacted into a tough mass. As yet the cause of their formation is unknown. Among the nodules are hard bands of limestone, devoid of nodular structure, but consisting merely of an indurated form of the

* I would suggest that the term "Wheatley Limestones" should be retained for all these deposits and not displaced by Mr. BUCKMAN'S new term "Holton Beds" [9, p. 53]. Not only are the greatest, oldest and most famous quarries in the centre of Wheatley, while the nearest quarry to Holton is that at Lye Hill, half a mile away, but Wheatley is a well-known spot on both the main road and the railway, while Holton is a village of such obscurity that even the average Oxfordian might be pardoned for never having heard of it.

same material. At the top of the pit are $3\frac{1}{2}$ ft. of "Pendle." The fossil list from these nodule beds is as follows :—

Cidaris florigemma (spines).
Pseudomelania heddingtonensis.
Bourguetia striata.
Chlamys nattheimensis.
Pygaster sp. (10 ft. above Shell-cum-Pebble Bed).
Thecosmilia annularis.
Exogyra nana. *Serpulæ.*

A quarter of a mile north of the Vicarage pit lies the great Magdalen or Workhouse Quarry, in which very few recognisable corals occur. Here the dip is more easterly, indicating a reef, possibly a continuation of the last, in the direction of Headington Hill. On the western side of the quarry the Shell-cum-Pebble Bed is overlain by nearly 20 ft. of the same nodular rubble as in the Vicarage Quarry, with occasional hard bands known as "Headington Hard." One band in particular of this rubble is noteworthy, and that the only continuous feature, namely, the peculiar stone known to the quarrymen as the "Hedgehog Course" (see fig. 12). This is a constant band of tough limestone of a speckly appearance, due to the number of included *Cidaris* spines and other calcitic fossil remains, some of which appear to be fragments of *Thecosmiliæ*. On the west it is 2 ft. thick and stands 10 ft. above the Shell-cum-Pebble Bed; 50 yards to the east it has thinned to 3 in. and dropped to 9 in. above the Shell-cum-Pebble Bed. It thus forms a useful criterion of the false dip.

On the east of the pit this dip brings down about 12 ft. of white "Pendle," the term applied by the local quarrymen to the white porous mass of loosely comminuted calcareous fragments at the top of the

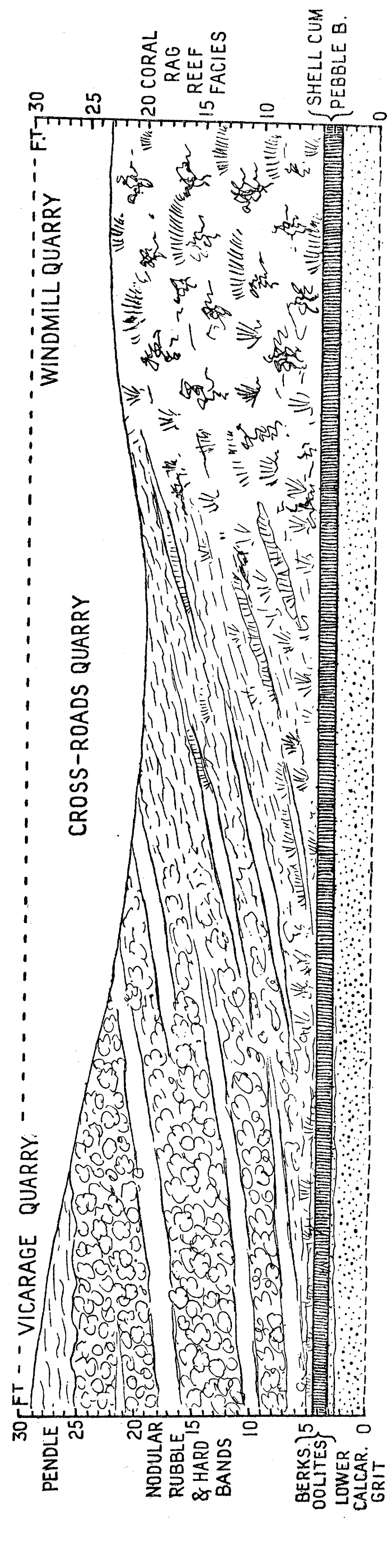


FIG. 11.—Osmington Oolite Series—Diagram-section at Headington. Horizontal scale much compressed. To show gradual passage from coral reef or island to nodular rubble, which passes in turn into Wheatley Limestones.

section. The "Pendle" here is not quite the same at that at Wheatley and elsewhere, being whiter, more homogeneous, less flaggy, and softer.

One of the most important points shown in this quarry is the complete lateral passage, in the space of a few yards, of $2\frac{1}{2}$ ft. of white "Pendle" into the Nodular Rubble. At Wheatley we have seen that the Nodular Rubble is intimately mixed with, and a facies of, the Wheatley Limestones. This confirms the conclusion arrived at from an investigation of the composition of these three types of deposit, *i.e.*, that they are interchangeable and merely variations of the same class of detrital waste from the coral reefs, of which the different forms are due to exigencies of currents and bottom conditions about which we can only speculate. Subsequent solution of some of the limestone by percolating water, followed by re-deposition as calcareous cement, may account for the differences

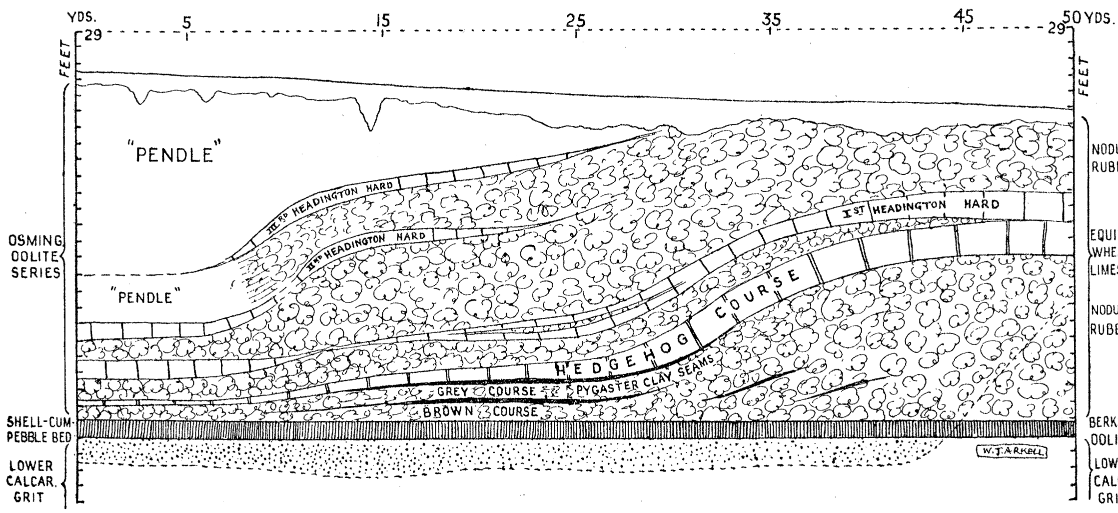


FIG. 12.—Section at Magdalen or Workhouse Quarry, Headington. Drawn from measurements at 10 yards intervals. Showing quarrymen's names for different forms of rag débris, false-dipping from the reef.

in hardness and for the frequent rhythmic alternation of hard and soft bands. Elsewhere we shall note the passage of true Coral Rag directly into each of these deposits.

According to the workmen some of the Perisphinctids which they find in Magdalen Quarry are obtained from a part of the Nodular Rubble known by them as the Brown Course (see fig. 12), and I was also given one which they asserted came from the "IInd Headington Hard" (see the fig.) 10 ft. above the sands (the matrix confirmed their statement), and was the first to be found so high up in the quarry for many years. Unfortunately these are all bad specimens, devoid of suture-lines, and though better than the few fragments obtained at Wheatley, they are not sufficient for specific determination. They resemble closely some of the forms common in the underlying Shell-cum-Pebble Bed, and may be said with safety to indicate that the Coral Rag belongs to the *antecedens* zone of SALFELD. Confirmation of this came recently with the finding by myself of a fragment of narrow-whorled *Perisphinctes*, identical with some of these, in the true reef facies of the Coral Rag near Friars Mill, north of Shrivenham. Inflated *parandieri*-like forms also occur, however.

The fallacy of dividing up Magdalen Quarry into beds and assigning these beds to different hemeræ, as has been attempted [9, p. 50], is shown in fig. 12, which was drawn from measurements taken at regular intervals along the quarry face.

North of Headington Quarries there is evidence that other coral islands existed, and in the tract about Elsfield, Woodperry and Stanton St. John the same changes as we have described are repeated. One such island was probably situated in the neighbourhood of Barton Mill, but most of it has been removed during the cutting down of Bayswater Brook. Its influence is seen in the old roadside quarry one mile east of Magdalen Quarry, where broken rag, consisting of coral fragments and clay with all the usual reef fossils, reappears.

In the quarry beside the road from Headington to Stanton St. John we appear to be on the other side of this island and slightly farther away, for we see 18 ft. of Wheatley Limestones dipping away towards Woodperry and Stanton St. John; but we are closer to the corresponding reef than at Wheatley or Lye Hill, for recognisable coral fragments still play an important part, as well as broken Coral Rag shells. I collected *Thecosmilia, Pecten, Ctenostreon proboscideum, Ostrea, Exogyra nana, Lithodomus inclusus, Nucleolites scutatus* and spines of *Cidaris florigemma*. This quarry shows rocks intermediate lithologically between Coral Rag and Wheatley Limestones, just such as we may presume to exist somewhere beneath Shotover Hill, half-way between the reefs of Horspath and the limestones of Wheatley.

By the time Stowe Wood and Woodperry are reached the transformation is complete. In the Stowe Wood quarry 11 ft. of ordinary Wheatley Limestones are exposed; while at Woodperry we are presented with a repetition of all the three types of detrital rocks we have described, combined in a single quarry face 14 ft. deep. At the base of this interesting excavation are 6 ft. of Wheatley Limestones, consisting of alternate bands of hard crystalline limestone and broken-shell marl. In one of the latter *Nucleolites scutatus* is abundant, and *Diplopodia versipora* also occurs. The limestone is full of little white pellets, like certain bands at Lye Hill. These beds pass up gradually, with some lateral alternation, into 6 ft. of typical Nodular Rubble resembling that in the Vicarage and Magdalen quarries at Headington; about the centre is a hard band, forming a kind of transient return of the underlying limestones and indistinguishable from them. At the top of the quarry are 18 in. of flaggy limestone, like parts of the "Pendle" in the Vicarage pit, let down and distorted by solution of the underlying rubble.

Finally, at Stanton St. John, we have the quarries farthest in the direction of the open sea. Behind the school 10 ft. of Nodular Rubble are exposed. Here the only common fossils are *Exogyra nana* and *Nucleolites scutatus*, but I have also obtained *Cidaris* spines, *Bourguetia striata*, casts of *Pleuromya, Gervillia*, and some other Lamellibranchs.

The old quarry on the opposite side of the road is now nearly filled up, but in 1877 Blake and Hudleston stated that " about 24 ft. are seen, composed of alternate layers of hard doggery bands and marl. Towards the base the hard bands are closer together, thicker and more crystalline . . ." and " . . . what is remarkable about the fauna here is that all corals seem to be absent, or very scarce, nor are there any Pectens to be seen. It is, however, a complete nest of Echinoderms, the chief being *Cidaris florigemma*, [*Diplopodia*] *versipora*, [*Nucleolites*] *scutatus* and *Dysaster* (?). The accompanying fossils are *A. plicatilis*, [*Pseudomelania*] *heddingtonensis*, *Gervillia aviculoides*, *Lima rigida*, [*Limatula*] *elliptica*, and *Exogyra nana*." [6, p. 310.]

The top part, which is still visible, appears to be a continuation of the Nodular Rubble Beds seen in the adjacent quarry behind the school, with a greater admixture of clay, and from the description quoted it would seem that these passed down into an argillaceous type of the Wheatley Limestones. Blake and Hudleston's interpretation is undoubtedly correct, that we have here " a natural termination of the Coral Rag in this direction " [*loc. cit.*], the greater proportion of clay being the natural result of the tail end of the coral débris being spread out on the sea bed and mixed with deeper-water sediment.

Before leaving the district east of the Thames it is necessary to describe two quarries south of Wingfield Hospital, Headington, which present features exceptional in several respects. They lie only 200 yards apart, on either side of a little valley already mentioned, worn down to the Oxford Clay. In the southern quarry, on the western side, Coral Rag in position of growth is separated from the Lower Calcareous Grit by the Shell-cum-Pebble Bed, 1 ft. in thickness. This is easily recognisable, as it is dark blue-grey in colour and particularly rich in *Astarte ovata*, *Velopecten velatus* and many other Shell-cum-Pebble Bed fossils, including *Trigonia meriani*. It seems to rest upon an uneven floor of the Lower Calcareous Grit, and in an easterly direction it thins out. Proportionately as the Shell-cum-Pebble Bed thins out, another band of hard limestone makes its appearance above it, attaining, in the east of the pit, a maximum thickness of 4 ft. This limestone is lighter in colour than the other, and at once suggests the Wheatley Limestones. In places it is crowded with *Exogyra nana*, while pebbles and most of the other fossils are lacking.

The same limestone, $2\frac{1}{2}$ ft. thick, appears in the northern quarry, resting directly upon the sand of the Lower Calcareous Grit, without the intervention of the Shell-cum-Pebble Bed. Between it and the Coral Rag are $2\frac{1}{2}$ ft. of softer nodular rubble ; but this, although possessing the same nodular structure as that already described, differs from it in being coarsely oolitic and in containing a rich fauna, of which *Exogyra nana* is still the most conspicuous member. Fragments of Perisphinctids may be collected, but until the quarry is reopened it is impossible to obtain recognisable specimens.

South Quarry, Wingfield Hospital.

		Ft.	ins.
Osmington Oolite Series.			
4. Typical Coral Rag with the usual fossils. Maximum		9	0
3. Wheatley Limestone. Hard white course, full of *Exogyra nana*	0 to	4	0
Cidaris florigemma (spines). *Opis phillipsi.*			
Thecosmilia annularis. *Serpulæ.*			
Berkshire Oolite Series.			
2. Shell-cum-Pebble Bed. Blue-grey limestone with pebbles and many large shells	0 to	1	0
Astarte ovata. *Lima mutabilis.*			
Velopecten velatus. ,, *rigida.*			
Trigonia meriani. *Gervillia aviculoides.*			
Chlamys splendens. *Perna mytiloides.*			
,, *fibrosus.* etc.			
Lower Calcareous Grit.			
1. Yellow sand, seen to		2	0

North Quarry, Wingfield Hospital.

	Ft.	ins.
Osmington Oolite Series.		
4. Typical Coral Rag with the usual fossils. Max.	8	0
3. Oolitic nodular rubble	2	6
Perisphinctes (fragments). *Limatula elliptica.*		
Thecosmilia annularis. *Lima mutabilis.*		
Cidaris florigemma. *Ostrea gregaria.*		
Chlamys fibrosus. *Exogyra nana.*		
,, *nattheimensis.* *Pleuromya tellina.*		
Camptonectes lens. *Serpulæ.*		
Velopecten velatus.		
2. Wheatley Limestone. Hard white course full of *Exogyra nana*	2	6
Thecosmilia annularis. *Chlamys nattheimensis.*		
Cidaris florigemma. *Lima rigida.*		
Camptonectes lens. *Limatula elliptica.*		
Velopecten velatus. *Opis phillipsi.*		
Chlamys fibrosus. *Exogyra nana.*		
Serpulæ.		
Lower Calcareous Grit.		
1. Yellow sand, seen to	1	6

In the neighbouring Windmill Quarry and on the W. side of the southern of the two quarries just described, we saw that corals grew directly upon the Shell-cum-Pebble Bed. Here, however, where that bed was not protected by coral growth, it was removed by currents. Originally this spot, densely peopled by *Exogyræ,* was probably the site of a channel between two coral islands; later the corals spread over it, linking up the islands. This hypothesis is substantiated by the "grain" of the corals (incipient stratification) in the southern quarry. On crossing to the Berkshire side of the

Thames we do not meet again with the Nodular Rubble, but we find further evidence of the relations of the other two types of detrital deposit to the Coral Rag.

A large area of typical Wheatley Limestones exists in the neighbourhood of Sunningwell and Wootton. In the old quarry, by the main road S.W. of the latter village, 16 ft. of ground-up shell marl alternating with hard limestone, a consolidated form of the same material, are still seen, though formerly quarried much deeper. *Cidaris* spines and *Exogyra nana* are common, but other recognisable fossils are hard to find. The proportions of soft marly and hard crystalline bands vary in short distances, and near the top both are occasionally false-bedded. The quarry bears a close resemblance to those at Lye Hill and Wheatley. The boring at Wootton Waterworks proved that these beds have a thickness of about 30 ft.

The two quarries at Wootton Limekilns show either the top of these beds, or beds at a slightly higher level. In one corner of the northern quarry is an intensely hard course of limestone, full of ramifying calcite-lined cavities in the shapes of Thecosmilian corals, with occasional large masses of *Isastræa* and beautifully preserved Pectens (*P. nattheimensis*, *P. qualicosta*, *P. splendens*, *P. fibrosus*). Above this lie 5 ft. of the same poorly fossiliferous limestones as below, but they pass laterally into typical rubbly broken Coral Rag, and this again passes laterally into " Pendle," like that in the Magdalen Quarry, Headington.

A magnificent reef in position of growth was exposed in Blake and Hudleston's time at Bradley Farm, near Cumnor, and large masses of *Isastræa* and *Thamnastræa* litter the fields on the surface of the surrounding plateau. Only the edge is seen in the present condition of the quarry (1927). Besides the characteristic *Lima zonata* and *Cidaris florigemma*, many rarer fossils have been found here, including *Terebratula insignis*. When traced round the quarry the rag is seen to pass laterally into two detrital beds, an upper of loose rubble composed of broken shells and coral fragments, and a lower of flaggy limestone, merely a consolidated form of the same material. The reef is narrowest at the bottom and broadest at the top, showing that, as growth proceeded, the corals spread out horizontally over an embankment of their own waste (see p. 77).

In the adjacent quarries at Cumnor Cross Roads, which are now unfortunately becoming obscured, blue and white limestones and coralline rubble, all with *Cidaris florigemma*, overlie to a depth of 7 ft. what Blake and Hudleston took to be the representative of the Coral Rag, " soft brash in a loose calcareous paste " [6, p. 308, Bed 3]. It was this quarry and that below the brickworks at the foot of Shotover Hill* which led those authors to form their theory that the Wheatley Limestones were all of post-Coral Rag age.

Similar limestones overlie the reef which is exposed in the two quarries on either side of the road on Cumnor Hill, and in the numerous cuttings recently made there in connection with building operations. In a continuous temporary section, opened in laying the electric cable from Ferry Hinksey towards Hen Wood, the two types of rock seemed to

* For description of this quarry, see p. 149.

alternate, as they do also on Wytham Hill. A quarry in which true Coral Rag overlies 12 ft. of Wheatley Limestones may be seen on the N.E. side of Boars Hill, one mile W. of South Hinksey. All these Berkshire exposures show that in some places the corals grew upon detrital limestones, while in others detrital beds were heaped upon the corals.

(*c*) *Marcham to Blunsdon.*—Between Marcham and Blunsdon exposures of the Coral Rag are for the most part shallow. The rag is rarely in request for its own sake, but it is often removed as overburden from the top of quarries worked for the Berkshire Oolite limestones. In all these exposures it consists of corals in, or near, their position of growth, and it maintains a monotonously uniform character along the whole outcrop, suggesting in every way a thin fringing reef.

The last of the Wheatley Limestones are left at Marcham (see fig. 2, p. 92), where 5 ft. of poorly fossiliferous white limestone with a band of marly rubble overlies a 2-ft. band of rolled corals. The latter is presumably the source of the rare *Phymopedina marchamensis*. Typical exposures may be seen at Lower Lodge near Pusey, Hatford, Shellingford, Coxwell, Watchfield and many other places. Since the character and fossil content of the rag at all these places is the same, approximating closely to that in the Windmill Quarry, Headington, descriptions would be superfluous. The only new fossil which has been found by the writer in this area is *Præconia rhomboidalis*, at Shellingford Cross-Roads. *Ornithella margarita* is recorded from Faringdon by DAVIDSON.

Particularly fine corals may be obtained in a quarry (opened 1924) beside the Highworth–Shrivenham road, S.E. of Friars Mill. From this quarry was obtained the only fragment of an Ammonite hitherto known from the Osmington Oolite Coral Rag of the district. The fossils are as follows :—

FOSSILS FROM THE CORAL RAG OF STONEFIELD BARN QUARRY, SOUTH OF FRIARS MILL.

Perisphinctes cf. *antecedens*.
Cidaris florigemma.
Bourguetia striata.
Pseudomelania heddingtonensis (with shell preserved).
Littorina muricata.
Lima zonata.
Chlamys nattheimensis.
Lithodomus inclusus.
Gervillia aviculoides.
Exogyra nana.
Serpulæ.
Isastræa explanata.
Thamnastræa concinna.
,, *arachnoides*.
Thecosmilia annularis.

West of the River Cole the Coral Rag forms a broad plateau extending to Stanton Fitzwarren. Over the southern part of this plateau it overlaps the Berkshire Oolites and Lower Calcareous Grit, coming to rest between Warneford Place and Stanton Park upon the Oxford Clay (see the map). Many rag quarries not exceeding 7 ft. in depth have exposed the Coral Rag of this plateau, the fossils quoted above (except for the

Ammonite) being characteristic of them all. Half a mile south of Queenlains Farm Gastropods are very numerous, and specimens of *Bourguetia striata* may be obtained with the fifth and even sixth whorl intact and bearing much of the shell. (The species is generally found exclusively in the form of internal casts.) From one of the quarries near the Swindon road at Stanton Firs I obtained a test of *Hemicidaris intermedia*, an Echinoid which is very rare north of Calne. During the digging of a trench in the Coral Rag near Kingsdown Brewery in 1923–24 I also found some small *Terebratulæ*, which appear to belong to a new species (see *Terebratula kingsdownensis*, p. 175, Plate 1, fig. 6).

At the western end of the plateau, at Stanton Fitzwarren, is situated a quarry of great interest by reason of the peculiar, and, so far as is known, unique condition of its corals. The quarry is worked principally for a band of very hard limestone, 3 ft. thick, containing a large number of corals belonging to five species. Generally the internal structure of the corals in this band has been dissolved away and replaced by an extremely fine-grained, hard, green, calcareous mudstone. This is devoid of any structure and so fine-grained as to resemble chalcedony. After solution in hydrochloric acid the only residue is a faint milky discoloration. It is opaque under the microscope. Where the corals had been bored by *Lithodomi* these latter have been filled by transparent crystalline calcite. The green ramifications in the shapes of the various species of corals give the rock a peculiar appearance, for in all other known places where corals have been dissolved the cavities are lined by, or complete replacement has been effected by, transparent crystalline calcite, such as is restricted in this quarry to the *Lithodomi*.

Stanton Fitzwarren Quarry. (Q. 108 on map.)

Osmington Oolite Series.	Ft.	ins.
3. Flaggy, poorly fossiliferous, cream-coloured limestone. *Thecosmilia annularis, Lithodomus inclusus, Exogyra nana, Præconia rhomboidalis, Serpulæ*	1	9
2. Soft, marly, calcareous rubble, with much race. *Cidaris florigemma* spines, *Exogyra nana, Littorina muricata, Thamnastræa concinna, Serpulæ*	2	2
1. Massive block of very hard coral limestone, the corals replaced by fine-grained, green, calcareous mudstone. On the west of the quarry the top 16 in. break up into soft rubble continuous with the overlying bed	3	0

Isastræa explanata.	*Velopecten velatus.*
Thamnastræa arachnoides.	*Limatula elliptica.*
,, *concinna.*	*Lithodomus inclusus.*
Thecosmilia annularis.	*Ostrea* sp.
Rhabdophyllia phillipsi (?)	*Exogyra nana.*
Cidaris florigemma spines.	*Serpulæ.*
Littorina muricata.	

