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The Fauna of the Basal Shell-Bed of the Portland Stone, Isle of Portland.

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(including a description of the Polyzoa by
W. D. LANG, M.A., Sc.D., F.G.S.)

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INTRODUCTION.



ALTHOUGH the Isle of Portland has supplied a stratigraphical term of universal adoption, our knowledge of the fossil fauna of the rocks of this locality has hitherto been very scanty. It is true that the geological student, at an early stage in his career, is presented with a hand-specimen of the Roach, and learns to identify the cavities in it as *Cerithium portlandicum*. He soon becomes familiar with the gigantic ammonites with which every museum is well stocked—but, for the rest, would probably be unable to name more than half a dozen species which are to be found in the Portland Stone.

The Portlandian rocks of the Island have, in fact, been very much neglected by collectors and other workers in the past. It is therefore extremely fortunate that Lt.-Col. R. H. Cunnington, R.E., of Weymouth, has, during the past year,

undertaken a closer investigation of the fossils which are to be collected there, and has soon discovered that our Portlandian fauna is much more varied and interesting than is usually supposed. Of especial interest is the fauna of the very basal bed of the stone-series. From this bed Col. Cunnington has obtained a series of fossils which, by reason of their variety and excellent state of preservation, are probably the most important set of specimens which have ever been collected from our Portlandian rocks.

I am very much indebted to Col. Cunnington, both for his kindness in placing these specimens at my disposal for description, and for his hospitality, when I had the pleasure recently of visiting his collecting-ground.

THE ISLE OF PORTLAND.

As is well known, the top of the Island, which slopes gently to the south, is a dip-slope formed by rocks of the Purbeck Formation, which are rapidly being stripped away by quarrying activities. The Portlandian Formation beneath consists of a series of stone-beds, about eighty feet in thickness, underlain by the Portland Sands, soft arenaceous and marly beds, usually of a dark colour, with occasional bands of cement-stone. These pass down into true Kimmeridge Clay, the exact horizon at which the boundary between the two formations should be drawn being still an undecided question.

The whole sequence is well shown on the western side of the Island, where the structure is not so obscured by landslips and quarry-tips as on the eastern side. It is at once seen that the top portion of the cliffs is formed by the Stone, and is vertical, or even overhanging, while the basal portion of the cliffs, formed by the Sands, slopes down to the sea at a fairly steep angle. The beds which are quarried all occur in the upper portion of the stone-series. At the very top is the Roach, the well-known oolitic shelly limestone, about three feet thick, honeycombed with casts of *Trigonia*, *Cerithium portlandicum*, etc. Below this comes the sparsely fossiliferous oolitic

limestone, the Whit Bed, which yields the best building stone, and averages about 10ft. in thickness. The Base Bed, another oolitic limestone, about 8ft. below the Whit Bed, is the lowest stone that is quarried. Below this, beds of flint, often of considerable thickness, become intercalated with increasing frequency in the limestone sequence, and the flint-banding becomes fairly regular until about 7—8 feet from the base of the Stone. With the exception of occasional beds with *Ostrea* and *Trigonia*, this flinty series is very unfossiliferous.

THE BASAL SHELL-BED.

The bottom 7—8 feet of the Stone, with which the present paper deals, is a very different type of rock from the overlying limestones. It is an extremely hard limestone composed very largely of shells and shell-fragments, together with innumerable tubes of the worm, *Serpula gordialis*. This rock has undergone intense recrystallisation since its original deposition. Many of the shells, with their surrounding, and enclosed matrix, are entirely recrystallised as calcite, which exhibits the characteristic cleavage-planes of this mineral, and breaks very readily along them, irrespective of boundary between shell and matrix. It is usually an impossible task to break shells out of this matrix. Fortunately for the palæontologist, years of atmospheric erosion have accomplished what is impossible artificially, and many of the shells on the surface have been very beautifully “weathered out,” and adhere to the original rock only by a small portion of matrix. Even then, collecting is by no means a simple task, and much patience with the hammer and chisel is required before these weathered-out specimens can be obtained undamaged from the surface of the stone.

COLLECTING LOCALITIES.