At Blunsdon are two fine quarries, constituting together the best exposure of the typical reef facies of the Osmington Oolite Series at this end of the district. In appearance and fossil content they resemble closely the Windmill Quarry at Headington, 30 miles away. One quarry is situated at the hamlet of Broadbush, the other a quarter of a mile south of Cold Harbour, and together they provide about 100 yards of section with a depth of about 10 ft. The well recently sunk at Cold Harbour proved that the rag has here a thickness of 20 ft. (see p. 116).

FOSSILS FROM THE CORAL RAG OF BROADBUSH AND COLD HARBOUR QUARRIES, BROAD BLUNSDON.

Camptonectes lens (rare).
Chlamys splendens.
,, *nattheimensis*.
Ctenostreon proboscideum.
Gervillia aviculoides.
Exogyra nana (v. com.).
Lima zonata (v. com.).
,, *mutabilis* (rare).
Limatula elliptica (rare).
Lithodomus inclusus (v. com.).
Perna mytiloides.
Plicatula weymouthiana (rare).
(?) *Cerithium*, large cast (rare).
Pseudomelania heddingtonensis.
Littorina muricata (v. com.).
Neritopsis decussata (rare).
Bourguetia striata.
Cidaris florigemma (v. com.).
Nucleolites scutatus (rare).
Thamnastræa concinna (v. com.).
,, *arachnoides*.
Isastræa explanata.
Thecosmilia annularis (v. com.).
Serpulæ.

JAMES BUCKMAN in 1858 recorded two species of *Stylina* and two species of *Diadema* [*Diplopodia* (?)] from Blunsdon, together with some other fossils, but the identifications are not all reliable [7].

(*d*) *The Purton District*.—The widening of the Coral Rag outcrop over the Purton anticline is accompanied, as has been already stated, by the reappearance of detrital deposits similar to those in the Oxford district. Hand-specimens of the semi-crystalline, non-oolitic white limestones of the Purton district are practically indistinguishable from hand-specimens of the Wheatley Limestones. Unfortunately, however, exposures in this district are both fewer and shallower than near Oxford.

The first indication of the return to these limestones was found in the Cold Harbour well (see p 116). Half a mile to the south-west, in a quarry at Blunsdon St. Andrew, a 2-ft. band penetrated in the well has expanded or been supplemented by others to a visible extent of 5 ft., and still continues below the base of the quarry, the whole being penetrated by veins of calcite. Above there only remain $4\frac{1}{2}$ ft. of rag. Some of the limestones are shelly, but all the shells are broken and only the ends protrude from the weathered quarry face, so that identification is difficult. Spines of *Cidaris florigemma*, *Littorina muricata*, *Exogyra nana* and *Thecosmiliæ* are conspicuous, and *Chlamys nattheimensis*, *C. fibrosus* and *Opis phillipsi* have been identified. An identical section may be seen about 2 miles to the S.E. in the fields near Sheepslaight Plantation.

Sheepslaight Plantation Quarry.

Osmington Oolite Series.	Ft.	ins.
2. Coral Rag, reef facies ; rather less fossiliferous than usual and the corals badly preserved. *Thamnastræa concinna* dominant, *Thecosmilia annularis, Isastræa explanata, Stylina tubulifera, Astarte* cf. *ovata* (small form), etc.	4	0
1. Wheatley Limestones. Very hard non-oolitic limestones, separated by softer non-oolitic bands, all apparently composed of ground-up shells and corals, but with very few recognisable fossils	5	0

The most instructive exposure of the Wheatley Limestones in the Purton district is the old quarry S.E. of Purton Church, which is still quarried to a depth of 18 ft. (see fig. 13). The upper part of the quarry consists of Coral Rag. This has a somewhat

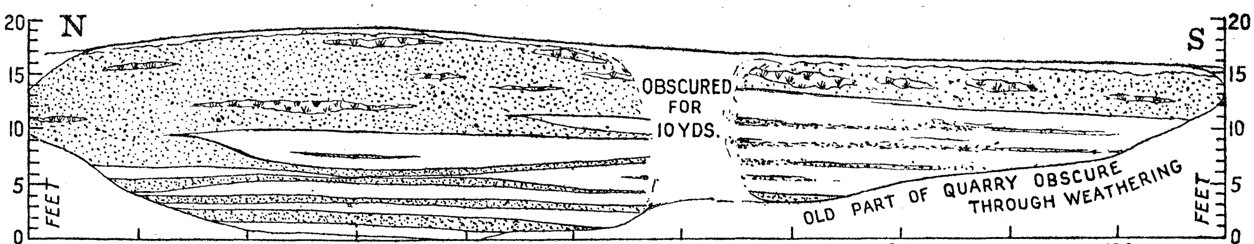


Fig. 13.—Osmington Oolite Series.—Quarry S.E. of Purton Church, showing Coral Rag (dotted) with lenticles of *Thamnastrææ*, passing into hard and soft limestone bands.

different appearance from the Coral Rag elsewhere, being more finely broken up than usual, and consisting mainly of fragments of *Thamnastræa concinna*, *T. arachnoides* and *Comoseris irradians*, while pieces of *Thecosmilia* play only a subordinate part. Besides the corals the following typical Coral Rag fossils are common :—*Cidaris florigemma*, *Littorina muricata*, *Exogyra nana*, *Lima zonata*, *Chlamys nattheimensis*, *Ctenostreon proboscideum*, *Lithodomus inclusus* and *Serpulæ*. I have also obtained *Lima rigida*, *Pseudomelania heddingtonensis* and uncertain Lamellibranch casts. At various horizons in the rubble lie sheets of *Thamnastrææ* in position of growth, forming lenticles of hard tabular coral from a few inches to a foot or more in thickness and up to 20 yards in length.

In the northern end of the quarry this rag has a thickness of 12 ft. It is underlain by a few feet of typical Wheatley Limestones, in alternate hard and soft bands, the soft bands bearing a close resemblance to the overlying rag in a more finely ground condition. The hard bands bear a very close resemblance to many of the Wheatley Limestones in the Oxford district, and some of the courses even contain the same little white pellets which give the flecked appearance to some of the bands of limestone at Lye Hill and Woodperry. *Exogyra nana* and *Cidaris florigemma* spines are abundant, but other fossils are usually fragmentary and difficult to determine ; this in spite of the fact that ground-up shells form one of the principal constituents. As we pass southward along the quarry face, higher bands of this limestone appear, until at the southern end there is almost a solid mass of limestone overlain by only 3 ft. of Coral Rag. In other words, making a slight allowance for dip—the general trend of the bedding is nearly horizontal—in a distance of about 50 yards in a northerly direction about 9 ft. of limestones merge into Coral Rag, the hard bands tapering out, while the soft bands pass into it by imperceptible gradation.

Diligent search of these limestones reveals most of the fossils found in the overlying Coral Rag, the fauna, though in bad condition, being richer than that of the limestones of Wheatley, etc., which were not formed so close to the parent reef. I have been able to double Messrs. BLAKE and HUDLESTON'S list of eight, and the complete catalogue now stands as follows (the first mentioned being the commonest) :—

FOSSILS FROM THE WHEATLEY LIMESTONES, PURTON.

Exogyra nana.	*Perna mytiloides.*
Cidaris florigemma.	*Lima zonata.*
Littorina muricata.	,, *rigida.*
Serpulæ.	,, *subantiquata.*
Chlamys nattheimensis.	*Limatula elliptica.*
,, *qualicosta.*	*Ctenostreon proboscideum.*
Velopecten velatus.	*Pseudomonotis ovalis.*
Ostrea, small sp.	*Pseudomelania heddingtonensis.*

Even were the passage into actual rag not visible, the presence in considerable abundance of *Cidaris florigemma*, *Littorina muricata* and *Lima zonata* with *Chlamys qualicosta* would be a strong argument in favour of these limestones being of the age of the Osmington Oolite rag.

Obviously this quarry is most valuable in throwing light on the age and origin of the Wheatley Limestones, the conclusions arrived at from a study of the Oxford district being entirely vindicated. It is rather remarkable, therefore, that Messrs. BLAKE and HUDLESTON not only failed to appreciate this point, but obtained an absolutely erroneous impression of the age of the rocks, correlating them with the Berkshire Oolites of Highworth [6, p. 295]. Their only grounds for this correlation appear to have been the presence of *Pseudomonotis ovalis*, which at that time had not been found so high as the Pusey Flags. It is impossible, however, to disregard (i) the lithological resemblance to the Wheatley Limestones, (ii) the fact that in the Berkshire Oolites the shells are whole and perfect, while in these rocks they are ground up, and (iii) the strong negative evidence of the absence of all the Berkshire Oolite Perisphinctids, Cardiocerates, Aspidocerates and characteristic Lamellibranchs.

A somewhat similar section at Dogridge, west of Purton, shows 5 ft. of Coral Rag overlying 14 ft. of Wheatley Limestones. The latter are here on the whole softer, being fit only for lime-burning, and are much less fossiliferous, though of the same minute composition. *Exogyra nana* is abundant at some horizons, but the only other fossils appear to be *Cidaris florigemma*, *Nucleolites scutatus* and *Chlamys nattheimensis*.

Exposures of both these types of rock are duplicated in neighbouring road-cuttings. Six feet of the limestones were exposed in 1924 beside the main road in the middle of Purton, and 5 ft. of Coral Rag at the brow of the hill leading from Dogridge to Braydon.

At the latter place *Lima zonata* is abundant, associated with *Ctenostreon proboscideum*, *Chlamys nattheimensis*, *Cidaris florigemma*, *Exogyra nana* and *Lithodomus inclusus*.

Perhaps the most striking quarry in Corallian rocks anywhere west of Lye Hill and Wheatley is that $\frac{3}{4}$ mile N.E. of Lydiard Millicent. The limestones of Purton are here laid bare in a vertical wall, 20 ft. high, and no Coral Rag is present. It is some years since this quarry was worked, and the whole has weathered into what appears to be one hard homogeneous mass of limestone. The alternation of hard and soft bands is only revealed by closer scrutiny. The smoothness of the face is broken by only a single soft band, which divides it into two courses, the lower 7 ft. and the upper 12 ft. thick. The 3 ft. subjacent to the soil are split up and softened by the weather, thus probably affording a parallel to the formation of the "Pendle" at Wheatley. Fossils are rare, except for *Exogyra nana* and *Cidaris* spines, which are evenly distributed throughout.

As in the Oxford district, these massive limestones are not continuous for more than short distances. Only half a mile N.N.E. of this exposure and a shorter distance from the Purton quarry, we find a splendid reef, and we are taken back to the conditions where "every stone is Madreporarian and the roads are all mended with magnificent specimens of *Thamnastrœa* and *Isastrœa*" [6, p. 296, in description of the Purton district].

This small reef or coral island is quarried half a mile north of Common Platt. The corals are exposed to a depth of 9 ft., throughout which they are undoubtedly in position of growth; but instead of the corals mentioned we find almost exclusively *Comoseris irradians*, growing with a luxuriance unmatched anywhere in the South of England. There is a high proportion of brown clay, in which occur all the usual reef fossils, including *Cidaris florigemma*, *Littorina muricata*, *Lima zonata* and *Chlamys nattheimensis*, as well as a few of the more usual reef-builders, *Thamnastrœa arachnoides*, *Thamnastrœa concinna*, *Isastrœa explanata* and *Thecosmilia annularis*. Some of the blocks of limestone formed of clusters of the dominant coral are of great beauty.

This growth of *Comoseris* also has only a local distribution, for in the quarry one mile to the east the other corals predominate once more. Here ordinary broken Coral Rag, with much dark clay and all the usual fossils, is exposed to a depth of 8 ft., and *Rhabdophyllia phillipsi* is added to the list. This type of rag resembles that at Blunsdon, and it may also be seen in the old road-cutting on the brow of the hill descending from Moredon to Haydon Wick. It was likewise exposed in 1925 during road-widening $\frac{1}{4}$ mile west of Moredon turning.

Only about 500 yards from the last exposure, in a quarry S.E. of Moredon turning, are seen 4 ft. of beds which cannot be matched in the direction from which we have been travelling, except perhaps in the N. quarry near Wingfield Hospital, Headington (Bed 3, p. 131). These consist of highly oolitic drab-coloured marls, soft and argillaceous towards the top, becoming rather more consolidated below. They are overlain by about 3 ft. of hard flaggy limestone, such as is often associated with the Coral Rag. The marls are even-bedded, but the regularity is disturbed towards the top by solution and the caving-in of the overlying limestones. The appearance and fossils of the latter place the bed immediately with the Osmington Oolite Coral Rag; *Exogyra nana*, *Cidaris florigemma*, *Lithodomus inclusus*, and *Littorina muricata* are numerous, and besides these *Thecosmilia annularis*, *Chlamys fibrosus* and *Modiola bipartita* occur.

When we come to the marls, however, we find a strong lithological resemblance to the Urchin Marls of the Berkshire Oolites, and we need the guidance of the fossils to convince us that we are dealing with a rock in close association with Coral Rag. The fauna, of which the first four are abundant, is as follows :—

Fossils from the Oolite, Moredon.

Cidaris florigemma (spines).	*Thamnastræa concinna.*
Diplopodia (spines).	*Limatula elliptica.*
Littorina muricata.	*Velopecten velatus.*
Exogyra nana.	*Opis phillipsi.*
Perna mytiloides.	*Lithodomus inclusus.*

We probably see here the first indication of a type of deposit alien to our district, the white oolites and pisolites, which set in south-westward of Wootton Bassett and characterise the non-coralline southern province of South Wilts and Dorset, the type facies of the Osmington Oolite Series.

Most writers have expressed the opinion that the true reef seen at Ballards Ash, N.W. of Wootton Bassett (a very old quarry, mentioned by William Smith, and the only exposure in a stretch of nearly five miles) rests upon oolite, as is seen at Greens Cleeve and Catcombe. There has been difference of opinion again as to the precise age of these oolites, but much light is thrown on the subject by the two quarries still worked near by, at Tockenham Wick.

In the quarry S. of the road 9 ft. of Coral Rag are seen, passing down into from 15 in. to 2 ft. 10 in. of partly blue-centred oolite and pisolite, containing *Thecosmilia annularis* and spines of *Cidaris florigemma*, and presumably comparable with the oolite of Moredon in a harder condition. As has previously been stated (p. 117), this oolite is separated by a softer pisolitic parting from the lithologically rather similar Shell-cum-Pebble Bed.

Fossils from the Coral Rag, Tockenham Wick.

Thecosmilia annularis.	*Velopecten velatus.*
Thamnastræa concinna.	*Chlamys nattheimensis.*
Isastræa explanata.	,, *fibrosus.*
Cidaris florigemma (test).	*Camptonectes lens.*
Diplopodia versipora (tests).	*Perna mytiloides.*
Nucleolites scutatus (tests).	*Plicatula weymouthiana.*
Littorina muricata.	*Ostrea gregaria.*
Nerita (?)	*Exogyra nana.*
Lima zonata.	*Lithodomus inclusus.*
Limatula elliptica.	*Serpulæ.*
Ctenostreon proboscideum.	*Spongia floriceps.*

This list is unusually rich for the Coral Rag. H. B. WOODWARD records other species from here, but does not specify from which beds they were obtained, but *Hemicidaris intermedia* and *Stylina* [47, p. 115] presumably came from the Coral Rag.

South-westward of Lyneham the Coral Rag appears intermittently in reef form, but it is represented in many places by the oolites and pisolites. Determinate fossils are as a rule rare, but there is no doubt that the Coral Rag passes into them at Calne, a supposition borne out by the wonderful profusion of Echinoderm tests occurring there, beneath about 20 ft. of false-bedded, poorly fossiliferous, white oolites. Some of the Echinoderms are such typical Coral Rag species as *Cidaris florigemma* and *Diplopodia versipora*, while others, like the oolites containing them, do not occur in the area immediately to the N. and N.E.

ECHINODERMS FROM CALNE.*

Acrosalenia angularis.
Cidaris florigemma.
,, *smithi.*
Glypticus hieroglyphicus.
Hemicidaris intermedia.
Diplopodia versipora.
Pseudodiadema pseudodiadema.
,, *mamillanum.*
Stomechinus gyratus.

Calne does not come within the province of this paper, but this list of Echinoderms is inserted in order to show that, palæontologically as well as lithologically, it is partially isolated from our district. It is difficult to account for these facts, except by connecting them with the analogous change which is observed in the Berkshire Oolites, and to attribute the whole to the effects of the uplift of the Purton anticline. We find final confirmation of these conclusions in a study of the Upper Calcareous Grit.

(*e*) *The Littlemore Clay Beds.*—It is well known that at Littlemore near Oxford, and at Hilmarton, Wiltshire, the Lower Calcareous Grit is succeeded by Corallian Clays. These clays raise such interesting points that it is considered desirable to treat of them in a separate subsection, together with similar beds which, it is less generally known, occur at two intervening places. The beds consist of alternate bands of blue-grey clay and nodular, white-weathering, argillaceous limestone or mudstone, in layers a few inches in thickness. The areas where they occur are very limited in extent, and pass through to the inner or shore side of the reef. With regard to their age, it can be seen that these beds pass laterally into Coral Rag, and at Littlemore they plainly overlie the representative of the Berkshire Oolites.

Two explanations are possible. Either the clays are a continuation of the Ampthill Clays, which we may presume were being laid down in the deeper water along the seaward side of the reef (over the present Lower Oolite outcrop), which for some reason tongued into the reef at these points, dissecting it with deep-water channels, or, alternatively,

* A fine collection may be seen in the Wiltshire Museum, Devizes.

coral growth at these points was checked by muddy sediment brought down from the land by rivers and streams. The latter theory was first propounded to account for the clays of Littlemore by Mr. E. S. COBBOLD [10], and an examination of the field evidence leads us to the conclusion that it is the correct explanation.

The best section is the very fine one in the railway cutting at Littlemore. The clay

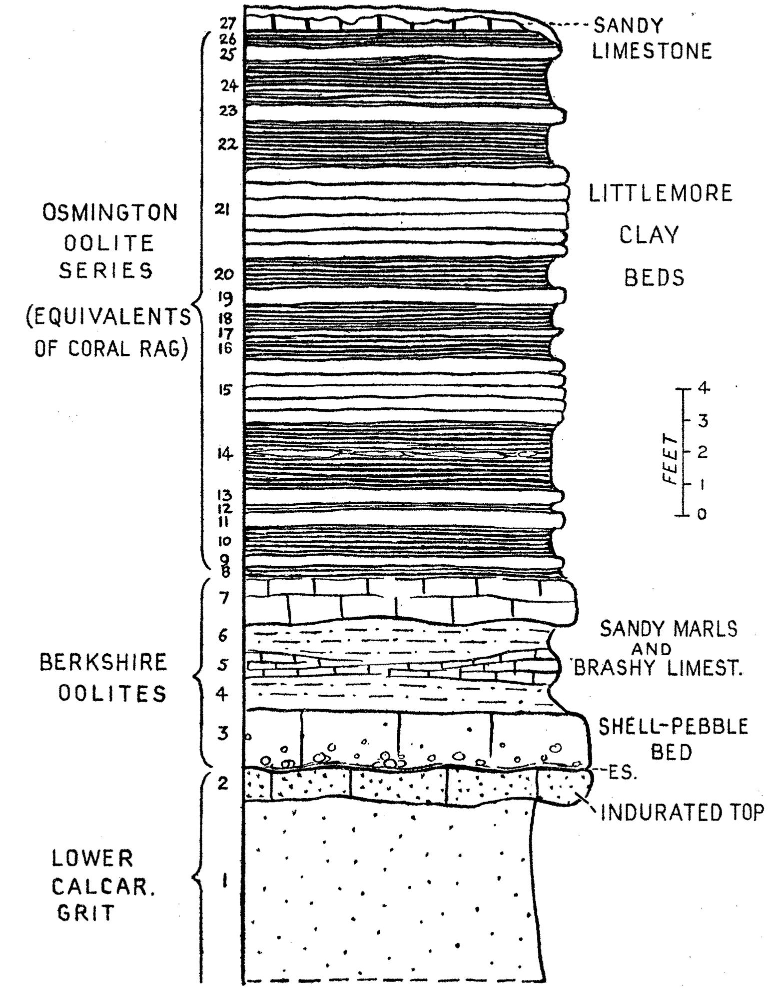


FIG. 14.—Littlemore Railway Cutting, showing type section of the Littlemore Clay Beds, which pass laterally into Coral Rag. Beds numbered after Mr. J. PRINGLE.

beds here have a thickness of about 17 ft., comprising 20 bands of clay separated by as many of nodular, grey, white-weathering, argillaceous limestone. The upward passage from the Berkshire Oolites is moderately abrupt. The section has recently been described by Mr. J. PRINGLE [32 and 33] and, since I cannot improve on his description, I append a condensation of it, adding my own interpretations and fossil lists. The details are shown in fig. 14.

Littlemore Railway Cutting Quarry.

	Ft.	ins.
Osmington Oolite Series.		
27. Greyish-white sandy limestone, slightly oolitic, with fragment of a Perisphinctid	0	6
8–26. Littlemore Clay Beds. Alternate layers of brownish-black clay and white-weathering argillaceous limestone, the layers varying from 3 in. to 2 ft. Fragile fragments of the casts of Perisphinctids found in Beds 15 and 21	17	3

Perisphinctes spp.
Belemnites oxyrrhynchus.
Pleurotomaria munsteri.
Lima rigida.
,, *mutabilis.*
Ctenostreon proboscideum.
Astarte ovata.
Isocyprina cyreniformis.
Placunopsis radiatus.
Camptonectes lens.
Chlamys nattheimensis.
,, *fibrosus.*
Pholadomya canaliculata.
Lithodomus inclusus.
Exogyra nana.
Serpula intestinalis.
Cidaris smithi.
,, *florigemma.*

	Ft.	ins.
Berkshire Oolite Series.		
7. Shelly limestone with *Aspidoceras* sp. passing up into above	2	0

Chlamys fibrosus.
Camptonectes lens.
Lima rigida.
Gervillia aviculoides.
Exogyra nana.
Pseudomelania heddingtonensis.
Nucleolites scutatus.
Serpula intestinalis.

	Ft.	ins.
6. Buff shelly sand, crowded with small specimens of *Pecten fibrosus* and *Exogyra nana* .10 in. to	1	0

Perisphinctes sp.
Gervillia aviculoides.
Ostrea large sp. like *O. quadrangularis.*
Pseudomelania heddingtonensis.
Exogyra nana.
Serpula intestinalis.

	Ft.	ins.
5. Brownish-grey sandy, marly limestone, variable in thickness ; *Exogyra nana, Serpulæ* 0 in. to	1	0
4. Brown shell sand with *Pecten fibrosus, Exogyra nana* and *Serpulæ,* resting on irregular surface of Bed 3	1	3
3. Shell-cum-Pebble Bed. Dark grey gritty limestone, containing in upper part *Perisphinctes* cf. *antecedens,* Salfeld (and *Perisphinctes* of *wartæ* style. I cannot agree with this—W. J. A.). At base is a shelly layer with small pebbles of chert and quartz and grey limestone. *Perisphinctes* aff. *martelli,* Oppel, and *Anacardioceras excavatum,* (J. Sow.) ; cemented firmly on to Bed 2	2	0

Cardioceras cf. (?) *pingue.*
Belemnites oxyrrhynchus.
Trigonia meriani.
Gervillia aviculoides.
Lima rigida.
,, *mutabilis.*
Camptonectes lens.
Chlamys splendens.
,, *fibrosus.*
Ostrea sp.
Exogyra nana.
Pleuromya tellina.
Nucleolites scutatus.
Serpulæ.

	Ft.	ins.
Lower Calcareous Grit.		
2. Dark grey calcareous sandstone, the indurated top of the underlying sands . . . . . .0 to	0	10
1. Buff sands, with spherical elongated masses of hard grey calcareous sandstone on three levels. The middle band forms a fairly constant layer, 1 ft. to 1 ft. 3 in. thick	15	0

Mr. BUCKMAN has published identifications of the fragments of Perisphinctids found in Beds 15, 21 and 27, and he assigns them to the following species:—*Perisphinctes* cf. *gerontoides*, SIEM, *Perisphinctes* cf. *linki*, CHOFFAT, *Ataxioceras* cf. *bifurcatus*, SIEM, *Perisphinctes tizianiformis*, CHOFFAT, and *Perisphinctes* cf. *bolobanowi*, NIKITIN. He also includes them in his list of hemeræ, thereby claiming that these beds are higher than any others exposed in the Oxford district [9, pp. 61, 67].

I had the pleasure of being present while Mr. PRINGLE was measuring and describing this quarry, and saw the specimens, and in addition I have found other specimens myself. I feel bound to state that, in my opinion, the small size of the material (Perisphinctids are almost impossible to identify in the young state), their fragmentary and crumbling condition, and the complete absence of suture lines, admit of little foundation for these identifications or for the resulting hemeral conclusions. It is purely a matter of opinion whether the material does not resemble the young stages of some of the Berkshire Oolite forms just as closely as the species suggested by Mr. BUCKMAN, the forward peripheral sweep of the ribbing being equally pronounced in some of the common Perisphinctids from the Berkshire Oolites of Berkshire and Wiltshire, and more pronounced in others from the Ampthill Clay.

Attention is drawn by Mr. PRINGLE to a noticeable feature in one part of the quarry, where about 6 ft. of the evenly bedded strata, lying slightly above the middle, merge abruptly into a mass of nodular chalky limestone. The surfaces of the nodules are covered by clusters of *Exogyra nana* and *Serpula intestinalis*, and these organisms of themselves occasionally form ball-like masses. It appears that this is the transverse section of a shoal or shell-bank, running E. and W., and there are indications of a similar and parallel bank a few yards farther south, in the older part of the cutting. They may be taken to indicate estuarine conditions, and from their trend it would appear that the direction of the current was either northerly or southerly.

Exactly similar bands of clay and limestone appear on the western side of the Thames in Bagley Wood, where they are exposed to a depth of 14 ft. The Littlemore succession can be recognised almost bed for bed, but fossils are more numerous. The presence of *Trigonia perlata* towards the base may indicate that the lower part of the beds are of Berkshire Oolite age, but more probably it merely shows that *Trigoniæ*, like the Ammonoidea, survived here, in the absence of corals, into the early part of the Osmington Oolite period. The following are added to the fauna:—

Trigonia perlata.	*Pseudomelania heddingtonensis.*
Isocyprina cyreniformis.	*Natica arguta.*
Perna mytiloides.	,, *clytia.*
Pholadomya hemicardia.	*Cidaris florigemma.*
Pleuromya tellina.	*Holectypus corallinus.*

There is no indication of what becomes of these clay beds in a northerly or southerly direction, but eastward and westward they undoubtedly pass into Coral Rag or the equivalent limestones. A mile and a half west of the Bagley Wood quarry, at Sunningwell and Wootton, Wheatley Limestones reappear, the transition being sealed beneath the promontory of Kimeridge Clay and Lower Greensand forming Boars Hill. To the east the nearest quarries, those at Bullingdon Green, 2 miles N.E. of Littlemore, show normal Coral Rag. In a southerly direction there are no exposures, and directly north the Corallian has been removed altogether by the Thames, which now flows over a narrow plain of Oxford Clay. Two and a half miles N.W., however, on the edge of the Thames Valley, some clue remains of the former extension of the Littlemore Clay Beds. At North Hinksey a quarry shows about 10 ft. of impure clay with an admixture of rubbly limestone, in which occur huge disconnected blocks of Thamnastræan and Isastræan corals, encrusted with *Serpulæ* and *Exogyræ*. The section is unlike any other in the district, and suggests very forcibly a reef which has been continually smothered by pollution of the water with muddy sediment.

Ferry Hinksey Quarry.

	Ft.	ins.
Osmington Oolite Series.		
4. Wheatley Limestones and Rag (exposed in trial opening above main quarry). Very massive corals interstratified with structureless Wheatley Limestones	8	0
3. Coral Rag, showing transition to Littlemore Clays. Blue-grey clay with high proportion of rubbly *Thecosmiliæ* in a peculiar calcitic condition; the inter-septal spaces are filled with blue-grey mudstone, and the septa and epitheca are in the form of transparent calcite pseudomorphs. Occasionally there are bands of pure bluish clay. *Lima zonata* is common. In this clayey rubble are suspended large isolated masses of *Thamnastræa* and *Isastræa*, covered with *Serpulæ* and *Exogyræ*. In the top 2 ft. these reef-builders, together with *Comoseris irradians*, preponderate, and the rock assumes the aspect of normal Coral Rag .	12	0
Berkshire Oolite Series.		
2. Shell-cum-Pebble Bed. Impersistent band of hard, mottled grey and brown, fairly shelly, oolitic limestone, containing grey limestone pebbles bored by *Lithodomus inclusus* and pebbles of "lydite" and quartz . . . . 0 to	2	0

Camptonectes lens.	*Modiola bipartita.*
Chlamys splendens.	*Trichites giganteus.*
,, *fibrosus.*	*Exogyra nana.*
Isocyprina cyreniformis.	*Pseudomelania heddingtonensis.*
Gervillia aviculoides.	*Pleurotomaria reticulata.*
Perna mytiloides.	*Natica arguta.*
Lima rigida.	*Cidaris* spines.
Limatula elliptica.	*Serpulæ.*

	Ft.	ins.
Lower Calcareous Grit.		
1. Yellow sand with a band of doggers $3\frac{1}{2}$ ft. down	14	0

We saw that all the evidence of the Lower Calcareous Grit pointed to a river flowing into the sea to the S. of Oxford in that period, bringing vast quantities of sand and pebbles. Further, we saw the diminished influence of this river throughout Berkshire Oolite times in the sandy condition of the Shell-cum-Pebble Bed and the sands above it at Bullingdon, Cowley, Littlemore and Bagley Wood, and in the interlaminated sand and clay separating the Trigonia Beds at Marcham. Now, in the Osmington Oolite period, when coral reefs were growing upon the old sandbank piled up by this river in its more vigorous youth, we find muddy sediment entering the same corner of the district. The inference is that the same river, in common with lesser streams farther W., had now approached nearer its base level, and was bringing mud where formerly it brought sand and pebbles—the natural cycle of all rivers, the effects of which are so often displayed in the so-called " Tripartite Series " of the English Jurassic.

If we have rightly interpreted the North Hinksey section as denoting the edge of the area formerly occupied by the Littlemore Clay Beds (where coral growth was not quite extinguished), then the course of the river through the coral islands to the open sea probably lay northwards, between the hills of Wytham and Elsfield. The path of the old river, in fact, coincided with that of the Thames, but stoped in the opposite direction. This may be more than mere coincidence. Tertiary denudation would have lowered the clays to a greater extent than the surrounding limestones, and a weak spot would have been prepared, providing the easiest southward passage for the Thames.*

The neighbourhood of Littlemore has been treated in some detail because it embodies features common to all the three more westerly occurrences of the Littlemore Clay Beds, which only differ in that, while here they may be studied first-hand in excellent exposures, there we have to rely chiefly upon former records for our information, and the conclusions by themselves would seem correspondingly insecure.

The next occurrence is north of Swindon, where our only source of information is a description of " a cutting on the M.S.W.J. Railway, east of Sparsholt (Sparcell's) Farm (where the G.W.R. crosses), which showed a good section of the Upper Corallian rocks," by H. B. Woodward [47, p. 117]. This cutting is now entirely overgrown, and no other exposures exist. According to that writer, " South of the bridge the beds consist of grey earthy limestone and clay, with layers of compact coral rock, with *Thecosmilia annularis*, Sponge-remains, *Lithodomus inclusus* and *Gastrochœna recondita* (?) North of the bridge we find at the base, beds of grey clay with bands of rubbly irregular grey marly and septarian limestone, containing [*Ctenostreon proboscideum*], *Exogyra nana* and *Cidaris florigemma*. Above there is a seam of black carbonaceous clay, and, on top, clay with two layers of stone that coalesce towards the North. Here again *Cidaris* is met with. The thickness near the bridge is about 12 ft., but altogether about 20 ft. of Corallian beds are shown." This description would not apply exactly to the beds at Littlemore, but it is more applicable to them than to any other known Corallian rock.

The area covered by these clay beds seems to be of very limited extent. That it

* The route over the clay lowlands east of Shotover Hill was probably stopped by the Portlandian and Cretaceous rocks, more recently breached by the Thame. Rocks of this age still modify to a considerable extent the course of the Thames at Nuneham.

cannot be more than a mile wide is proved by the occurrence of Coral Rag in the exposures N. of Common Platt and W. of Moredon. Light is thrown on its southerly extension by the deep boring at the G.W.R. works at Swindon, in which the highest 22 ft. of the Corallian consisted predominantly of clays; in fact, it is only when viewed in this light that the record of that boring becomes intelligible [44, No. 158, pp. 85, 86]. Here, then, as at Littlemore, the continuity of the coral reef was interrupted by a long, narrow channel filled with muddy sediments, and the most reasonable explanation seems to be that through this channel the waters of a stream found their way to the open sea from the land to the S.E.

After studying the gap of the Thames at Sandford and that of the Ray north of Swindon, it was natural to seek to account in the same way for the next important gap in the Corallian escarpment, that utilised by the G.W.R. main line at Wootton Bassett. Here, it may be observed, the Lower Calcareous Grit is absent, and the Oxford and Kimeridge Clays were mapped by the Survey as in contact—a complete failure of the Corallian, which seemed inexplicable. Unfortunately no good exposures now exist at this important point, but the clays were cut through some 25 years ago during the construction of the new Badminton line to South Wales, and the record of the cutting was preserved by Prof. Reynolds, who collected sufficient fossils to prove that the Upper Corallian here takes on a clay facies comparable with that at Littlemore. It seems worth while to repeat Prof. Reynolds' description [36]:—

Section in the Railway Cutting at the Road Bridge West of Wootton Bassett Station.

By Prof. S. H. Reynolds, 1902.

	Ft.
Corallian.	
4. Clay, with hard bands not markedly pisolitic, the hard bands predominating at top . . seen	20
3. Hard pisolite, with a thin irregular band of black clay, sometimes pisolitic	4
2. Pisolitic clay	1
Oxford Clay.	
1. Stiff dark-blue clay with *Thracia*, becoming more sandy above	9½

Prof. Reynolds remarks that *Cidaris florigemma* and *Ostrea* sp. (*Exogyra nana ?*) were common in all the beds above the Oxford Clay, and that *Thecosmilia annularis*, *Chemnitzia* and *Belemnites abbreviatus* also occurred. The presence of the pisolite at the base is noteworthy, in view of what has previously been said in connection with the pisolite underlying the Coral Rag at Banners Ash and Tockenham Wick.

The last occurrence of Littlemore Clay Beds is that at Hilmarton. It lies, strictly speaking, outside our area, but no account of these beds would be complete without a mention of it. In an old quarry E. of the village, 7 ft. of clays alternating with bands of nodular, white-weathering, argillaceous limestone are still exposed. The quarry was described and figured by BLAKE and HUDLESTON in 1877, when work was still in progress and a deeper section lay open [6, pp. 291, 292].

The following is the emended fossil list, based on the list of BLAKE and HUDLESTON and my own collecting :—

FOSSILS FROM THE LITTLEMORE CLAY BEDS, HILMARTON.

Astarte ovata.
,, *subdepressa.*
Chlamys nattheimensis.
,, *qualicosta.*
Ostrea gregaria.
Mytilus ungulatus.
Perna mytiloides.
Pholadomya æqualis.
Ctenostreon proboscideum.
Isocyprina cyreniformis.
Exogyra nana.
Lima rigida.
,, *zonata.*
Limatula elliptica.
Lithodomus inclusus.
Lucina goldfussi.
Cidaris florigemma.
,, *smithi.*
Diplopodia versipora.
Rhabdophyllia phillipsi.
Thecosmilia.
Thamnastræa.
Plicatula weymouthiana.
Velopecten velatus.
Alaria sp. (cf. *tenuistria*, BUV.).
Pseudomelania heddingtonensis.
Littorina muricata.
Terebratula insignis.
Ornithella margarita.
Thecidium ornatum.
Parendea bullata.

This rich fauna shows more affinity with the Osmington Oolite Coral Rag than with any other part of the Corallian, even the occurrence of *Astarte ovata* being paralleled in the base of the Littlemore section. A further analogy between this and the other occurrences of the Littlemore Clay Beds lies in the fact that the Corallian escarpment is here breached by a modern stream, a tributary of the River Marden.

If we follow the outcrop of the Corallian southward into Dorsetshire we find the same type of rock repeated at intervals in other localities, always in the same stratigraphical position but varying greatly in the richness of its fauna, according probably to the distance from the nearest reefs and the source of the mud-bearing currents. In the deep road-cutting S. of Sturminster Newton, Dorset, the clays and nodular mudstone bands are exposed to a thickness of 12 ft.; here they are rich in *Nucleolites scutatus* and other fossils, including *Chlamys qualicosta*. They separate the basal pisolite of Dorset from the false-bedded series of the Marnhull and Todber Freestones. In the railway cutting N. of the town much of the clays has probably passed laterally into the base of the false-bedded series, as the latter appear not far above the pisolite; the cutting is becoming obscured, however. Another development of the Littlemore Clay Beds seems to be indicated at Marnhull and Todber by Messrs. BLAKE and HUDLESTON'S mention of "hard blue marl with small stones, 17 ft.," which they were informed underlay the false-bedded series of the freestones.

Finally, we encounter the finest development of all in the cliffs E. of Osmington Mills, where at least 35 ft. of the total 60 ft. of the Osmington Oolite Series consists of these alternate bands of clay and mudstone, bearing a remarkable resemblance to the type section at Littlemore.

The four facies of the Osmington Oolite Series may be conveniently represented as follows :—

Northern Coralline Area (Wilts, Berks). Deposits.		Conditions.		Southern Area (Dorset) still Uncolonised by Corals. Deposits.
Coral Rag	←	Coral Reefs		
Wheatley Limestones	←	Clear Water (grinding the reefs)	→	White Oolites and pisolites.
Littlemore Clay Beds	←	Muddy Currents (preventing coral growth)	→	Littlemore Clay Beds.

VI.—The Upper Calcareous Grit Period and the Trigonia clavellata Beds.

As has already been remarked, the *Trigonia clavellata* Beds of Dorsetshire are so far unknown in our area, but they may reasonably be expected to occur in the centre of the district about Shrivenham and South Marston. The record of a "shell bed" at this horizon in a well at Shrivenham is suggestive [5, p. 74]. The Red Down boring, Highworth, passed through 8 ft. of limestones with bands of clay above the Coral Rag, but there is no palæontological evidence to show whether these represent the *Trigonia clavellata* Beds or are merely Wheatley Limestones belonging to the underlying Osmington Oolite Series. A small sample pointed rather to the latter view being the correct one. The only other hint of beds which may represent this period is a band of sandy, shelly, cream-coloured limestone, overlying the Littlemore Clay Beds, in Littlemore cutting (Bed 27, fig. 14). The same bed was exposed in 1925 during the laying of a pipe-line beside the road from Kennington to Radley, a quarter of a mile south of Little London, where Kimeridge Clay was seen resting directly upon it. No *Trigoniæ* were found, nor any other fossils by which the age of the rock could be determined more precisely than was suggested by its stratigraphical position. An indeterminate fragment of a *Perisphinctes* was found in the bed at Littlemore.

Concerning the Upper Calcareous Grit in our area we have more definite evidence, although in these beds no permanent exposure has ever, so far as I am aware, been opened. Over the area of the Oxford Anticline the Upper Calcareous Grit is entirely missing and Kimeridge Clay rests upon a marked eroded surface of the Coral Rag or Wheatley Limestones. The junction may be seen in a quarry at the foot of Shotover Hill beside the London coach road. This quarry was noticed by Prof. Phillips, who, as early as 1871, called attention to the profound break to which it testifies at the base of the Kimeridge Clay [29, p. 299]. Time has now much defaced the section, and I therefore quote a description by H. B. Woodward, adding my own interpretations in square brackets :—

Quarry at the Foot of Shotover Hill [47, p. 131].

	Ft.	ins.
[Kimeridge Clay.]		
6. Dark bluish-grey clay with Saurian bones, *Ammonites*, *Ostrea deltoidea*, and large crystals of selenite.		
5. Grey racy clay.		
4. Marly layer }		
[Osmington Oolite Series; Wheatley Limestones, decomposing at top into "Pendle"] }	1	0
3. False-bedded sandy rock (decomposed) and passing down into bed beneath; with Bed 4 }		
2. Hard grey shelly limestone	1	6
1. Coral rock, with bands of hard grey shelly limestone (building-stone); few fossils	12	0

A similar section was temporarily exposed in 1925 during the widening of the Oxford–Thame road E. of Shotover Lodge. Here Mr. Pringle [33, p. 63] recorded Kimeridge Clay of the *Rasenia cymodoce* zone, resting directly upon Wheatley Limestone, so that not only are the *Trigonia clavellata* Beds and the whole of the Upper Calcareous Grit missing, but also the basal zone of the Kimeridge Clay (zone of *Pictonia baylei*).

How far westward the state of affairs indicated in these sections continues is uncertain from field indications. West of Marcham an old Kimeridge Clay pit formerly penetrated to ferruginous beds above the Coral Rag, and highly ferruginous specimens of *Rhynchonella inconstans* from this locality are preserved in Oxford University Museum. This bed is probably the same as the "peculiar bright red earthy layer, from 4 to 6 in. thick" with *Rh. inconstans*, which was described by E. S. Cobbold at Sandford-on-Thames [10, p. 318]. Since in Dorset and elsewhere the first appearance of *Rh. inconstans* is always taken to mark the beginning of the Kimeridge Clay, we must assign this bed to the Kimeridgian rather than to the Upper Calcareous Grit. Here the red colour may be due to the decomposition of pyrites to limonite in the overlying clays, as suggested by Mr. J. Pringle [33, p. 69], rather than to the presence of any ferruginous Upper Calcareous Grit.

Indications of red rocks of greater importance begin to appear towards Charney Bassett and Stanford in the Vale, and in quarries at the latter place and at Shellingford Cross-Roads over 3 ft. of bright red earthy clay overlies the Coral Rag and merges upward into the red soil. The tongue of Kimeridge Clay capped with Lower Greensand, which projects N. to Faringdon and Badbury Hill, seems to overstep this red feature. No section of the junction is now exposed, so that the following description by Blake and Hudleston of the old clay pit near the Wantage road, W. of Faringdon Folly, is of considerable interest.

Section in Faringdon Clay Pit [6, p. 301].

	Ft.	ins.
4. Solid pale grey unstratified Kimeridge Clay	6	0
3. Gradual passage into a reddish-brown porous earth	0	9
2. Chocolate-coloured ferruginous earth, with black stains from dissolved fossils, and lumps of calcareous clay, ironstone, and fragments of *Ostrea deltoidea* and *Serpula* towards the base	1	2
1. Coral Rag, with the surface and fissures iron-stained	3	4

The signs of erosion here at the base of the Kimeridge Clay did not escape BLAKE and HUDLESTON, who comment as follows [*loc. cit.*]: "This shows us the fragment of ferruginous beds which here and there appear to have escaped removal by denudation before the formation of the Kimeridge Clay. . . . They remind us . . . of the great development of this class of rock at Sandsfoot Castle (Weymouth)."

Returning down the dip-slope on the W. side of the N.-projecting promontory of younger rocks, we find ferruginous sands and clays forming an increasingly important feature above the Coral Rag, and at this point they begin to be mapped by the Survey as Upper Calcareous Grit. The outcrop widens rapidly, until at Shrivenham it becomes quite a prominent feature, forming a small sand escarpment rising above the Coral Rag plateau. The sands are best developed at Sandhill Farm, N.W. of Shrivenham. No fossils are yet known from them. There are some indications at this point of a clay beneath, but exposures are scanty, being confined to rabbit-burrows and ditches.

Southward down the dip-slope we pass on to a typical oolitic iron ore. This iron ore was cut through during the construction of the now derelict Wilts and Berks Canal in the early years of the nineteenth century, and happily the exposure came under the notice of Dean BUCKLAND of Oxford, the remains of whose collection still survive in the University Museum, and other geologists, who deposited their finds in the British Museum. The collections contain some fine *Ringsteadiæ* in an ironshot oolite matrix, labelled "Marston, near Swindon," which can only have come from this source. Some have been figured by Dr. SALFELD in his monograph, one species being called *R. Marstonensis* [39].

We may thus correlate the oolitic iron ore and the underlying grit and clays directly with the Westbury section and so with the Dorset coast.

WEYMOUTH.	WESTBURY.	SHRIVENHAM.
Ringstead Coral Bed, 8 ins.	—	—
Oolitic Iron Ore (Wyke), passing into clays with red clay-ironstone nodules. *Ringsteadiæ* common, *c.* 10 ft.	Oolitic Iron Ore with abundant *Ringsteadiæ*, 11–14 ft.	Oolitic Iron Ore with *Ringsteadiæ* *c.* 10 ft. (?)
Sandsfoot Grits; chiefly ferruginous sands with subordinate clays, 6–30 ft.	Ferruginous Grits, 4–7 ft. . .	Ferruginous Grits and subordinate clays. *c.* 20 ft. (?)
Sandsfoot Clay, 20–30 ft.	—	Clay, locally replacing grit to 20 ft.

Judging from several widely divergent well-records at Shrivenham these beds are very variable and interdigitate with clays [5, pp. 73, 74]. All the records agree in one respect, however, namely, that ferruginous sandy beds alternate to a variable extent with clays up to 35 ft. above the Coral Rag.

On the outliers of Red Down and Queenlains Farm, S. of Highworth, the soil is bright red, but the rock overlying the Coral Rag is chiefly clay. The Red Down boring penetrated 23 ft. of clay, with a thin ironstone band 3 ft. below the surface. A sample of this contains no determinate fossils and is only sparsely oolitic. It is probable that this represents the Westbury Iron Ore, the 20 ft. of clays beneath it representing the sands at Shrivenham (since the locality is farther from the direction in which we may suppose the coastline to have lain). The possibility must not be excluded, however, that the clay may be, in part or wholly, true Kimeridge Clay, containing a development of ironstone on the horizon of that at Abbotsbury (*Rasenia* zone).

W. of the village of South Marston all ferruginous beds come to an abrupt termination and, over the area affected by the Purton Anticline, Kimeridge Clay rests once more upon Coral Rag. A thin seam of ferruginous matter is reported to have been passed through in the Swindon boring, but none of the old clay pits at Swindon penetrated down to the Corallian. Direct evidence may be obtained at the present time, however, in Mr. ILES' brickyard near the cross-roads at Lower Stratton, where Ermine Street crosses the railway. About a hundred yards N. of the brickyard Coral Rag crops out at the surface, dipping S. beneath the brickyard. In the brick pit pure blue-grey brick clays are dug to within a few feet of the top of the Coral Rag, and these clays to the base contain layers of cement-stone "crackers," with *Pictoniæ, Raseniæ* and rarely *Amœbocerates*. Here the failure of the Upper Calcareous Grit is apparently complete and abrupt.