The numerous quarries on the Island do not, of course, penetrate below the stone-beds of commercial value, and, to examine the lower portion of the Portland Stone, and the Sands below, the cliff-sections must be visited. The eastern

cliffs are so screened by quarry-tips and landslips that they offer few exposures, and nowhere can the base of the Stone be well examined. Fortunately the western cliffs, although hidden in places by boulders tipped over from the quarries, offer some good sections of the whole sequence. Starting from the town of Chiswell, at the northern end of the Island, a foot-path leads us past the end of the Chesil Beach, on to the undercliff, formed chiefly by blocks of stone fallen from above. About two hundred yards before this path ends, a steep, zigzag path leads to the left up to the top of the cliffs; by ascending this, we can examine the whole sequence of stone-beds. The basal shell-bed crops out about eighty feet below the top, and, beneath it, a narrow ledge occurs at the top of the steep slope formed by the Portland Sands. Proceeding along this ledge to the right we can examine *in situ* a very fine section of the shell-bed, some two hundred yards long, and, with the aid of hammer and chisel, can collect those of the weathered-out fossils that are within reach. Immediately to the south of this exposure the cliffs are very steep, and the shell-bed inaccessible. Further on, however, a second exposure, somewhat similar to the first, may be examined. Just before Blacknor Battery, a path leads down from the edge of the cliffs, and, by turning to the left, the collector can scramble along the ledge at the foot of the shell-bed, and follow this right round the headland, as far as the small bay known as Mutton Cove. Here the section becomes obscured by *débris* from the quarry at the edge of the cliff. From this point, to where the base of the Stone finally reaches the foot of the cliffs and disappears, the sections, where not obscured, are so inaccessible as to be quite beyond the collector's reach.

It is thus seen that the shell-bed can only be examined *in situ* for a total distance of about a quarter of a mile. On the beach below these exposures, however, many fallen blocks of the same bed can be examined, and, now that the best accessible specimens from the cliff have been obtained, the collector will probably find these more fruitful. The shell-bed

is so peculiar and easily recognised that no mistake can be made in identifying the fallen boulders.

Where exposed on the Mainland, the corresponding bed at the base of the Stone seems usually to be a softer rock, and it is nowhere so highly fossiliferous as on the Island.

PREVIOUS WORK ON THE SHELL-BED.

The excellent state of preservation of the fossils of the shell-bed raises the question why it has been so neglected in the past. It is true that Blake (1880*, p. 192), refers to it, and, while recording ten species from it, remarks that it has been by no means thoroughly searched. The bed was also known to Hudleston—a few specimens collected by him in Mutton Cove form part of the collection recently presented by Miss Raisin to the Geological Survey Museum. These are, however, indifferent examples of the commonest species, and indicate only a hasty visit to the locality. The fact that no previous attempt has been made to collect systematically from the bed is probably to be attributed to the inaccessibility of the exposures.

PREVIOUS WORK ON THE BRITISH PORTLANDIAN.

The importance of the series of fossils collected by Col. Cunningham is emphasised by reference to previous work on the Portlandian of this country.

For a long time the only described molluscan species from this formation were ten in Sowerby's "Mineral Conchology," nine in J. de C. Sowerby's appendix to Fitton's important memoir (1836), and three others in Miss Benett's monograph (1831). Subsequently a few further forms were described by Damon (1860), Phillips (1871) and Lycett (1872-9), but it was not until the publication of Blake's important paper (1880) that it was demonstrated that our Portlandian fauna is much larger than had been supposed. In this paper he describes sixteen new species, and records a large number of other forms

* See references at end of paper.

previously known only from France, where they had been described in the monographs of Buvignier (1852) and de Loriol (1867, 1868, 1872, 1874-5). Since Blake's time a paper by Hudleston (1881) describes several Portlandian gastropods, while, much more recently, Buckman (1909-) has figured some of the ammonites.

It will be seen that this literature is very scanty, when compared with what has been written about the fossils of most of our formations. Moreover, most of the works which have been cited deal with the Portlandian as developed at the inland localities in the counties of Wilts., Oxon., and Bucks. Recent work on the succession of ammonite zones, initiated by Salfeld (1914), has also dealt mostly with these inland localities, and the need for a detailed investigation of the I. of Portland succession has been felt by those who have been engaged in this work.

HORIZON OF THE SHELL-BED.

The detailed zonal succession of the beds of the Isle of Portland can only be worked out when a large number of accurately collected ammonites are available for study. The collecting of these will be no easy task, since the specimens are mostly of enormous size, and embedded in extremely hard matrix. Those which I have been able to examine in writing the present paper have been few in number, but seem to confirm the opinion of Salfeld that the base of the Stone is at about the junction of the *gorei* and *pseudogigas* Zones. A specimen which seems to be a typical *gorei* has been collected from the very base of the shell-bed, while *pseudogigas* itself is observable *in situ*, this being the first locality and horizon from which the species is recorded by Blake (1880, p. 192; see, however, the palæontological section of the present paper, dealing with the ammonites).

Buckman (1922, p. 26) gives a tentative zonal classification of the Portland Beds, and places the Flinty Series of the Island (+ -) in his *gorei* Hemera, fairly late in his Behemothan age. Much more collecting must be done before Buckman's

succession can either be substantiated or disproved—at present it is purely hypothetical.

FAUNA OF THE SHELL-BED.