S.W. of the area affected by the Purton Anticline the ferruginous beds reappear near Tockenham Wick and Wootton Bassett, whence they form an impersistent feature southward to Westbury and into Dorsetshire. Their apparent occasional disappearance is probably due to local lateral passage wholly or partly into clays. The old brickyard at Wootton Bassett formerly penetrated to the equivalents of the oolitic iron ore, which yielded abundant *Ringsteadiæ*. (Many may be seen in the British Museum.)

In this connection it is interesting to turn to the opposite extremity of our area, the Ampthill Clay region, N.E. of the Oxford Anticline, and to enquire whether there also the normal succession of zones is present. Mr. J. PRINGLE writes: "It would appear . . . that the marked stratigraphical break between the Corallian and Kimeridge formations in the Oxford neighbourhood is less perceptible at Brill" [33, p. 75]. At Rids Hill Brickyard the Upper Calcareous Grit appears to be represented by a considerable thickness (14 ft. seen to base of pit) of clays with *Perisphinctes decipiens*, a Sandsfoot Grit fossil, and Mr. PRINGLE considers that the well-known Brill Serpulite Bed with *Prionodoceras superstes* represents the *Pictonia* zone.

VII.—THE AMPTHILL CLAY.

No account of the Corallian formation of Oxfordshire would be complete without a reference to the Ampthill Clay region. For that reason I shall touch briefly upon some of its more general aspects, although no new sections have come under my notice during the course of the present work. The principal question which concerns us here is that of correlation with the shallow-water facies to the S.W. It has already been stated that the replacement of this shallow-water facies by clays occurs with surprising abruptness

N.E. of the Oxford Anticline, coincidently with the appearance of the *Rhaxella* chert or Arngrove Stone at the base of the Lower Calcareous Grit.*

For our knowledge of the Ampthill Clay of this region, as of the Arngrove Stone, we are indebted to Dr. A. MORLEY DAVIES. In a paper published in 1916 he gives a general correlation of the clays between Wheatley and Sandy, illustrated by a diagram; this diagram shows an eastward overstepping of the Oxfordien (in HAUG'S sense) by the Ampthill Clay, which is shown as equivalent to the "Coral Rag" [24, p. 399]. Here the Coral Rag is evidently taken to mean the whole of the "Upper Corallian" of the Survey, but the whole is assigned to the *martelli* zone. The *martelli* zone is an unsatisfactory stratigraphical-chronological term, for several reasons. First because it is not sufficiently precise, being here taken to include the whole of our Berkshire Oolites and Osmington Oolites; secondly, because of the specific uncertainty of the index fossil, of which the writer only knows a single specimen from our district really comparable with the holotype, although the district is so uncommonly rich in Perisphinctids.

In default of new exposures it would not be possible to improve on this account of the Ampthill Clay. But between 1907 and 1909 a magnificent section was opened in the cutting for the G.W. Railway near Ashendon Junction, of which Dr. MORLEY DAVIES has been so kind as to place an unpublished description at my disposal, together with his collection of fossils made at the same time. This description I now append, with his permission, in amplification of the general account of the cutting already published by him [23] [24]. With the aid of the fossils it is possible to draw, with some degree of certainty, some interesting conclusions regarding the ages of the various parts of the Ampthill Clay.

GENERALISED SECTION IN THE CUTTINGS ON THE G.W.R. BETWEEN ASHENDON JUNCTION AND THE RUSHBEDS WOOD TUNNEL.

By Dr. A. MORLEY DAVIES.

	Ft.
AMPTHILL CLAY.	
7. Pale grey clay with small Selenite crystals	30
6. Stone-band with Perisphinctids, less than	1
5. Clay	10
4. Three 9-in. stone-bands (not fossiliferous) with clay between . . . about	5
3. Drab clay with fossils, both in the clay and in concretions	4
2. *Exogyra nana* beds, very variable: clay, brown, blue-grey or white, often full of race; calcareous clay with many brown oolite grains; marly limestone; fine compact sand, etc., *E. nana* abundant, spines of *Cidaris smithi* common, spines of *C. florigemma* rare, many *Serpulæ*, small belemnites, etc., etc. . . . 6 to	10 or more.
OXFORD CLAY.	
1. Clay weathering grey, with many large *Gryphæa dilatata*, with Cardiocerates of the *præcordatum* and *tenuicostatum* type.	

* For general account and references, see [47], p. 134 *et.. seq.*

Beginning at the base of this section, the *Exogyra nana* beds first claim attention. The mass of this small oyster, associated with *Cidaris* spines, at once suggests equivalence with the lower parts of the Wheatley Limestones and Littlemore Clay Beds, in other words, with the Osmington Oolite Coral Rag. In Dr. MORLEY DAVIES' collection there is a good specimen of *Chlamys nattheimensis*, which suggests that corals were not, in fact, far distant at the time that the *Exogyra nana* lived. Beds 3, 4 and 5 also answer well to the description of the Littlemore Clay Beds, differing only in the higher proportion of clays to stone bands. This would give the Littlemore Clay Beds here a thickness of about 25 ft., a reasonable comparison with Littlemore, where the thickness is about 18 ft.

There is, however, in Dr. MORLEY DAVIES' collection a thick-whorled Perisphinctid from Bed 2 agreeing exactly with some in my own collection from the Shell-cum-Pebble Bed of Cowley. The excess of *Cidaris smithi* over *C. florigemma* I also take to be indicative of the earlier Berkshire Oolite Coral Rag, rather than the later rag of Osmington Oolite age. It would seem probable, therefore, that the Berkshire Oolites are represented in an argillaceous form, greatly reduced in thickness and possibly even rearranged, at the base of the *Exogyra nana* Bed. If that is so there is not here such an extensive stratal failure as has previously been implied, and we have only the horizon of the Pebble Bed (base of the Berkshire Oolites or Argovien = base of the Continental shallow-water episode) resting upon the highest zone of the Oxford Clay, a condition with which we are already familiar at Purton, Wilts. The greater part of Beds 2–5 must, however, be taken to represent the Osmington Oolite Series, or Rauracien.

We are now left with 31 ft. of beds at the top of the section, which bring the total thickness of strata assigned by Dr. MORLEY DAVIES to the Corallian up to 55–60 ft., three times the thickness of the Ampthill Clay in Cambridgeshire according to Dr. RASTALL [35, p. 209], and nearly three times the thickness of the "Upper Corallian" in most of the quarries about Oxford.

At this point the fauna of the "stone-band with Perisphinctids," Bed 6, comes to our aid. The Perisphinctids are, in fact, finely ribbed, narrow-whorled forms, some approaching the *P. wartæ* type, others with a very pronounced forward sweep of the ribbing on the periphery. The latter character has been taken by Mr. BUCKMAN to be indicative of a high horizon for the Perisphinctids from the Littlemore Clay Beds [9, p. 61], but whereas specimens have been obtained from Lower horizons comparable with the Littlemore examples, in no instance at Littlemore has this forward sweep on the periphery occurred to such a marked degree as in the examples from Bed 6 at Ashendon. The most conspicuous fossils after the Perisphinctids in this stone band are *Alariæ*, of types occurring in the *Trigonia clavellata* Beds and in the higher parts of the Osmington Oolite Series of Dorset. This fossil band tells us definitely, I think, that we have here an horizon probably equivalent to some part of the *Trigonia clavellata* Beds of Dorsetshire.

It follows from this that the highest 30 ft. of the Ampthill Clay are Sequanien, the probability of which has long been suggested to the writer by the aspect of the oysters of the *deltoidea* and *discoidea* types. The *Trigonia clavellata* Beds in Dorset are succeeded by the Sandsfoot Clay, 40 ft. thick, yielding just such oysters, and we have seen 20 ft. of the same clay in Wiltshire, where it may also replace in part the succeeding Sandsfoot Grits. The upward continuation of the Ashendon section has already been described in Rids Hill Brickyard, BRILL (p. 151), which, if Mr. PRINGLE's interpretation is the right one, fits on to the Ashendon section with but little break, and possibly even with a few feet of overlap.

In conclusion we may note that Ashendon, where this great development of Sequanian clays occurs, is almost exactly midway between Dr. RASTALL's Sedgeley–Lickey and Nuneaton Axes, and that the Ampthill cutting, where there is a similar development, is midway between his Nuneaton and Charnwood Axes. Since we have seen in the previous pages that the Sequanian is missing at Oxford, on the first axis, it will be interesting to learn what further research will reveal in the difficult clay areas about Leighton Buzzard and Biggleswade, situate upon the other two axes. Dr. MORLEY DAVIES has already shown that at Sandy, near Biggleswade, the base of the Ampthill Clay rests upon the *Renggeri* zone of the Oxford Clay, but it is probable that the eastward overlap is not so simple and continuous as is shown in his diagram [24, p. 399]. Data for the higher beds or for the Leighton Buzzard district are not yet available.

VIII.—THE TERM "CORALLIAN," ITS SUBDIVISIONS AND CORRELATION.

The English geologist is liable to be stigmatised by his modern Continental colleagues as insular for retaining the word "Corallian" in his vocabulary. In 1913 Dr. SALFELD wrote, "Dispensing with Dr. D'ORBIGNY's separate stage of Corallian, I agree with OPPEL in extending the Oxfordian stage up to the Kimeridge, the lowest zone of which I recognise to be that characterised by *Pictonia baylei*" [37, p. 423].

At first sight this simplification appears to be an admirable one. For the loss of our Corallian appears to be amply compensated by the abolition of the, to an Englishman, extremely confusing terms Argovian, Rauracian, Sequanian, Astartian, Strombian and Continental Corallien. As we read on, however, we begin to be disillusioned. This new "Oxfordian" is divided into an Upper and a Lower substage, but the base is drawn at the base of the zone of *Cardioceras cordatum* and *C. tenuistriatum*, that is, somewhere in our Lower Calcareous Grit. This leaves the Oxford Clay outside the Oxfordian, for the term is still used *sensu Gallico*. By this expedient, in fact, the complication is only transferred lower down, and we are still faced with the irreconcilable English Callovian and Continental Callovian, Chanasian, Divesian and English Oxfordian, into which to parcel the Oxford Clay and Kellaways. Further, not all writers since 1913 have followed Dr. SALFELD, and he himself has not been quite consistent. In another paper published in the same year he speaks of Lower and Upper Oxfordien as together an upper subdivision of the "Oxford" [38].

Dr. Morley Davies in his correlation table [25] of four years later brings the base of the Kimeridge down to the top of the *Martelli* Zone, and extends the Oxfordien, *sensu Gallico,* a zone lower than Salfeld, just below the top of the Oxford Clay of the Oxford district. This makes an overlap of one zone with the Oxfordian, *sensu Anglico*, which is equivalent to the upper part of the Continental Callovian. The confusion and ambiguity arising from this dual terminology are only too apparent. To make use of the term Oxfordian at all is to court unintelligibility.

In view of these facts we seem thoroughly justified in retaining the word Corallian for the rocks which have for so long been known by that name. Apart from the fact that it has become so familiar that the geologist who makes use of it is at least sure of being immediately understood, it is even admitted by the leading Continental stratigraphers that some such name is indispensable whereby to designate the shallow-water episode between the Oxford and Kimeridge Clays. Thus Haug, whose universal review of the Jurassic system may claim to be the widest extant, although rejecting Corallian because it does not conform strictly to the laws of nomenclature, adopts the alternative name Lusitanien* [13, p. 1045]. The Lusitanien, in its restricted zonal sense, however, assigns to the Oxford and Kimeridge Clays in England shallow-water deposits, which must logically be classed with the intervening series. From every point of view, therefore, we seem justified in retaining the convenient term Corallian for the whole of the shallow-water episode in this country.

With regard to the subdivision of the Corallian rocks in different parts of England, British workers have left much to be desired. The unsatisfactory nature of the literature on the subject is reflected in the difficulty experienced by Continental geologists in bringing the English deposits into line with the Continental [*e.g.*, 13]. The surveyors and other geologists familiar with the great quarries of Headington, near Oxford, long renowned as fossil localities, have been in the habit of dividing the formation in our area into a Lower Corallian or Lower Calcareous Grit and an Upper Corallian or Coral Rag. Above the latter, and not concerning workers at Oxford, lay patches of a third division, mapped as Upper Calcareous Grit. This method of subdividing the formation may suffice at Headington, but considered as a whole, even within the limits of the district dealt with in this paper, a fourfold division is essential. For as we proceed S.W. from Oxford the Lower Calcareous Grit and the Coral Rag come to be separated by the increasingly important series of strata here designated Berkshire Oolites, yielding the majority of the fossils to be obtained from the formation, and, near Highworth, attaining a thickness of over 30 ft.

The repeated attempts in the past to impose the arbitrary division applicable only at Headington have always led to confusion. No two authors have agreed where the line between Lower and Upper Corallian should be drawn, so that the important series coming in between has been included at one time with the Upper and at another with the Lower, while at others it has been variously distributed between the two.

* Proposed by Choffat for Portugal in 1885.

The Upper Calcareous Grit of our district has been satisfactorily correlated with the Sandsfoot Grit and the succeeding beds of Dorset, but its relation to the Supra-Coralline Beds of Yorkshire is still somewhat obscure; on the whole, however, it occupies a strictly analogous position. The Lower Calcareous Grit (*sensu stricto*) is now known to be equivalent to the Lower Calcareous Grit of Yorkshire, while it seems probable that the Lower Limestones or Hambleton Oolite Series of Yorkshire, with their peculiar fauna and included coral rag, are represented by the Pebble Bed of the Midlands and South of England. This makes the Yorkshire Middle Calcareous Grit with its included *Trigonia perlata* Beds equivalent to the Berkshire Oolite Series, and correlates under the Osmington Oolite Series the maximum development of coral rag and white oolites all over England.

We have seen that Continental geologists have taken exception to the term Corallian, on the grounds that it is only the name for a facies deposit and does not conform to the laws of nomenclature; but that the peculiar circumstances in this country render the name indispensable. The case for the term Coral Rag, however, is less happy. It is a time-honoured name for coral rock, of a definite type and age, in Wiltshire, Berkshire, Oxfordshire and Yorkshire; but, above all, coral rag is essentially a facies rock formed at different times in different places, or even in the same place.

In England coral rag occurs at five distinct horizons, and on the Continent continues into what we should call Kimeridge Clay, finally terminating as late as the Virgulian, which corresponds with our "leathery shales" with *Exogyra virgula*. In Dorset the Corallian formation exceeds 200 ft. in thickness, but corals are practically confined to the highest 8 in., where they form a dividing bed between the Upper Calcareous Grit and the Kimeridge Clay (the highest occurrence of corals in the British Corallian). Yet we do not correctly express our meaning if we say that the Coral Rag is missing in Dorset, for, so far from there being non-sequence, unconformity or stratal failure, the Coral Rag is represented in Dorset by as much as 60 ft. of white oolites, marls and clays, the Osmington Oolite Series. Corals merely did not happen to grow in Dorset at that period. Without geographical qualification, then, we may not speak of *the* Coral Rag; to do so is definitely misleading and unpermissible.

Since in Wiltshire, and particularly at Calne, the coral reefs which have always been known as "the Coral Rag" can be seen to alternate with, and finally to pass into, thick white oolites and marly clays, which there is no difficulty in tracing through N. Dorset and correlating with the Osmington Oolite Series of the Dorset coast, I have employed BLAKE and HUDLESTON's term Osmington Oolite Series as the stage name for the rocks of that age in England. They are nowhere better exposed than in the magnificent cliff sections at Osmington near Weymouth.

The embodiment of this Dorset name in our classification serves the useful purpose of bringing into prominence an important datum line for the correlation of the Corallian rocks all over England. It serves as a reminder that the *Trigonia* Beds of Dorset, which *overlie* the Osmington Oolites, are younger than the *Trigonia* Beds of Berkshire, which *underlie* the equivalent "Coral Rag." It is apparent from the writings of BLAKE and HUDLESTON that those authors had failed to grasp this point, and their correlations consequently involved them in difficulties which proved extremely embarrassing. Where was the "Coral Rag" in Dorset? SALFELD suggested that it was represented by the Sandsfoot Clay, a view for which there is not a scrap of evidence. What became of the 60 ft. of Osmington Oolites in Wiltshire, Berkshire and Oxfordshire? BLAKE and HUDLESTON actually described the passage of the Oolites into Coral Rag at Calne, but still they failed to draw the logical inferences.*

In order to guard against a recurrence of this mistake I suggest renaming the *Trigonia* Beds of Dorset the *Trigonia clavellata* Beds, and the *Trigonia* Bed and associated limestones of Berkshire the *Trigonia perlata* Limestones, and I append a tabulation of the principal differences :—

DORSET.	BERKS AND WILTS.
1. The common *Trigoniæ* are *T. clavellata*, PARK. and *T. bronni*, AG., species characteristic of the Astartien of Normandy. The large Marcham forms are unknown.	1. The common *Trigoniæ* are *T. perlata*, AG., and *T. hudlestoni*, LYC., species characteristic of the Argovien of Normandy. I have never seen an authentic specimen of *T. clavellata* or *T. bronni*.
2. Thousands of the little *Astarte polymorpha*, CONTJ. and *A. supracorallina*, D'ORD. are conspicuous; these forms give the alternative name of Astartien to the Sequanien of Normandy.	2. *Astarte ovata* abundant, the small Dorset species not known.
3. *Ostrea deltoidea* is common.	3. *Gryphæa dilatata* is common.
(This allies the *Trigonia clavellata* Beds with the Kimeridge Clay and the *Trigonia perlata* Limestones with the Oxford Clay.)	
4. *Pecten fibrosus* is represented by a modified form, for which I suggest the name *P. superfibrosus*.	4. The typical form of *Pecten fibrosus*† is one of the most characteristic fossils.
5. *Pecten qualicosta*† is abundant as also in the underlying Osmington Oolite.	5. *Pecten qualicosta* does not appear until the overlying Coral Rag.
6. *Cucullæa contracta*, PHIL. (= *C. corallina*, DAMON), short var. common.	6. *Cucullæa contracta* long var. (= *C. elongata*, PHIL. non SOW.) only.
7. Cephalopods very rare.	7. Cephalopods extremely abundant.

The *Trigonia clavellata* Beds of the Dorset coast preserve their peculiar and highly fossiliferous characters from Weymouth throughout N. Dorset, where they are frequently seen lying upon the Marnhull and Todber freestone (the representative of the Osmington Oolite Series). Shortly before being lost from view beneath the overlapping Cretaceous on the N. side of the Vale of Wardour they contain appreciable quantities of corals, and they reappear at Steeple Ashton in the form of a true coral reef, with only occasional *Trigonia clavellata*, resting upon the same even-bedded and false-bedded white oolites

* For BLAKE and HUDLESTON's correlation of the *Trigonia clavellata* Beds of Dorset with the *Trigonia perlata* Beds of Wilts, see the "conclusions" at end of their paper [6] and their correlation table. See also SALFELD's correlation table [38].

† See Plate 2, figs 6 and 7.

as at Marnhull and Todber, Sturminster Newton and Osmington. Those who have in the past correlated the coral rag of Steeple Ashton with that farther N., besides overlooking the stratigraphical discrepancy, failed to remark the fact that at Steeple Ashton the corals belong to a wider range of species and are in a different state of preservation.

From this it may be seen that we must seek the equivalent of the Berkshire Oolites in Dorset beneath the Osmington Oolite Series; and we are not disappointed. The large *Trigoniæ* of the *perlata-hudlestoni* type, which form so conspicuous a feature in Berkshire, occur in the topmost bed of the Nothe Grits of the Weymouth district. This bed is best studied at Redcliff, near Preston, whence Mr. BUCKMAN has named it the Preston Grit; but for the sake of uniformity I suggest that its name should give some indication of the importance of its contents, and I therefore refer to it as the *Trigonia perlata* Limestone. It forms a prominent band, 6 ft. in thickness, of massive, gritty, shelly, fucoidal limestone, bearing a close resemblance but for the fucoid markings to the brownish-grey, gritty, shelly, speckled, but doubtfully oolitic *Trigonia perlata* Limestones of Highworth. The most striking resemblance, however, is found in the fauna. Besides the characteristic *Trigoniæ* we find large quantities of the familiar and typical form of *Pecten fibrosus* (*P. qualicosta* is absent), also *Camptonectes lens*, *Chlamys splendens*, *Cucullæa contracta*, *Gryphæa dilatata* (abundant), *Pteria expansa*, *Pseudomonotis ovalis*, *Ostrea quadrangularis*, *Perisphinctes helenæ*, *Cardioceras excavatum*, *C. vertebrale*, and other fossils which we have seen are, without exception, common in the Berkshire Oolites. Upon this massive band, which forms a prominent overhanging ledge in the lower part of the cliff and can be studied in huge fallen cubes on the foreshore, lie the poorly fossiliferous Nothe Clay and Bencliff Grit. These have their counterparts in the Berkshire Oolites of our district, in the form of the Highworth Clay and Highworth Grit.

In the accompanying table-diagram (Table I) the correlation outlined above is summarised. The divisions containing coral rags are edged with thick lines. It is noteworthy that coral growth appeared first in Yorkshire, migrating southward over the British Isles, only becoming established in S. Dorsetshire in the closing phase of the Upper Calcareous Grit. On the Continent reefs continued to flourish, as has been stated, until the Virgulian.

In Table II the substance of Table I is summarised into a single sequence for S.W. England as a whole, and the beds are provisionally correlated with the major divisions of N. France.

IX.—CORALLIAN GEOGRAPHY.

It is no new suggestion that the present outcrop of a formation may often indicate the position where it attained its greatest thickness. The Corallian of this district would seem to illustrate this point. The nature of the deposits indicates that they cannot have been formed far from a shore line. It might be anticipated, therefore, that in one direction they would be found to thin out against this shore line, and in the opposite

TABLE I.—Correlation of the Corallian Deposits of the South of England and the General Succession in Yorkshire. Divisions containing Coral Rags edged with thick line.

Zone	WEYMOUTH	NORTH DORSET	WESTBURY STEEPLE ASHTON & SEEND	HILLMARTON CALNE & WESTBROOK	PURTON & WOOTTON-BASSETT	SHRIVENHAM HIGHWORTH KINGSTON	OXFORD	YORKSHIRE	Zone
PECTEN MIDAS	RINGSTEAD CORAL BED	——	——	——	——	——	——	UPPER CALCAREOUS GRIT	OSTREA DELTOIDEA
PECTEN MIDAS	OOLITIC IRON ORE (WYKE)	OOLITIC IRON ORE	OOLITIC IRON ORE	?	——	OOLITIC IRON ORE	——	UPPER CALCAREOUS GRIT	OSTREA DELTOIDEA
PECTEN MIDAS	SANDSFOOT GRITS	FERS. GRITS	FERS. GRITS	FERS. GRITS	——	FERS. GRITS	——	UPPER CALCAREOUS GRIT	OSTREA DELTOIDEA
PECTEN QUALICOSTA & P. SUPERFIBROSUS	SANDSFOOT CLAY	CLAY	——	——	——	CLAY	——	UPPER CALCAREOUS GRIT	OSTREA DELTOIDEA
PECTEN QUALICOSTA & P. SUPERFIBROSUS	TRIGONIA CLAVELLATA BEDS WITH FEW CORALS	TRIGONIA CLAVELLATA BEDS WITH CORALS	CORAL RAG WITH TRIGONIA CLAVELLATA	?	——	? ["SHELL BED" IN BORING]	——	?	OSTREA DELTOIDEA
PECTEN QUALICOSTA & P. SUPERFIBROSUS / PECTEN FIBROSUS	OSMINGTON OOLITE SERIES: E.B. WHITE OOLITES; F.B. WHITE OOLITES; LITTLEMORE CLAY BEDS FACIES; PISOLITE	E.B. WHITE OOLITES; F.B. WHITE OOLITES; LITTLEMORE CLAY BEDS FACIES; PISOLITE	E.B. WHITE OOLITES; F.B. WHITE OOLITES; PISOLITE	LITTLEMORE CLAY BEDS FACIES; CORAL RAG; E.B. WHITE OOLITES; F.B. WHITE OOLITES; PISOLITE	LITTLEMORE CLAY BEDS FACIES; WHEATLEY LIMESTONES FACIES; CORAL RAG; WHITE OOLITES	CORAL RAG; PUSEY FLAGS, F.B. SANDY OOLITES	LITTLEMORE CLAY BEDS FACIES; WHEATLEY LIMESTONES FACIES; CORAL RAG	CORAL RAG; WHITE OOLITES	
PECTEN FIBROSUS	BENCLIFF GRIT	——	——	——	——	HIGHWORTH GRIT	——	WHITE OOLITES	GRYPHAEA DILATATA
PECTEN FIBROSUS	NOTHE CLAY	——	CLAY IN WESTBURY BORING ?	——	——	HIGHWORTH CLAY	——	WHITE OOLITES	GRYPHAEA DILATATA
PECTEN FIBROSUS	TRIGONIA PERLATA LIMESTONE [PRESTON GRIT, S.B]	LIMESTONES AT LANGHAM & CUCKLINGTON ?	TOP SHELL BED OF GRIT (PARS) SEEND ?	——	SHELL-CUM-PEBBLE BED WITH TRIGONIA PERLATA	TRIGONIA PERLATA LIMESTONES WITH CORAL REEFS PEBBLE BED	SHELL-CUM-PEBBLE BED WITH TRIGONIA PERLATA	LO. PARTS OF MALTON PICKERING ETC. OOLITES & TRIGONIA PERLATA BEDS	GRYPHAEA DILATATA
PECTEN FIBROSUS	NOTHE GRIT	LOWER CALC. GRIT	LOWER CALC. GRIT	LOWER CALC. GRIT	LOWER CALC. GRIT	LOWER CALC. GRIT	LOWER CALC. GRIT	MIDDLE CALC. GRIT; LOWER LIMESTONE WITH CORALS; LOWER CALC. GRIT	GRYPHAEA DILATATA

Note on Table I.—Further research in Yorkshire has made minor modification of the correlation of the lower part of the Yorkshire column desirable; *see ante* p. 156.

TABLE II.

	South West of England.	Approximate Equivalence of Haug's Continental Classification.	
Kimeridge Clay.	Clays with *Exogyra virgula*.	Virgulien.	Kimeridien.
	Abbotsbury Iron Ore with *Raseniæ*. Clays with *Rhynchonella inconstans* and *Pictoniæ*.	Ptérocerien (Strombien).	
Corallian.	Upper Calcareous Grit. Weymouth Coral Bed with *Pictonia densicostata*. Oolitic Iron Ore of Westbury, Wyke, Marston, etc., passing into waxy clays with clay-ironstone nodules; *Ringsteadiæ*. Sandsfoot Grits with *Perisphinctes decipiens* and *Pecten midas*. Sandsfoot Clay.		
	Trigonia clavellata Beds. Highly fossiliferous limestones with *T. clavellata*, *T. bronni*, *Astarte polymorpha*, *A. supracorallina*, *Ostrea deltoidea* and *Pecten superfibrosus*, passing into coral reefs at Steeple Ashton and in North Dorset.	Sequanien (Astartien).	Lusitanien.
	Osmington Oolite Series. False-bedded and even-bedded white oolites, pisolites and marls in the south, passing in the north into coral reefs, also into Littlemore Clay Beds. Near the reefs are detrital beds of Wheatley Limestones. *Pecten qualicosta*.	Rauracien.	
	Berkshire Oolite Series. Pusey Flags; false-bedded sandy oolite flags, a link with the series above. Bencliff and Highworth Grits. Nothe and Highworth Clays. Urchin Marls; oolitic marls crowded with *Nucleolites scutatus*. *Trigonia perlata* Limestones, full of *T. perlata*, *T. hudlestoni*, *Perisphinctes helenæ*, *Gryphæa dilatata*, *Pecten fibrosus*, etc.; coral reefs at Highworth. Pebble Bed.	Argovien.	
	Lower Calcareous Grit. Sands and doggers with *Cardioceras cordatum* and *Gryphæa dilatata*. Nothe Grits of Weymouth.	Oxfordien.	
	Oxford Clay. Clays with *Cardioceras cardia*. ,, ,, *Creniceras renggeri*. ,, ,, *Quenstedticeras lamberti*. ,, ,, *Cosmocerates*.		

direction to taper into deeper-water sediments. Since in the direction of their strike they do neither of these things, from Oxford to the coast of Dorset, a distance of about 100 miles, we need look for the shore line in only two directions, at right angles to the strike.

Borings at Ware, Slough, Winkfield, and many points in and round London, have revealed that the Corallian disappears in a S.E. direction [15, etc.]. In fact it is well established that throughout Jurassic times, except for a temporary transgression during the Great Oolite, a land-mass existed to the S.E. of a line not many miles removed from the present escarpment of the Chalk.

This land-mass has received a great deal of attention in the past, and it was roughly mapped as early as 1856 by Godwin-Austen, who supposed it to have extended over the North Sea and the Scandinavian region throughout the Jurassic Period [12, p. 46]. It received the most detailed study in 1913 by Sir Aubrey Strahan, who, on the evidence of deep borings, constructed a contoured map of the Palæozoic platform as it appeared before being affected by post-Cretaceous folding. The author of this map then remarked that " One of the results of the elimination of post-Oligocene movements has been to accentuate the importance of the elevated tract of Eastern England at the expense of the Palæozoic areas of Western England and Wales " [40].

Away from this land-mass during the Corallian Period, to the N.W. of the present outcrop, we may suppose to have been an area of deeper water and slow pelilithic deposition. Beyond the land-mass again, under the Weald of Kent, Corallian rocks reappear, but of a very different character. There is a notable absence of the sands forming so great a proportion of the formation in Wilts, Berks and Oxfordshire, and the beds, chiefly limestones, attain a thickness of over 300 ft.—three times their maximum thickness in these counties [18].

These Kentish rocks were deposited in a great basin, in which deposition was very active, extending over the Continent [34], Dorsetshire and South Wiltshire. As we pass W. from Kent to Dorset and then N. to Wiltshire, the formation becomes progressively thinner and contains a higher proportion of sand in the lower half, approaching more nearly to the type of deposit constituting the strip of rocks forming the subject of this paper. N. and E. of Wheatley the formation suddenly terminates, or rather continues to be represented only by the Ampthill Clay. Apparently the ordinary type of Corallian was never deposited in this direction, although fossils indicate that the equivalents of most of it are present.

The fact that pelilithic sedimentation was here never interrupted indicates the prevalence of very different conditions. What where those conditions? The most satisfactory answer is the stiller, deeper water of a landlocked sea, in which deposition proceeded more gradually than in the open southern ocean. It was this inland sea which probably spread round N. of the present Corallian outcrop, depositing comparatively deep-water, thin, argillaceous sediments, which have since been denuded, together with the Oxford Clay, from the surface of the Cotswolds and the Midlands.

The opening to the southern ocean was probably to the S.W. over Somerset and South-West Wiltshire. To the N.E. the sea stretched to Yorkshire, where the reappearance of sands, corals and all the normal deposits indicates shallow water and the proximity of the opposite coastline. In Yorkshire even a considerable part of the Oxford

Clay can be traced laterally into arenaceous beds as the shore is approached [17, p. 276]. W. of the Pennines a long gulf reached to Scotland, as is proved by the occurrence of marine Corallian in Sutherlandshire and elsewhere.

In the light of this interpretation of the geography of the period, the thin narrow strip of Corallian rocks which runs through Berkshire and Wiltshire is less difficult to explain. It comes to be regarded as a coastal deposit, fringing the N.W. shore of the Palæozoic land-mass, from the denudation of which its materials were derived. Starting as a long sandbank it passed through the vicissitudes that have been described, supporting from time to time the growth of coral reefs and islands.

Movements continually affected the trough surrounding the London platform or massif, and the periodic subsidence of this trough has been held to be the major factor controlling deposition in England throughout the Jurassic Period. It has been shown, however, that in addition earth-movements of another kind played an important part in this area during the formation of the Corallian.

APPENDIX I.

PALÆONTOLOGY.

LISTS OF INVERTEBRATA OCCURRING IN THE CORALLIAN IN THE DISTRICT COVERED BY THIS PAPER.

(Not including the faunas of the Arngrove Stone or the Calne Oolite.)

These lists by no means claim to be exhaustive; they must be regarded as purely provisional, being a first attempt to collect and co-ordinate records from the writings of previous authors, while eliminating some errors.

A number of species not previously known from the district are recorded for the first time, including some hitherto undescribed.

To save constant repetition, fossils mentioned in the text are not followed by their authors' names; these are set forth here, and all names of fossils are to be interpreted as understood in the following lists.

Authorities.

W. Recorded in the list of WHITEAVES, 1861 ('Annals of Nat. Hist.,' vol. 8, 1861, pp. 143–144.).

P. Recorded in the list of PHILLIPS, 1871 ('Geology of Oxford and the Valley of the Thames,' pp. 300–306).

B. Recorded by BLAKE and HUDLESTON, 1877 ('Q. J. G. S.,' vol. 33, pp. 260–405).

O. Available for study in collections of Oxford University Museum.

A. Collected by the author.

I.—Porifera.

Authorities.	*Species.*
B.	*Parendea bullata*, Étallon. Hilmarton, Littlemore Clay Beds.
Morley Davies, A.	*Rhaxella perforata*, Hinde. Arngrove Stone and at Purton.
A.	"*Spongia*" *floriceps*, Phil. Osmington Oolite Series coral rag of Tockenham Wick and Kingsdown.

II.—Cœlentera.—Anthozoa.

W. P. O.	*Cladophyllia conybeari*, Edw. Cumnor (P.).
A.	*Comoseris irradians*, Edw. Common Platt near Purton, Osmington Oolite Rag.
A.	*C.* sp. nov. Hangman's Elm Quarry, Highworth, *Trigonia perlata* Limestones, coral bed.
W. P. O. A.	*Isastræa explanata* (Goldf.) *et* Edw. Berkshire Oolites—Osmington Oolites.
W. P. Edw.	*I. greenoughi*, Edw. "Botley Hill" (Edw. and Haime).
P. O. A.	*Montlivaltia dispar* (Phil.) *et* Edw. Berkshire Oolites—Osmington Oolites.
W. P. A.	*Rhabdophyllia phillipsi*, Edw. Osmington Oolite Rag, Moredon (A.), Cumnor (P.).
J. Buckman	*Stylina delabechi*, Edw. Blunsdon.
J. Buckman, A.	*S. tubulifera* (Phil.) *et* Edw. Osmington Oolite Rag, Sheepslaight Plantation Quarry, near Kingsdown (A.); Blunsdon (J. Buckman).
O. A.	*Thamnastræa arachnoides* (Park.) *et* Edw. Berkshire Oolites—Osmington Oolites.
O. A.	*T. concinna* (Goldf.) *et* Edw. Berkshire Oolites—Osmington Oolites.
W. P. O. A.	*Thecosmilia annularis* (Flem.) *et* Edw. Berkshire Oolites—Osmington Oolites. Also in Lo. Calc. Grit rag of Yorkshire and Upper Calc. Grit of Weymouth. A gigantic specimen over 1 ft. long in the Coral Rag of Cowley.

III.—Echinodermata.

P. O.	*Astropecten rectus*, M'Coy *et* Wright. *Trigonia perlata* Bed, Marcham (O.); Headington (P.).
W. P. B. O. A.	*Cidaris* (*Paracidaris*) *florigemma*, Phil. *et* Wright. Common in Osmington Oolites, rare in Berkshire Oolites.
W. P. B. O. A.	*C.* (*Plegiocidaris*) *smithi*, Wright. Berkshire Oolites, Osmington Oolites.

Authorities.	*Species.*
P.	*Clypeus subulatus*, Young and Bird *et* Wright. Headington (P.). (Doubtful.)
W. P. B. O. A. . .	*Diplopodia versipora* (Phil.) *et* (Wright). Osmington Oolites.
W. P. O. A. . . .	*Hemicidaris intermedia* (Flem.) *et* Wright. Headington (P.); near Highworth (A.). Osmington Oolites.
A.	*Holectypus corallinus*, D'Orb. *et* Cotteau. Littlemore Clay Beds, Bagley Wood.
P. Buckman . . .	*Nucleolites dimidiatus* (Phil.) *et* Wright. Headington (P.), Cowley (B.).
W. B. O. A. . . .	*N. scutatus*, Lam. *et* Wright. Lo. Calc. Grit—*Trigonia clavellata* Beds.
W. P. O.	*Phymopedina marchamensis* (Wright). Osmington Oolite Rag, Littlemore and Marcham.
W. P. B. O. A. . .	*Pygaster semisulcatus*, Phil. (= *P. umbrella* Wright *et* Auct.). Berkshire Oolites—Osmington Oolites.
W. P.	*Pygurus blumenbachi* (Koch and Dunker) *et* Wright. Bullingdon (P.).
W. P.	*P. costatus*, Wright.
O.	*P. hausmanni* (Koch and Dunker) *et* Wright. Osmington Oolite Coral Rag, Hinksey and Bullingdon.
W. P. O. A. . . .	*P. pentagonalis* (Phil.) *et* Wright. *Trigonia perlata* Bed, Kingston Bagpuize and Littleworth (A.).

IV.—Annelida.

Pringle, A. . . .	*Serpula intestinalis*, Phil. Especially common in Littlemore Clay Beds.
W. P.	*S. runcinata*, Sow.
P.	*S. squamosa*, Phil.
W. P. B. A. . . .	*S. tricarinata*, Sow.
W. P.	*Vermicularia ovata*, Sow.
W. P.	*Vermilia sulcata*, Sow.

V.—Brachiopoda.

Davidson, B. . .	*Ornithella margarita*, Oppel *et* Davidson. Faringdon and Calne (D.), Hilmarton (B.). Osmington Oolite Coral Rag.
Davidson, O. . .	*Terebratula boloniensis*, Rigaux and Sauvage *et* Davidson. Coral Rag of Bullingdon, Horspath, etc. This is by far the commonest Brachiopod in the district.
Davidson, O. . .	*T. gesneri*, Etall. *et* Davidson. Osmington Oolite Rag of Bullingdon and Horspath.

Authorities.	*Species.*
P. B. O.	*T. insignis*, SCHUBLER *et* DAVIDSON. Headington and Cumnor (P.), Hilmarton (B.). Osmington Oolite Rag.
A.	*T. kingsdownensis* sp. nov., Osmington Oolite Coral Rag, Kingsdown, near Swindon; also Stratton St. Margaret (HUDLESTON Coll.) (Plate 1, fig. 6).
DAVIDSON, B., Geol. Assoc. . .	*Thecidium ornatum*, MOORE *et* DAVIDSON. Lyneham (D.), Hilmarton (B.), Shellingford (Geol. Assoc.). Osmington Oolite Coral Rag.

VI.—LAMELLIBRANCHIA.

A.	*Anisocardia damoni*, ROLLIER (= *Isocardia tumida* AUCT. *non* PHIL. = *I. minima* DAMON *non* SOW. ? = *P. isocardioides* BL. & H.).
W. P.	*A. isocardina* (BUV.) *et* (WHIT.) (*Cypricardia*). Probably synonymous with last.
P. A.	*Arca* (*Barbatia*) *æmula*, PHIL. *T. perlata* Limestones, Kingston Bagpuize, etc.
A.	*A.* (*Parallelodon*) *quadrisulcata*, SOW. Coral Bed, Stanton Fitzwarren Rly. cutting (Plate 2, fig. 8).
B.	*A.* (*Parallelodon*) *sublata*, D'ORB (*A. langei*, THURM. *et* CONTJ.) (?). A very doubtful species.
W. P. B. O. A. . .	*Astarte ovata*, SMITH, SOW., *et* PHIL. This species is very variable in form, and some of the varieties have been given specific names.
B.	*A. subdepressa*, BLAKE and HUDLESTON. Very rare.
O.	*Camptonectes giganteus*, ARKELL. Shell-cum-Pebble Bed, Headington. Rare.
W. P. B. O. A. . .	*C. lens* (SOW.). Abundant throughout the Corallian.
O.	*Chlamys* cf. *blyensis*, DE LORIOL *et* ARK. Very rare. Cowley.
O. A.	*C. nattheimensis*, DE LORIOL *et* ARK. Coral Rag. Common.
B. A.	*C. qualicosta* (ETALLON) *et* ARK. Osmington Oolite Series coral rag, Wootton; oolites, Calne, etc. (Plate 2, fig. 7).
O. A.	*C. splendens* (DOLLFUSS) *et* ARK. Common.
P. B. O. A. . . .	*Chlamys* (*Æquipecten*) *fibrosus* (SOW.) *et* ARK. Abundant from Lower Calc. Grit to Osmington Oolite Series (Plate 2, fig. 6).
O.	*C.* (*Æ.*) *inæquicostatus* (PHIL.) *et* ARK. Shell-cum-Pebble Bed, Headington. Very rare.
W. P. B. O. A. . .	*Corbicella lævis* (SOW.). The holotype (in the B. M.) came from Marcham, where the species is common in the *T. perlata* Bed (Plate 2, fig. 9).

Authorities.	*Species.*
W. P. O. A. . . .	*Ctenostreon proboscideum* (Sow.) (= *Lima rudis,* Sow.) (Plate 1, fig. 4).
W. P. B. O. A. . .	*Cucullæa contracta,* Phil. (= *C. corallina,* Damon). Only long forms like *C. oblonga,* Phil. *non* Sow. occur in this district, but they are connected by intermediates to the type form in the *T. clavellata* Beds of Dorset and throughout the Yorkshire Corallian.
O. A.	"*Cyprina*" cf. *corallina,* D'Orb. Berkshire Oolites (Plate 1, fig. 5).
B. O. A.	"*C.*" *tancrediformis,* Blake and Hudleston. Lower Calc. Grit and Berkshire Oolites. (? = *Eocallista.*)
O. A.	*Entolium solidum* (Roem). Rare. *T. perlata* Limestones.
W. B. O. A. . . .	*Exogyra nana* (Sow.) *et* (Phil.). The commonest Corallian mollusc.
A.	*E. spiralis,* Goldf. The common form in the Lower Calc. Grit of Seend.
H. B. Woodward .	*Gastrochœna recondita* (Phil.). *Gastrochœnœ* are probably commoner than generally supposed, being usually mistaken for *Lithodomi.*
W. P. B. O. A. . .	*Gervillia aviculoides* (Sow.). Abundant, especially in the *T. perlata* Beds.
O. A.	*Goniomya V-scripta* (Sow.). Holotype in B. M.; often misquoted as *G. literata.*
A.	*Homomya shellingfordensis* nov. Urchin Marls, Shellingford. Possibly = *H. grimstonensis, nomen nudum,* Hudleston's Yorkshire list; misquoted from Yorkshire as *H. tremula,* Buv.
O. A.	*Isocyprina cyreniformis,* Buvignier. Berkshire Oolites, etc.
O.	*Lima* (*Plagiostoma*) *highworthensis,* Arkell. Very rare.
P. B. O. A. . . .	*L.* (*P.*) *læviuscula,* Sow. Rare in England except in Yorkshire.
O. A.	*L.* (*P.*) *mutabilis,* Arkell. Common, also in Yorkshire.
W. P. B. O. A. . .	*L.* (*P.*) *rigida,* Sow. Abundant throughout the Corallian all over England.
B. A.	*L.* (*P.*) *subantiquata,* Roem. *et* Hudl. *et* Ark. Rare.
O. A.	*L.* (*P.*) *zonata,* Arkell. Common in the rag fauna, never dissociated from corals.
W. P. B. O. A. . .	*L.* (*Limatula*) *elliptica,* Whiteaves. Common.
W. P. B. O. A. . .	*Lithodomus inclusus* (Phil.). Abundant in coral rag and pebble bed.
W.	*L. lycetti* (Whiteaves). Very rare.
A.	*L. goldfussi* Deshayes (= *L. aliena* Bl. & H. *non* Phil.). (*Crassina aliena* Phil. = *Astarte ovata* Smith, var.)

Authorities.	*Species.*
B.	*L. moreana*, BUV. Marcham.
P.	*L. polita*, PHIL. Most of the Lucinas are highly unsatisfactory, since they were probably recorded only on the strength of casts.
W. P. O. A. . . .	*Modiola bipartita*, SOW. Common from the Cornbrash to the Corallian.
W. P. B. A. . . .	*M.* (*Modiolaria*) *pulchra*, PHIL. (= *M. cancellata*, ROEM.). Rare; Wheatley, Shellingford, Highworth.
B. O.	*Myoconcha radiata*, D'ORB. (= *M. texta*, BUV.). Recorded by BLAKE and HUDLESTON as *M. sæmanni*, DOLLF. Very rare.
O.	*Mytilus ungulatus*, YOUNG and BIRD. Rare, but common in Cambridgeshire and Yorkshire.
W. P. B. O. A. . .	*Opis* (*Trigonopis*) *phillipsi* (D'ORB.) (including *O. corallina*, DAMON, to which all intermediate stages occur). Abundant.
A.	*Ostrea pseudocallifera* nov. Very rare. Marcham, Pebble Bed (Plate 1, fig. 2).
A.	*O. quadrangularis* nov. Characteristic of the *T. perlata* Beds (Plate 1, fig. 1).
W. P. B. O. A. . .	*O.* (*Lopha*) *gregaria*, SOW. Abundant.
A.	*O.* (*Gryphæa*) *bullata* (SOW.). The common form in the Lo. Calc. Grit of Seend.
P. B. O. A. . . .	*O.* (*G.*) *dilatata* (SOW.). Berkshire Oolites and Lo. Calc. Grit.
A.	*O.* (*G.*) *gryphæata*, ROLLIER. Lo. Calc. Grit, Spirt Hill.
B. O. A.	*Perna mytiloides*, LAMK. *et* GOLDF. Abundant, especially throughout the Berkshire Oolites.
P. B. O. A. . . .	*Pholadomya æqualis*, SOW. (*P. decemcostata*, ROEM.). Abundant.
O. A.	*P. canaliculata*, ROEM *et* MOESCH.
A.	*P. hemicardia*, ROEM *et* MOESCH. Littlemore Clay Beds, Bagley Wood.
O. A.	*P. lineata*, GOLDF. *et* MOESCH. Lower Calc. Grit, Pen Hill Well, Swindon. Also in the Arngrove Stone.
A.	*P. paucicosta*, ROEM. *et* MOESCH. *T. perlata* Bed, Kingston Bagpuize.
A.	*P. protei*, BRONG. *et* MOESCH. *et* CHOFFAT. *T. perlata* Limestones, Highworth.
W. P.	*Pinna lanceolata*, SOW. Rare.
W. P. A.	*Placunopsis radiatus* (PHIL.) (= *P. similis*, WHITEAVES). Littlemore Clay Beds and elsewhere.
P. O. A.	*Pleuromya recurva* (PHIL.). An extraordinarily persistent species, ranging up from the Great Oolite.