Ammonites are comparatively rare in this bed, the molluscan fauna consisting mainly of lamellibranchs and gastropods. It is with these two groups that the present paper mainly deals. Up to the present, representatives of about fifty-five species of lamellibranchs have been discovered, of which eighteen are described as new. Of the remainder, several have never before been found in this country, while others, although known from other localities, have previously been met with in such a bad state of preservation that their characters have been very incompletely known. Of the gastropods, a number of which have weathered out perfectly, about seventeen species have been discovered, nine of which are new. The excellent state of preservation of the weathered-out Echinoidea is also worthy of notice. These specimens are now being studied by Prof. H. L. Hawkins, who has been kind enough to supply me with a provisional list of his identifications, pending their fuller description on a later occasion. It is seen that five forms are definitely represented, including two new species and a new variety. The Asteroidea are represented by some star-fish ossicles, of undetermined genus.

Polyzoa are very rare, but those which have been found are of considerable interest. Dr. Lang has kindly added a description of these to the present paper ; it is seen that a new genus is represented.

Portions of the shell-bed are almost completely composed of the matted, coiled tubes of the worm, *Serpula gordialis*, this being by far the most abundant organism in the rock. No representatives of the remaining invertebrate groups have been found. The Brachiopoda, in particular, are conspicuous by their absence. Of higher organisms, the Reptilia are represented by *Cimiliosaurus portlandicus*, of which one dorsal vertebra has been found. A small fish-tooth belongs to a representative of the genus *Lepidotus*.

The general facies of the bed suggests very rapid deposition under quite shallow marine conditions—conditions which, in fact, were quite analogous to those of the deposition of the shelly crags of our Pliocene deposits. I know of no other Jurassic bed at all similar to the present one. Corals are entirely absent, so that conditions were quite different from those of the fossiliferous reef-deposits of the Corallian, for example.

Not much can be said concerning the affinities of the whole fauna. Prof. Hawkins has found that the echinoid fauna is more related to those of higher horizons than to the typically Jurassic faunas of the Kimmeridgian, and lower formations. The mollusca, on the other hand, are a typical Jurassic assemblage, some of the species here described being very similar to forms found at much lower horizons, such as the Corallian and Bathonian.

In the present paper a complete faunal list of the species hitherto collected by Col. Cunnington is first given, followed by a detailed palæontological section, in which the new, or little-known forms are described. Many of the species which figure in the list will not receive further mention, although extremely good specimens of some of them have been obtained. Such species are considered to be sufficiently well known already.

Before proceeding, I must acknowledge my indebtedness to two or three gentlemen who, in addition to those already mentioned, have assisted me in various ways during the writing of the present paper : to Dr. L. F. Spath, for discussing the ammonite identifications ; to Mr. C. P. Chatwin, for showing me the Hudleston Collection, and other specimens in the Geological Survey Museum, Jermyn Street ; to Prof. A. Morley Davies for the loan of specimens ; and to Messrs. E. I. White and W. E. Swinton, for identifying respectively the fish and reptile remains.

Col. Cunningham has most kindly presented the holotypes of the new species, and other specimens figured in the present paper, to the Geological Department of the British Museum. The numbers quoted in connection with the specimens are the registration-numbers of the collection of this Museum. A series of specimens will also be deposited in the County Museum at Dorchester.

FAUNAL LIST.

(C denotes species is abundant; R, especially rare;
the remainder are not very abundant).

VERMES.

- Serpula gordialis* Schlotheim
C.
Serpula sp.

ASTEROIDEA.

- Ossicles (gen. indet.)

ECHINOIDEA.

- Tetragramma* sp. nov.
Tetragramma sp. nov., aff.
T. rougonense (Cotteau)
Trochotiara sp., cf.
T. magnagramma (Wright)
Trochotiara thirriai
(Étallon), var nov.
Nucleolites (? *Clitopygus*)
brodiei (Wright)
? *Hemicidaris* sp. (radioles)

POLYZOA.

- Elaphopora cervina*, gen. et
sp. nov.
Berenicea damnatorum, sp. nov.

LAMELLIBRANCHIA.

- Nucula lorioli* sp. nov.
Nuculana (*Isonuculana*)
dammariensis (Buvignier) R.
Barbatia cavata (de Loriol) C.
Parallelodon dorsetensis
sp. nov. R.
Perna bouchardi Oppel.
Inoceramus cunningtoni
sp. nov. R.
Pseudomonotis sp. R.
Ostrea expansa J. Sowerby
C.
Ostrea blakei sp. nov.
Ostrea (*Lopha*) *solitaria*
J. de C. Sowerby
Ostrea (*Lopha*) *damoni*, sp.
nov. R.
Exogyra bruntrutana
(Thurmann) C.
Trigonia gibbosa J. Sowerby
C.
Trigonia tenuitexta Lycett
Trigonia portlandensis, sp.
nov. C.