Authorities.	*Species.*
W. P. B. O. A. . .	*P. tellina,* AG. (*P. decurtata* of BLAKE and HUDLESTON and other Corallian writers). Abundant everywhere.
O. A.	*Plicatula weymouthiana,* DAMON. *T. perlata* Limestones of Highworth and Shellingford, and coral rag of various localities (= *P. semiarmata,* ETALL). (Plate 1, fig. 3.)
P. O. A.	*Præconia rhomboidalis* (PHIL.). Coral rag of Marcham, Shellingford and Stanton Fitzwarren. (*Crassina*).
O.	*Protocardia fontana* (ETALL). A specimen apparently referable to this species from the Coral Rag of Cumnor.
B.	*Pseudomonotis lævis* (BLAKE and HUDLESTON). Rare. Lower Calcareous Grit of Headington district.
W. P. B. O. A. . .	*P. ovalis* (PHIL.). Lower Calcareous Grit to Osmington Oolite Series inclusive.
B. O. A.	*Pteria pteropernoides* (BLAKE and HUDLESTON). Locally common ; Berkshire Oolites to *Trigonia clavellata* Beds.
W. P. B. O. A. . .	*P.* (*Oxytoma*) *expansa* (PHIL.). *T. perlata* Limestones.
W. P. B. O. . . .	*Quenstedtia lævigata* (PHIL.) (*Psammobia*). Headington district and Highworth.
W. P. A.	*Sowerbya deshayesea* (BUV.). *T. perlata* Limestones, Highworth and Kingston Bagpuize. (*Isodonta*). Probably same as next.
W. P. B. A. . . .	*S. triangularis* (PHIL.) (= *S. deshayesea,* WHITEAVES *non* BUV.) (This is the commonest form in the Pusey Flags.)
W.	*S. truncata,* MORRIS and LYCETT (= *S. triangularis,* WHITEAVES, *non* (PHIL.)). We have only WHITEAVES' figure on which to base our inclusion of this as a separate species.
P. B.	*Tancredia curtansata,* PHIL. *T. perlata* Limestones, Highworth.
A.	*T. nigra* nov. *T. perlata* Bed, Marcham and Kingston Bagpuize.
O. A.	*Trichites giganteus,* QUENSTEDT. (*T. plotii* AUCT., *non* LHWYD.) Locally abundant in the *T. perlata* Beds.
O.	*T. granulatus* (SOWERBY). Headington Shell-cum-Pebble Bed. (*Pinna ampla* AUCT., *non* SOW.)
LYCETT, B. O. A. .	*Trigonia meriani,* AG. Especially common at Kingston Bagpuize.
LYCETT, B. O. A. .	*T. perlata,* AG. Abundant.
LYCETT, B. O. A. .	*T.* ,, var. *hudlestoni* (LYCETT). Many other varieties equally abundant.
A.	*Unicardium apicilabratum,* ETALL. Highworth and Buckland, Berkshire Oolites generally (Plate 2, fig. 4).
A.	*U. excentricum,* D'ORB. Abundant throughout the Corallian (= *U. plenum,* BLAKE and HUDLESTON = *U. sulcatum,* DAMON, *non* LECK).
B. O. A.	*Velopecten velatus* (GOLDF.) *et* ARK.

VII.—Gastropoda.

Authorities.	*Species.*
W. P.	*Actæon retusus*, Phil. (Doubtful.)
W. P. O.	*Alaria seminuda*, Heb. and Desl. Shell-cum-Pebble Bed, Headington.
P. B. O. A. . . .	*Bourguetia striata* (Sow.). Lo. Calc. Grit, Marcham. Commonest in the Osmington Oolite Series.
W. P. O.	*Ceritella costata*, Whiteaves. Lo. Calc. Grit, Cumnor.
W. P. B. O. A. . .	*Cerithium muricatum*, Sow. Berkshire Oolites to *Trigonia clavellata* Beds.
B.	*C. humbertinum*, Buv. Coral Rag, Faringdon.
W. P. O.	*Cylindrites elongatus* (Phil.). Trigonia Bed, Kingston Bagpuize.
W. P. B. O. A. . .	*C. polygyrus* (Phil.) (?= *C. luidii*, Whiteaves, 1861, *non* Morris and Lycett, 1850, Bathonian sp.).
W. P. B. O. A. . .	*Littorina muricata*, Sow. Wherever corals abound.
O.	*L. pulcherrima*, Dollfuss. Coral Rag round Oxford.
W. P. O. A. . . .	*Natica* (*Ampullina*) *arguta*, Phil. (= *N. marchamensis*, Blake and Hudleston). Commonest in Lo. Calc. Grit, but ranging through the whole formation.
W. P.	*N.* (*A.*) *clio*, D'Orb. The differences distinguishing this species from *N. clytia* would hardly be detected in the cast, in which condition most of the Corallian Naticas are found, so this record is rather unsatisfactory. All the large forms I have seen are *N. clytia*.
B. O. A.	*N.* (*A.*) *clytia*, D'Orb. Generally a higher form in this district than *N. arguta*. Osmington Oolite Series.
B. O.	*N.* (?*A.*) *felina*, Blake and Hudleston. Lo. Calc. Grit, Marcham and Cumnor.
W. P. O.	*Nerinea goodhalli*, Sow. Lo. Calc. Grit, Cumnor.
Hudleston, 1881, A.	*Neritopsis decussata*, D'Orb. Osmington Oolite Coral Rag, Blunsdon.
W. B.	*N. guerrei* (Heb. and Desl.).
O. A.	*Pleurotomaria agassizi*, Munst. Casts apparently assignable to this species are sometimes found of very large size. They have been wrongly identified with De Loriol's *P. chavattensis* and *P. liesbergensis*.
W. P. Sowerby .	*P. bicarinata*, Sow. The holotype is from Marcham.
B. O. A.	*P. munsteri*, Roem. Common throughout the Corallian. Possibly only a variety of the following, but accepted as a species by Hudleston.

Authorities.	*Species.*
W. P. B. O. A. . .	*P. reticulata*, Sow. Distinguished from *P. munsteri* by the smaller spiral angle. Same horizons as *P. munsteri*.
O. A.	*Pseudomelania condensata*, D'Orb. (Plate 2, fig. 5.) This species is common in the Cumnor Natica Band and is almost certainly that identified by Blake and Hudleston as *C. abbreviata*, Roem.
W. P. B. O. A. . .	*P. heddingtonensis*, Sow. It was probably in error that this species was spelt by Sowerby with two d's and said to come from Heddington in Wilts, not Headington near Oxford, for Heddington is situated upon Upper Greensand. Common throughout the Corallian.
A.	*Trochotoma tornatilis* (Phil.) Shell-cum-Pebble Bed, Vicarage Quarry, Headington.
B.	*Trochus dædalus*, D'Orb. *T. perlata* Limestones, Highworth.
O.	*Turbo* cf. *bicinctus*, D'Orb. A cast from the Coral Rag of Headington agrees with this species in all respects but its large size.

VIII.—Cephalopoda.

Belemnitidæ.

W. P. B. O. A. . .	*Belemnites abbreviatus*, Miller *et* Phillips. The typical form is especially common in the Lower Calcareous Grit of Marcham and elsewhere, continuing rarely through the Berkshire Oolites to the Pusey Flags.
P. O. A. B. . . .	*B. oxyrrhynchus*, Lhwyd. Phillips ('Mon. Brit. Foss. Belemnitidæ, Jurass.,' p. 125, Plate XXXIV, fig. 84) classes this as a variety of *B. abbreviatus*, but it has far more claim to specific rank than var. *excentricus*. It maintains constant distinct characters, and its range is very different from that of *B. abbreviatus*. It does not appear until the Berkshire Oolites, and continues into the Osmington Oolites. It is primarily a Berkshire Oolite species (which Phillips notes under the heading "locality," p. 125), whereas *B. abbreviatus* is commonest in the Lower Calcareous Grit and rare at higher horizons.

Nautiloidea.

W. P. B. O. A. . .	*Nautilus hexagonus*, Sow. I have found this remarkably persistent form in the Lower Calcareous Grit (common), the *T. perlata* Limestones (Highworth), the *T. clavellata* Beds (West Stour, Dorset), and the extreme top of the Upper Calcareous Grit (Black Head, Osmington, Dorset).

Ammonoidea.

In the present state of flux of Ammonite nomenclature and classification no useful purpose would be served by inserting a list of species recorded from the district. The most important described species met with by the writer have been noticed in the text.

The Ammonites in beds older than the Upper Calcareous Grit belong to three distinct types, which it seems safest at present to regard as genera, namely *Perisphinctes*, *Aspidoceras* and *Cardioceras*. Mr. S. S. BUCKMAN has recently subdivided these in his 'Type Ammonites,' with the application of numerous generic names. Generic diagnoses are not published by him in any but a very few instances, so that generic characters cannot be distinguished from specific.

An exhaustive application of the methods used by Mr. BUCKMAN to a large body of material collected in the district by the writer has led to the conviction that those instances investigated are in no sense true genera, and that so to designate them involves a misuse of the accepted meaning of the word genus. Similarly it has been impossible to accept all of that writer's specific names as signifying true species.

It is so difficult to obtain two specimens alike among the mass of Ammonites continually excavated in some of the quarries in the *Trigonia perlata* Limestones that it seems impossible to avoid regarding them as belonging to comparatively few species susceptible to intense polymorphism. It is hoped that at some future date the materials collected may form the subject of a separate work. Meanwhile, three very distinct new forms are described, as they probably have some stratigraphical value (see p. 177).*

IX.—CRUSTACEA.

W. P. O. . . . . *Glyphæa rostrata* (PHIL.). Headington and Horspath. Probably Shell-cum-Pebble Bed.

L. TREACHER . . . *Goniocheirus cristatus*, CARTER. Shellingford Cross-Roads. Osmington Oolite Coral Rag.

SOME PREVIOUSLY RECORDED SPECIES OMITTED FOR GOOD REASONS FROM THE FOREGOING LISTS.

I.—CŒLENTERA.

Thamnastræa lyelli. Recorded by H. B. WOODWARD [47] from Tockenham. Great Oolite. See EDW. and HAIME, p. 118.

T. micraston, PHIL. Recorded by PHILLIPS [29]; = *T. concinna*; see EDW. and HAIME, p. 100.

II.—BRACHIOPODA.

Orbiculoidea radiata PHIL. Recorded in Mr. BAYZAND'S list [33]. PHILLIPS' species (described under *Orbicula*) is almost certainly a *Placunopsis.* BLAKE and HUDLESTON called it an *Anomia.*

* That the writer does not stand alone in these conclusions has recently been attested by several publications. See especially O. H. SCHINDEWOLF, "Zur Systematik der Perisphincten."—'Neues Jahrbuch für Min.,' etc., Beilage Bd. 55, Abt. B, p. 498 (1926).

Ornithella bucculenta, Sow. Recorded by PHILLIPS [29]. DAVIDSON ('Mon. Foss. Brach.,' IV, p. 173) says that its horizon is the passage bed of the Lo. Calc. Grit in Yorkshire, associated with *Ornithella hudlestoni*, *Terebratula fileyensis* and *Rhynchonella thurmanni*. Its occurrence in this district remains to be proved.

III.—LAMELLIBRANCHIA.

Alectryonia solitaria (Sow.). Recorded indiscriminately for *Ostrea gregaria*, Sow. It should be restricted to the quite distinct form in the Dorset *Trigonia clavellata* Beds, whence the holotype was obtained.

Anomia suprajurensis, BUV. Recorded by BLAKE and HUDLESTON [6, p. 299] from Highworth. BUVIGNIER'S shell ('Géol. de la Meuse,' p. 26, Plate XX) is from the Portlandian. Probably *Placunopsis radiatus* (PHIL.).

Cardium crawfordi, LECK. Recorded in the lists of WHITEAVES [46] and PHILLIPS [29]. A Kelloway Rock species. The explanation is probably to be found in a specimen of *Unicardium apicilabratum*, ETALL, in the Museum of Practical Geology (No. 43264, from Cumnor) labelled *Cardium crawfordii*.

Cucullæa corallina, DAMON, *C. oblonga*, PHIL., *C. elongata*, PHIL. PHILLIPS (1829), figured three Corallian Cucullæas from Yorkshire, *C. oblonga*, *C. elongata* and *C. contracta*. The first two names were already preoccupied by SOWERBY for Inferior Oolite species, and the third therefore takes precedence for the Corallian species. There can be no doubt that *C. contracta*, PHIL., was a young individual of the common variety known as *C. corallina*, DAMON (1860), and when sufficient material is examined it is apparent that all the English Corallian Cucullæas are varieties of one species, every stage being found intermediate between *C. contracta* and *C. elongata*, PHIL. *non* Sow. *C. laura*, D'ORB., and *C. texta* of many foreign authors also appear to be synonymous.

Exogyra bruntrutana, THURM. Recorded by BLAKE and HUDLESTON from Hilmarton; a Portlandian species.

Goniomya litterata, Sow. Recorded in the lists of WHITEAVES [46] and PHILLIPS [29] in error for *G. v-scripta*. See MORRIS and LYCETT, 'Gt. Ool. Mol.,' p. 120, where *G. litterata*, Sow., is said to be "Comparatively rare; we have obtained it in thin layers of . . . argillaceous limestone (at Minchinhampton) about 100 ft. above the Fullers Earth, also in a much lower position."

Isocardia tumida, PHIL. Recorded by PHILLIPS [29] and figured in the 'Geology of Yorks,' Plate IV, fig. 25, from the Yorkshire Lo. Calc. Grit. I have examined a topotype from the Lo. Calc. Grit of Scarborough (Whitby Museum No. 1648), and find it differs considerably from our Berkshire Oolite species. MORRIS and LYCETT consider *I. tumida*, PHIL., synonymous with *I. tenera*, Sow. ('Gt. Oolite Mol.,' p. 66).

Lima densepunctata, L. duplicata, L. pectiniformis, L. rudis, L. rustica, L. semiornata, L. tumida. See ARKELL [2], pp. 208–209.

Modiola cuneata, SOW. Recorded by PHILLIPS [29]. SOWERBY'S species ('Min. Conch.,' Vol. III, p. 19) comes from the Inferior Oolite of Somerset.

M. perplicata, ETALLON. Recorded by Mr. BAYZAND [33]. I can find no evidence of this very peculiar elongate *Modiola* having occurred in the British Corallian.

Mytilus pectinatus, SOW. Recorded by BLAKE and HUDLESTON [6], probably in mistake for a fragment of *Modiola pulchra*, in which the ornament is very similar. Highly characteristic of the *Trigonia clavellata* Beds of Dorset.

Pecten articulatus, P. demissus, P. episcopalis, P. similis, P. subtextorius, P. vagans, P. vimineus. See ARKELL [2], pp. 551–554.

Pinna ampla, SOW. Frequently recorded from the Corallian, but SOWERBY'S species, of which the holotype is preserved in the British Museum, is from the Inferior Oolite of Mitford (Midford ?). Should be *Pinna* (*Trichites*) *granulata* (SOW.).

Pleuromya calceiformis (PHIL.). Recorded by PHILLIPS [29], probably in mistake for a long variety of *P. tellina*, AG., since *P. calceiformis* was described from the Lower Oolites.

P. decurtata (PHIL.). The polymorphic *P. tellina*, AG., was identified with this species by BLAKE and HUDLESTON [6], certainly wrongly, as is seen by a comparison with figures of the Lower Oolite *P. decurtata* given by MORRIS and LYCETT as well as by PHILLIPS.

Thracia studeri, AG. Recorded in the lists of WHITEAVES [46] and PHILLIPS [29], Agassiz species (*Corimya studeri*, 'Mollusques Fossiles,' p. 269) is from the Portlandian, as is also ROEMER'S (figured as *Tellina incerta*, 'Versteinerungen,' p. 121, Plate VIII, 7). Not proven.

Trigonia clavellata, PARK. This species is certainly confined to the *T. clavellata* Beds of Dorset. Exhaustive field work and inspection of old collections have convinced me that all the numerous records from our district refer to *T. perlata*.

T. costata, SOW. Recorded in PHILLIPS' list [29]. This is certainly confined to the Lower Oolites.

T. incurva, BENNET. Recorded in Mr. BAYZAND'S list [33]. The species is certainly confined to the Kimeridgian-Portlandian.

T. triquetra, SEEBACH. It seems best to limit *T. triquetra* to the peculiar forms occurring exclusively in the Lower Calcareous Grit at Scarborough and Filey, Yorks (LYCETT, *loc. cit.*, Plate VI, fig. 2, and Plate XXXVI, fig. 7, *non* Plate VI, figs. 1, 1a). These differ in several important respects from any found at other horizons, and all specimens recorded in the Oxford district are assignable to the variable *T. perlata* AG.

Trichites ploti, LHWYD. LHWYD'S shell was described from the Lower Oolites. The Corallian species agrees closely with QUENSTEDT'S Corallian *T. giganteus*.

Unicardium depressum, PHIL. Recorded by BLAKE and HUDLESTON [6] from the *Trigonia perlata* Limestones of Highworth. PHILLIPS' species ('Geol. Yorks,' Plate IX, fig. 16) is from the Great Oolite, as is also MORRIS and LYCETT'S species ('Gt. Ool. Moll.,' Plate XIV, fig. 10 and p. 133). The common *Unicardium* at Highworth and elsewhere is rather similar to MORRIS and LYCETT'S figure of *U. depressum*, but the latter is too truncated anteriorly. On the other hand, the former exactly resembles Damon's figure of *Unicardium sulcatum*, LECK., from the Weymouth Corallian ('Supplt. Geol. Weymouth.,' Plate VI, fig. 7), which seems to be D'ORBIGNY'S U. *excentricum.*

U. plenum. So far as I have been able to ascertain, this is still a *nomen nudum*, which is mentioned by BLAKE and HUDLESTON from the *Trigonia perlata* Limestones of Highworth. A specimen of *U. excentricum*, D'ORB., in the Hudleston collection ('Mus. Practical Geology.,' No. Y 1910), is labelled "*Unicardium plenum*, sp. nov. Cor. Oolite, Malton."

IV.—GASTROPODA.

Chemnitzia abbreviata, ROEM., recorded by BLAKE and HUDLESTON [6] from the Natica Band of Cumnor and elsewhere. *C. abbreviata* is a Portland species, and I have no doubt that the fossil found was *Pseudomelania condensata* (D'ORB.). (See *C. abbreviata*, ROEMER, 'Versteinerungen,' p. 159.)

C. melanioides, PHIL. 'Geology of Yorks,' Plate IV, fig. 13. Recorded by PHILLIPS [29]. See HUDLESTON, 'Geol. Mag.,' 1880, footnote on p. 396.

Littorina lævissima, WHITEAVES [46]. Apparently a *nomen nudum.*

Murex haccanensis, PHIL. Recorded by PHILLIPS [29]. See HUDLESTON, 'Geol. Mag.,' 1880, footnote, p. 293—"There being no certain evidence that this is a Corallian form, it is not included among the Corallian Gastropods."

Natica autharis, DE LOR. Some young specimens of *Natica arguta* from the Cumnor Natica Band were so labelled in Oxford University Museum. They certainly bear some resemblance to DE LORIOL'S figures ('Couches Cor. inf. du Jura Bernois,' Plate XII, figs. 2–3), but careful comparison shows difference in shape—chiefly lack of rotundity. On the other hand, the specimens fall into a perfect series from the minute to the full grown stage of *N. arguta.*

Natica cincta, PHIL. Recorded by WHITEAVES [46]. See Morris and Lycett, 'Gt. Oolite Mol.,' p. 113, for synonymy. Lo. Oolites.

N. marchamensis, BLAKE and HUDLESTON [6, p. 394, Plate XIV, fig. 4], seems to be synonymous with *N. arguta*, PHIL., of which BLAKE and HUDLESTON make no mention in their paper, always referring to *N. marchamensis* in connection with the Cumnor Natica Band, etc.

Nerita brevispiralis, PHIL. [29, Plate XIV, fig. 4]. This is undoubtedly an internal cast of a *Neritopsis*, and, being only a cast, hardly justifies a new name. That PHILLIPS' idea of the genus *Nerita* was a very comprehensive one is shown by HUDLESTON 'Geol. Mag.,' 1881, p. 49.

N. minuta, SOW. Recorded in the lists of WHITEAVES [46] and PHILLIPS [29]. See HUDLESTON, 'Geol. Mag.,' 1880, p. 296. Confined to the Inferior Oolite.

NOTES ON NEW SPECIES.

Terebratula kingsdownensis (Plate 1, 6*a*, 6*b*).

? Zeilleria huddlestoni, DE LORIOL, 1889, 'Couches Coralligènes inférieures du Jura Bernois,' Plate XXXVI, figs. 21–24.

Non Waldheimia hudlestoni, DAVIDSON, 1878, 'British Fossil Brachiopoda,' IV, Plate XVII, figs. 14–16.

(Museum of Practical Geology, HUDLESTON Coll., No. Y 1835, eight specimens from Stratton, near Swindon, labelled *Waldheimia margarita*, OPPEL.)

Diagnosis.—Test small, about 11 mm. in length, oval and somewhat pentagonal. Valves implicate. Dorsal valve bearing a very conspicuous growth-line 4 mm. from the foramen, and others at 1·5 mm., 7 mm. and 8·5 mm. The test is finely punctate.

Horizon and Localities.—The holotype and one other specimen were collected by myself in the Osmington Oolite Coral Rag of Kingsdown, near Swindon, in a temporary opening in clay matrix amongst the corals. HUDLESTON'S locality is not known, but cannot be far from this.

Notes.—My specimens resemble DE LORIOL'S figures fairly closely, especially figs. 22, 23 and 25. They show not the least affinity, however, with DAVIDSON'S figures of *Waldheimia hudlestoni* ('Supplt. IV,' Plate XVII, figs. 14–16). The latter are elongate, smooth (lacking growth halts) and deeply plicate, so that it is difficult to see why DE LORIOL identified his specimens with them. There also seems little justification for the grouping by DE LORIOL of DAVIDSON'S *W. margarita* under the synonymy of this species.

Homomya shellingfordensis (Plate 2, fig. 10).

(British Museum, Stratigraphical Collection, unnumbered specimen from the Malton Oolite, Yorks, labelled *Homomya tremula*, BUV. Holotype in the author's collection.)

Diagnosis.—Shell very large, elongate. Umbones near the anterior, a marked ridge passing obliquely backward from them towards the posterior-ventral angle, which is produced. Ornament consists of numerous fine, irregular, concentric growth lines, giving the shell a rough "crinkled" appearance, as in *H. tremula*, BUV.

Dimensions of Holotype.—Length, 130 mm. Height, 71 mm. Inflation, 58 mm.

Notes.—A glance at BUVIGNIER'S figures of *H. tremula* (*Panopœa tremula*, BUV., 'Géol. de la Meuse,' Plate VII, figs. 13–15) suffices to show that the only resemblance is the ornament, which indicates, however, that the species are allied. The species is much less tumid than *H. gibbosa* of the Lower Oolites. The *Arca*-like shape of *H. shellingfordensis*, due to the posteriorly directed ridge from the umbones, might lead to the shell being classed as an *Arcomya*. The ventral margin is convex instead of concave in the centre as in *Arcomya rathieri*, DE LOR.; also the region of greatest tumidity is more anterior, not far behind the umbones, instead of central as in that species, and the umbones are less depressed. It is possible that this species may prove to be the same as the *Homomya grimstonensis* of HUDLESTON'S Yorkshire list, but that species is a *nomen nudum*.

Horizon and Localities.—Only the holotype so far known from the district; Urchin Marls of Shellingord, Berks.

Ostrea pseudocallifera (Plate 1, fig. 2).

(Holotype in the author's collection.)

Diagnosis and Notes.—Shell large, produced, curved. Hinge region narrow, the shell broadening ventrally and curving backward. Adductor scar large and square, situated near the posterior margin about half-way from the hinge line. This oyster bears a striking resemblance to GOLDFUSS' Tertiary *Ostrea callifera* ('Petrefacta Germaniæ,' Plate LXXXIII, fig. 2). It is somewhat intermediate in form between *O. quadrangularis* and *O. deltoidea*, and may be a forerunner of the latter.

Dimensions of Holotype.—Height, 125 mm. Length in hinge region, 52 mm. Length in centre, 61 mm. Greatest length, about 90 mm.

Horizon and Locality.—Pebble Bed of Sheepstead Farm Quarry, Marcham.

Ostrea quadrangularis (Plate 1, fig. 1).

(Holotype in the author's collection.)

Diagnosis.—Shell very large and square, the length in the hinge region being almost as great as at any other point. Hinge line with long and wide ligament area. Muscle scar large and rather square, more central than in *Ostrea pseudocallifera*. Dimensions sometimes very great.

Dimensions of Holotype.—Height, 131 mm. Length in hinge region, 98 mm. Length in centre, 106 mm. Greatest length, 116 mm.

Notes.—There is considerable diversity of form, some specimens being longer in proportion to their height, others less symmetrical, but all are characterised by the width and length of the ligament area. It is this character, together with the marked angularity of outline, which distinguishes the species from *O. colossa* DE LORIOL ('Rauracien inf. du Jura Bernois,' Plate X, fig. 1). In all but size there is some resemblance to the right valve of *O. moreana*, BUV., which has, however, an Exogyriform left valve.

Horizon and Locality.—Very characteristic of the *T. perlata* Beds at Highworth, Kingston Bagpuize and elsewhere; the most perfect specimens (including the holotype) were obtained at Littleworth, Berks.

Aspidoceras crebricostis (Plate 2, fig. 1).

(Holotype in the author's collection.)

Measurements.—Diameter, 220 mm. Whorl height, 29·5 per cent. Whorl thickness, 27 per cent. (22 per cent. between ribs). Umbilicus, 48·5 per cent.

Notes.—At 220 mm. there are 23 costæ to the whorl. The inner whorls resemble *A. hirsutum*, having prominent tubercles produced into spines. At a later stage these develop into exceptionally coarse ribs, into which the tubercles seem to be absorbed, the ribs becoming more closely crowded.

Horizon and Locality.—Pebble Bed, Lamb Inn Quarry, Kingston Bagpuize, Berks. Recorded in 'Type Ammonites,' V, Feb., 1925, as Aspidocerate sp. C.

Aspidoceras paucituberculata (Plate 2, fig. 2).

(Holotype in the author's collection.)

Measurements.—Diameter, 242 mm. Whorl height, 30 per cent. (thickness ?). Umbilicus 47 per cent. At 162 mm. the corresponding measurements are 162, 33, 30, 44.

Notes.—This species shows the opposite extreme of Aspidocerate development to *A. crebricostis*, its surface being distinguished by its unusual smoothness. At about 220 mm. there are only 12 pairs of tubercles, at about 160 mm. 14 pairs; in other words, the spaces between adjoining pairs of tubercles increase as growth proceeds, the opposite process to that occurring in *A. crebricostis*. The tubercles are always small, and the individuals of each pair are widely set apart, near the edges of the lateral areas. They do not become joined by appreciable ribs.

Horizons and Localities.—This is the highest *Aspidoceras* yet met with in the district, occurring half-way up the *T. perlata* Limestones of Hangman's Elm Quarry, Highworth (lowest foot of Bed 6). It also occurs in the Pebble Bed at Littleworth, Berks. Recorded in 'Type Ammonites,' V, Feb., 1925, as Aspidocerate, sp. A.

Cardioceras highmoori (Plate 2, fig. 3).

(Holotype in the author's collection.)

Measurements.—Diameter, 152 mm. Whorl height, 47 per cent. Whorl thickness, 38 per cent. Umbilicus, 24·5 per cent.

Notes.—This species is distinguished from *Cardioceras excavatum* by the much greater width of the umbilicus, $24\frac{1}{2}$ per cent. of the diameter as against the 12–16 per cent. of *Cardioceras excavatum* (which is the maximum, except when the measurement is taken near the termination of the body chamber, where it suddenly increases); also by the deeply excavated or undercut umbilical areas, which give an unusual sharpness to the angle between them and lateral areas, the whorl section forming almost an isosceles triangle.

Horizon and Localities.—Near the top of the *T. perlata* Limestones (Bed 8), Hangman's Elm or Highmoor Quarry, near Highworth, Wilts. Recorded 'Type Ammonites,' V, Feb., 1925, as Sp. C.

APPENDIX II.

Mapping.

The mapping of the eastern and western extremities of the district has been recently revised by the Geological Survey, and published on the 1-inch scale in their Oxford Special Sheet and Marlborough Sheet respectively. The revision of the intervening region, in which is comprised the greater part of the Corallian outcrop dealt with in this paper, still remains to be carried out.

The accompanying map represents but a small part of this area, near the town of Highworth. It is based on the 1925 edition of 'Berkshire Sheet XII, N.W., Wiltshire Sheet XI, N.W.,' of the 6-inch Ordnance Map. The area covered is 6 square miles. Within the compass of this sheet the Corallian attains its most complete development, and the Berkshire Oolites reach their maximum thickness.

The country lends itself excellently to geological mapping. Unlike so much of the Berkshire outcrop, it does not consist of a monotonous plateau, but of variously dissected hills, rising from 100 to 150 ft. above the general level of the Oxford Clay plain. The form of these hills bears a direct relation to geological structure.

The only geological map published hitherto is that of the Geological Survey, Old Series, sheet 34, by Edward Hull, published in 1857, revised in 1859. Much of the misleading nature of this map may be ascribed to the limitation imposed on the surveyor by the inadequate subdivision of the rocks. Of the three old divisions (Lower Calcareous Grit, Coral Rag and Upper Calcareous Grit), only the two first were considered to enter into this area, and it is obvious that the surveyor drew the boundary at different horizons in the Berkshire Oolites at different places.

This does not account, however, for the fact that, within the scope of three adjacent fields on Red Down, Oxford Clay, the whole sequence of the Corallian formation, and an outlier of Upper Calcareous Grit clay and possibly Kimeridge Clay, 25 ft. thick, are all mapped as Lower Calcareous Grit.*

* At W(101) on the map a deep boring was sunk in 1904, passing right through Red Down. For detailed account of strata penetrated, see 'Wilts. Arch. Nat. Hist. Mag.,' vol. 44, pp. 43–45 (1927).

Results.

The main objects of mapping this area were to demonstrate the local importance of the subdivisions established, their continuity and distribution, and the effect which they exercise upon the topography, the nature of the soil, and the water supply. Besides these, however, several important results of an unexpected nature have been obtained :—

(i) Accurate mapping has revealed the presence of luxuriant, but local, coral reefs in the *Trigonia perlata* Limestones, exposed in quarries which, on the evidence of the fossils, had formerly been regarded as showing typical Coral Rag of Osmington Oolite age. In at least two localities the massive corals are associated with the fauna characteristic of the later rag, and the Ammonite and Lamellibranch fauna of the *Trigonia perlata* Limestones is absent. In another locality, just outside the sheet but also mapped, the two faunas are mingled. Areas in which such local reefs are known to occur are marked C on the map.

(ii) The local overstepping of the later or Osmington Oolite Coral Rag on to Berkshire Oolites, Lower Calcareous Grit and Oxford Clay, between Warneford Place (S.E. corner of map) and Stanton Park (S.W. corner) denotes local uplift and erosion between Berkshire and Osmington Oolite times. This has been revealed by detailed mapping, and could have been discovered in no other way. It definitely excludes here such alternative explanations as involve the non-deposition of the missing rocks, or the simulation of the typical Osmington Oolite rag by an earlier rag. Thus is afforded a concrete example of what has been often surmised in preceding pages from the resting of the Osmington Oolite Coral Rag upon various levels of the Berkshire Oolites throughout Berkshire, and from the Pebble Bed at its base at Badbury Hill.

The uplift here was of limited lateral extent, since S.E. of Sevenhampton Lower Calcareous Grit and Berkshire Oolites are still an important surface feature. This local uplift and erosion must not be confused with the general S.W.–N.E. thinning of the Berkshire Oolites into Shell-cum-Pebble Beds in the directions of Headington and Wootton Bassett.

EXPLANATION OF LETTERS ON MAP.

Q = Quarries, sandpits or clay pits.

R = Principal exposures of sand due to the activities of rabbits or other causes.

F = Fossil localities on the ploughed fields, etc.

- F_1. Coral Rag with massive corals, *Lima zonata*, etc., exposed after heavy rains.
- F_2. Eight Perisphinctids found, plus *Trigonia meriani*, *Cucullæa contracta*, *Pholadomya canaliculata*, etc.
- F_3. Portions of a gigantic *Perisphinctes* found.
- F_4. *Trigonia perlata*, *Cucullæa contracta*, etc.
- F_5. Fragment of a *Perisphinctes*.
- F_6. *T. perlata*, *C. contracta*, *Astarte ovata*, etc.

F = Fossil, etc.—continued.

F_7. *Cucullæa contracta*, corals, etc.

F_8. *Cardioceras excavatum.*

F_9. *Gryphæa dilatata* in banks of stream.

F_{10}. Test of *Diplopodia versipora.*

W = Wells and borings of which records are available. For records and interpretations of these, see Arkell, W. J., "The Red Down Boring, Highworth, and its Geological Significance, with Notes on Neighbouring Wells," 'Wilts. Arch. Nat. Hist. Mag.,' XLIV, pp. 43–48 (1927). (W(101) = Red Down Boring.)

C = Local coral reefs in *T. perlata* Limestones.

EXPLANATION OF PLATES.

Plate 1.

Fig. 1. *Ostrea quadrangularis* nov. Holotype. (Right valve.) *Trigonia perlata* Bed, Littleworth, Berks. Author's coll. Nat size.

Fig. 2. *O. pseudocallifera* nov. Holotype. (Right valve.) Pebble Bed, Marcham, Berks. Author's coll. Nat. size.

Fig. 3. *Plicatula weymouthiana*, Damon. *T. perlata* Limestones, Highworth, Wilts. Author's coll. Nat. size.

Fig. 4. *Ctenostreon proboscideum* (Sowerby). Portion of the umbonal region of a young specimen in exceptional state of preservation, showing the tubular spines originating close to the umbo. Stanford in the Vale, Berks. Author's coll. Twice nat. size.

Fig. 5. *Cyprina corallina*, D'Orbigny. Redcliff, Weymouth, Dorset. Horizon not recorded. Museum of Practical Geology, 43266. Nat. size. (Species not previously figured.)

Fig. 6. *Terebratula kingsdownensis* nov. Holotype. Osmington Oolite Coral Rag, Kingsdown, near Swindon, Wilts. Author's coll. Three times nat. size.

Plate 2.

Fig. 1. *Aspidoceras crebricostis* nov. Holotype. Pebble Bed, Lamb Inn Quarry, Kingston Bagpuize, Berks. (Bed 3.) Author's coll. Reduced to 0·36 nat. size.

Fig. 2. *A. paucituberculata* nov. Holotype. *T. perlata* Limestones (base of Bed 6), Hangman's Elm or Highmoor Quarry, Highworth, Wilts. Author's coll. Reduced to 0·31 nat. size.

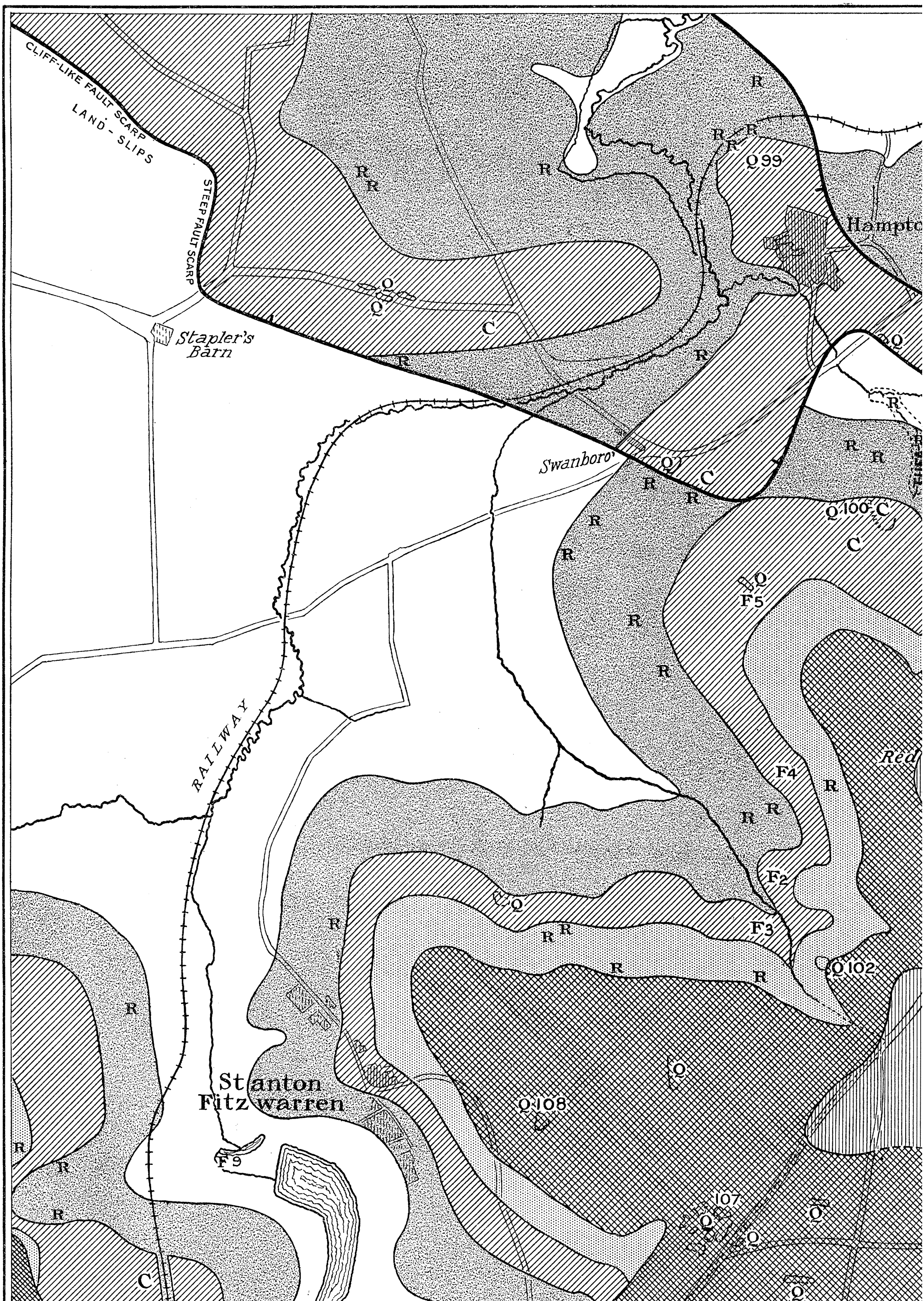
Fig. 3. *Cardioceras highmoori* nov. Holotype. *T. perlata* Limestones (Bed 8), Hangman's Elm or Highmoor Quarry, Highworth, Wilts. Author's coll. Reduced to 0·46 nat. size.

Fig. 4 *a* & *b*. *Unicardium apicilabratum*, Etallon. *T. perlata* Limestones, Highworth, Wilts. Author's coll. Nat size. The commonest constituent of the micromorphic fauna of the Pusey Flags, in which it forms a limestone at Carswell Farm, Buckland, Berks.

Fig. 5. *Pseudomelania condensata* (D'Orbigny). *Natica* Band near top of the Lower Calcareous Grit, Bradley Farm, Cumnor, Berks. Oxford University Museum. Nat. size, but not quite full grown.

Fig. 6 *a* & *b*. *Chlamys* (*Æquipecten*) *fibrosus* (Sowerby). *a* left valve, *b* right valve. The commonest and most characteristic fossil of the Berkshire Oolites from Oxford to Weymouth. (Author's coll., Highworth, Wilts.) Nat. size.

CORALLIAN SER



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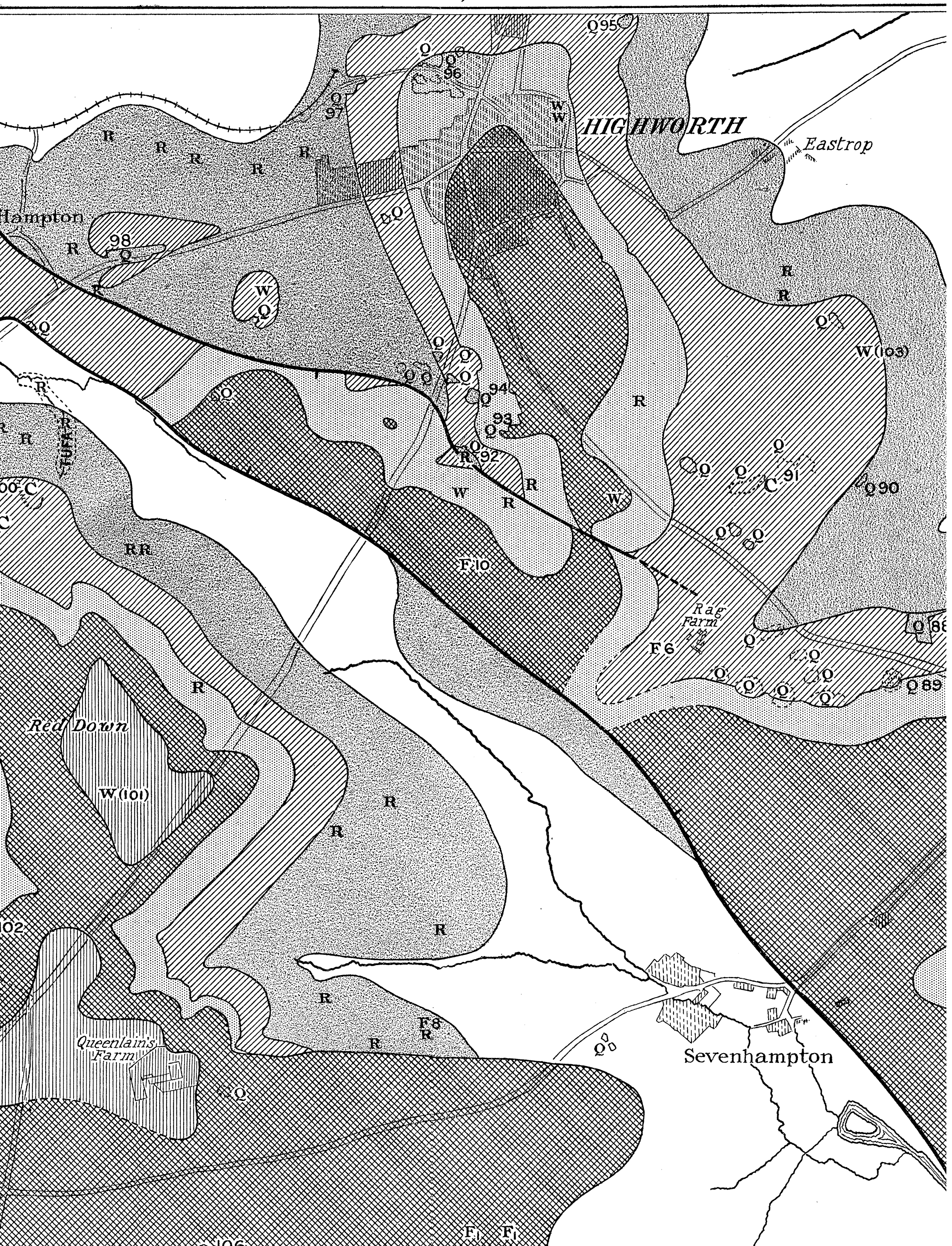

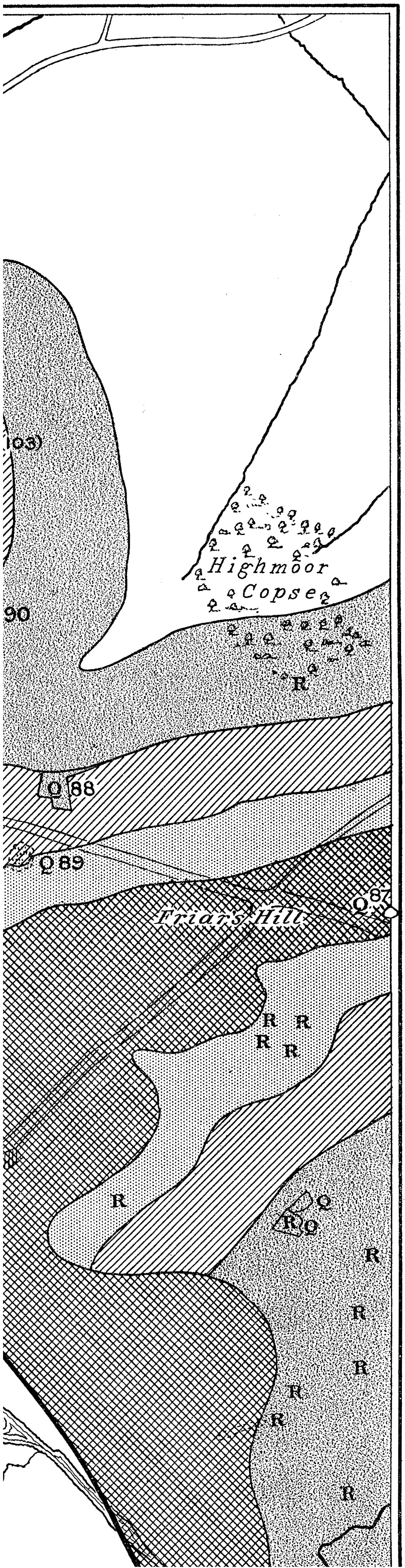
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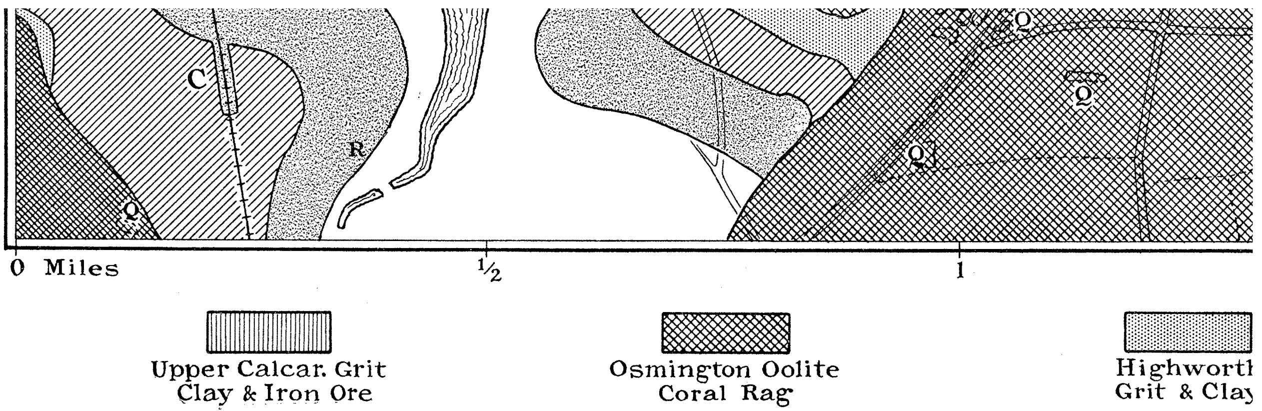
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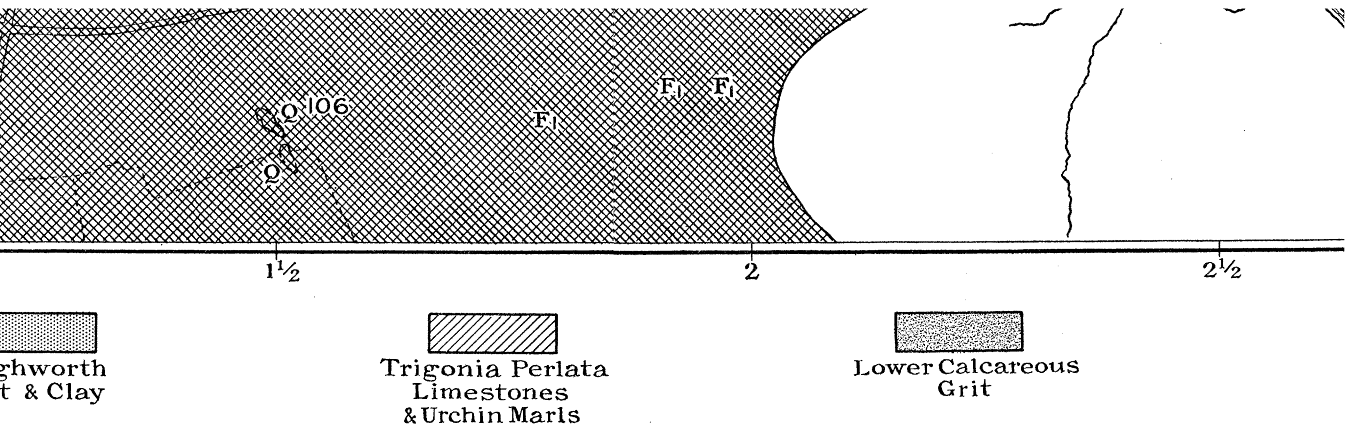

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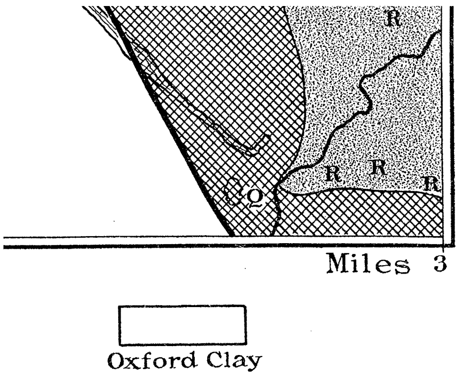


(Facing p. 180)

FIG. 7. *Chlamys qualicosta* (ETALLON). Right valve. The commonest and most characteristic fossil of the Osmington Oolite Series of Dorset and Yorkshire, occurring more rarely in the coral rag of the Wilts–Oxford coralline province. Unknown in the Berkshire Oolites. (B. M. Coll., Yorkshire.) Nat. size.

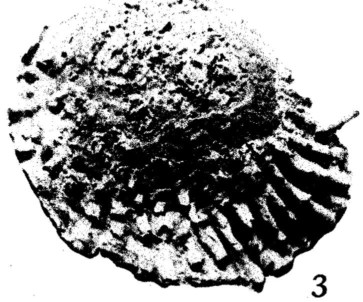
FIG. 8. *Arca* (*Parallelodon*) *quadrisulcata* SOWERBY. Coral reef in *T. perlata* Limestones, railway cutting, Stanton Fitzwarren, Wilts. Author's coll.

FIG. 9. *Corbicella lævis* (SOWERBY). Topotype. *T. perlata* Bed, Marcham, Berks. Author's coll. Nat. size. (Only the inside of the holotype, which is preserved in the British Museum, is visible or has been figured.)

FIG. 10. *Homomya shellingfordensis* nov. Holotype. Urchin Marls, Shellingford Cross-Roads Quarry, Berks. Author's coll. Nat. size.

(Photographs by Mr. A. D. PASSMORE, the author, and Mr. E. J. MANLY.)

1



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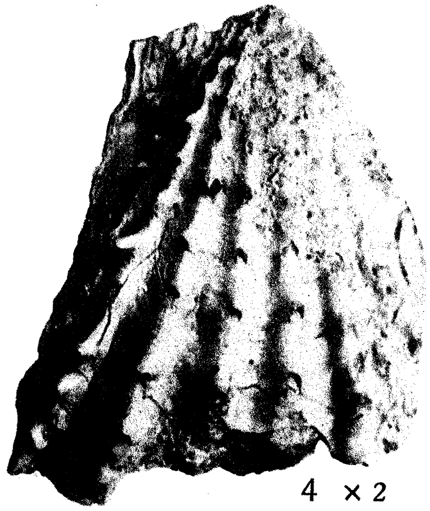
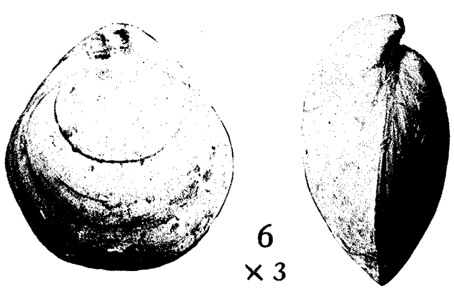


4 × 2

2

5

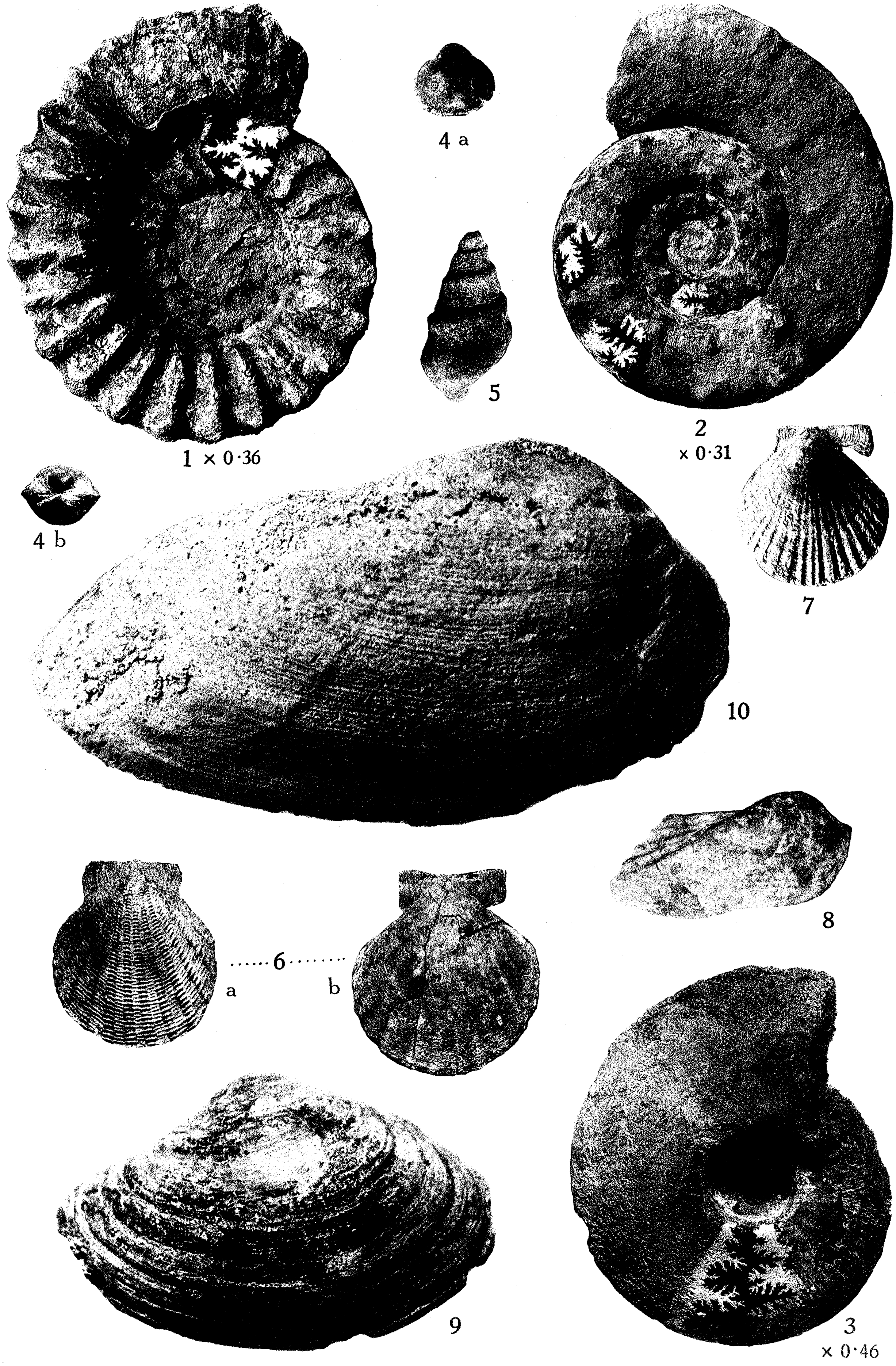


6 × 3

a b

Zinco Collotype Co., Edinburgh

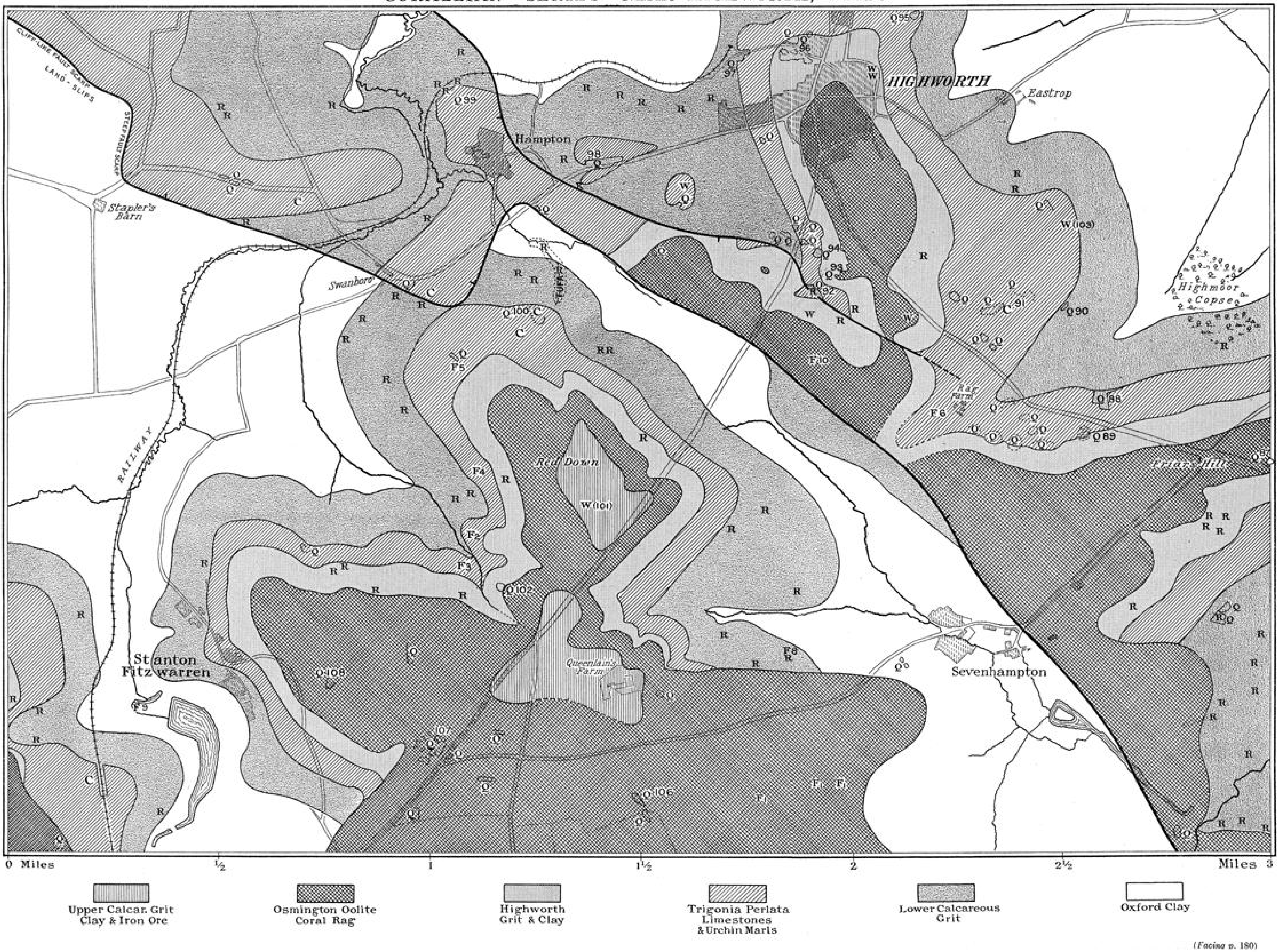
CORALLIAN MOLLUSCA and BRACHIOPOD.

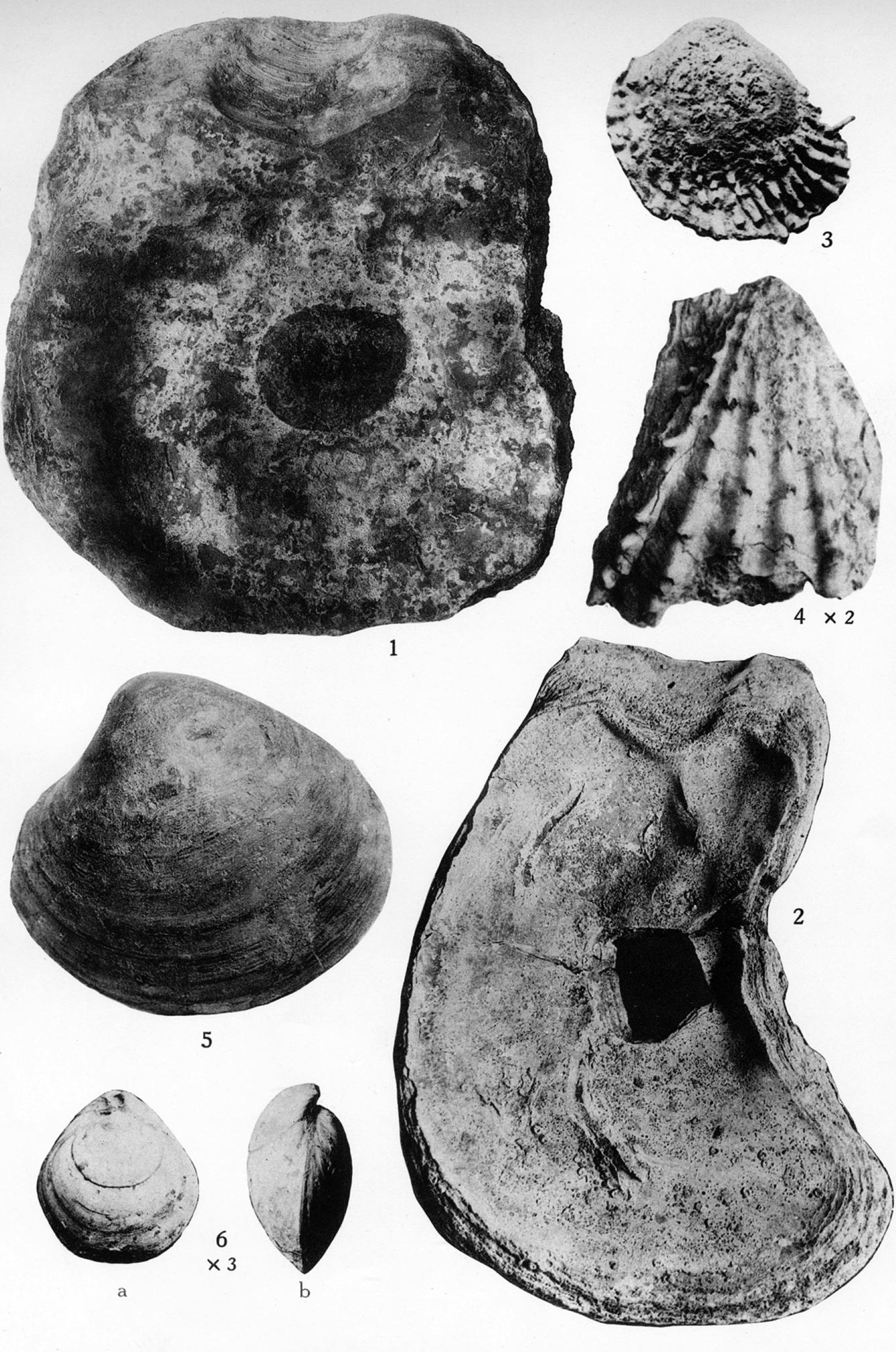


Zinco Collotype Co., Edinburgh

CORALLIAN MOLLUSCA.

CORALLIAN SERIES NEAR HIGHWORTH, WILTS.





CORALLIAN MOLLUSCA and BRACHIOPOD.

PLATE 1.

FIG. 1. *Ostrea quadrangularis* nov. Holotype. (Right valve.) *Trigonia perlata* Bed, Littleworth, Berks. Author's coll. Nat size.

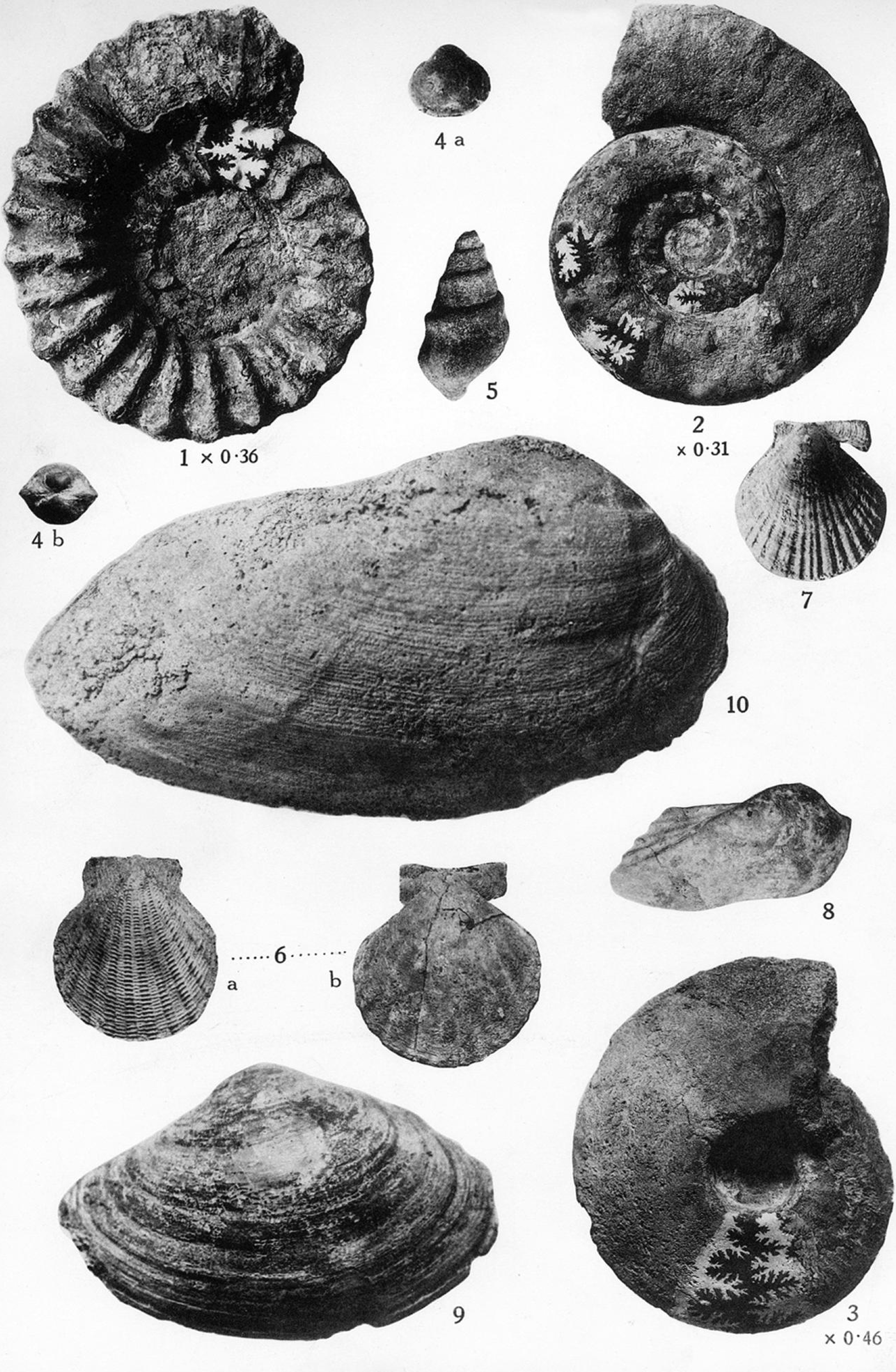
FIG. 2. *O. pseudocallifera* nov. Holotype. (Right valve.) Pebble Bed, Marcham, Berks. Author's coll. Nat. size.

FIG. 3. *Plicatula weymouthiana,* DAMON. *T. perlata* Limestones, Highworth, Wilts. Author's coll. Nat. size.

FIG. 4. *Ctenostreon proboscideum* (SOWERBY). Portion of the umbonal region of a young specimen in exceptional state of preservation, showing the tubular spines originating close to the umbo. Stanford in the Vale, Berks. Author's coll. Twice nat. size.

FIG. 5. *Cyprina corallina,* D'ORBIGNY. Redcliff, Weymouth, Dorset. Horizon not recorded. Museum of Practical Geology, 43266. Nat. size. (Species not previously figured.)

FIG. 6. *Terebratula kingsdownensis* nov. Holotype. Osmington Oolite Coral Rag, Kingsdown, near Swindon, Wilts. Author's coll. Three times nat. size.



CORALLIAN MOLLUSCA.

PLATE 2.

FIG. 1. *Aspidoceras crebricostis* nov. Holotype. Pebble Bed, Lamb Inn Quarry, Kingston Bagpuize, Berks. (Bed 3.) Author's coll. Reduced to 0·36 nat. size.

FIG. 2. *A. paucituberculata* nov. Holotype. *T. perlata* Limestones (base of Bed 6), Hangman's Elm or Highmoor Quarry, Highworth, Wilts. Author's coll. Reduced to 0·31 nat. size.

FIG. 3. *Cardioceras highmoori* nov. Holotype. *T. perlata* Limestones (Bed 8), Hangman's Elm or Highmoor Quarry, Highworth, Wilts. Author's coll. Reduced to 0·46 nat. size.

FIG. 4 *a* & *b*. *Unicardium apicilabratum*, ETALLON. *T. perlata* Limestones, Highworth, Wilts. Author's coll. Nat size. The commonest constituent of the micromorphic fauna of the Pusey Flags, in which it forms a limestone at Carswell Farm, Buckland, Berks.

FIG. 5. *Pseudomelania condensata* (D'ORBIGNY). *Natica* Band near top of the Lower Calcareous Grit, Bradley Farm, Cumnor, Berks. Oxford University Museum. Nat. size, but not quite full grown.

FIG. 6 *a* & *b*. *Chlamys* (*Æquipecten*) *fibrosus* (SOWERBY). *a* left valve, *b* right valve. The commonest and most characteristic fossil of the Berkshire Oolites from Oxford to Weymouth. (Author's coll., Highworth, Wilts.) Nat. size.