FAUNAL LIST—continued.

Trigonia incurva Benett
(fide Blake)

Trigonia sp. aff.

T. concentrica Agassiz R.

Trigonia radiata Benett C.

Camptonectes suprajurensis
(Buvignier) R.

Camptonectes lamellosus

(J. de C. Sowerby) C.

Plicatula boisdini de Loriol

Plicatula echinoides Blake

Plicatula sp. cf. *P. beaugrandi*
de Loriol R.

Lima rustica (J. de C. Sowerby)
C.

Myoconcha portlandica Blake

Mytilus suprajurensis sp. nov.

Modiolus hudlestoni sp. nov.

Modiolus pallidus J. Sowerby
R.

Modiolaria autissiodorensis
(Cotteau) C.

Pleuromya tellina Agassiz C.

Venilicardia implicata
(de Loriol) C.

Venilicardia elongata
(Blake) C.

Venilicardia courcellensis
(de Loriol)

Venilicardia pulchella
(de Loriol)

Venilicardia sp. cf.

V. intermedia (de Loriol)

Venilicardia subquadrata
sp. nov. R.

Venilicardia cunningtoni
sp. nov. R.

Isocyprina pringlei sp. nov.

Isocyprina elongata sp. nov.

Isocyprina compressa
sp. nov. R.

Isocyprina obesa sp. nov. R.

Plesiocyprina sp. R.

Anisocardia buckmani sp. nov.

Astarte kitchini sp. nov. C.

Astarte salfeldi sp. nov. R.

Unicardium verioti
(Buvignier)

Lucina portlandica

(J. de C. Sowerby) C.

Protocardia dissimilis

(J. de C. Sowerby) C.

Venus portlandica sp. nov.

Sowerbya (Isodonta) longior
Blake C.

Corbula mosensis Buvignier
C.

Corbula sp. cf. *C. ferruginea*
de Loriol R.

Corbula saltans Blake C.

Corbula bayani de Loriol R.

GASTROPODA.

Pleurotomaria rozeti de Loriol
(fide Blake)

Pleurotomaria rugata
(Benett) C.

Eumargarita durui (de Loriol)
R.

Proconulus foucardi (de Loriol)

FAUNAL LIST—continued.

<i>Delphinula portlandensis</i> sp. nov.	<i>Euspira ceres</i> (de Loriol) C.
<i>Nododelphinula vivauxea</i> (Buvignier)	<i>Vanikoro fittoni</i> sp. nov.
<i>Calliophthalmus</i> (<i>Metriophthalmus</i>) <i>nodosus</i> sp. nov.	<i>Actaeonina</i> (<i>Ovactaeonina</i>) <i>insularis</i> sp. nov.
<i>Ooliticia cunningtoni</i> sp. nov. C.	CEPHALOPODA.
<i>Chenopus</i> (<i>Quadrinervus</i>) <i>beaugrandi</i> (de Loriol)	<i>Trophonites pseudogigas</i> (Blake)
<i>Dicroloma richardsoni</i> sp. nov.	<i>Behemoth</i> sp.
<i>Pseudomelania</i> (<i>Oonia</i>) <i>chatwini</i> sp. nov.	" <i>Perisphinctes</i> " <i>gorei</i> Salfeld
<i>Zygopleura portlandica</i> sp. nov.	<i>Kerberites portlandensis</i> sp. nov.
<i>Procerithium</i> (<i>Rhabdocolpus</i>) <i>manselli</i> (de Loriol)	<i>Kerberites</i> sp.
<i>Uchauxia quadrigranosa</i> sp. nov.	PISCES.
" <i>Natica</i> " sp. R.	<i>Lepidotus</i> sp. (tooth) R.
	REPTILIA.
	<i>Cimiliosaurus portlandicus</i> (Owen) R.

Detailed Palaeontology.

LAMELLIBRANCHIA.

FAMILY NUCULIDAE.

Genus *Nucula* Lamarck, 1799.*Nucula lorioli*, sp. nov.

Pl. I., figs. 1a, b.

Diagnosis :—Shell small, moderately inflated, trapezoidal, with ratio of length to height about 4 : 3 ; umbones forming approximately right-angles, and situated about one fifth of shell-length from anterior end ; posterior hinge-margin slightly convex ; anterior margin short, obtusely angulated, the upper portion bearing the anterior hinge-teeth, the lower portion curving round to the ventral margin, which runs for some distance parallel to the posterior hinge-margin, and then curves round to meet this at a fairly sharp angle. Shell-surface smooth. Teeth of a typical *Nucula*.

Material :—The holotype (L. 39022), and about ten paratypes.

Dimensions of holotype :—Length 7.0mm., height 5.4mm., inflation 3.6mm.

Remarks :—*N. lorioli* is of about the same size as *N. obliquata* Blake, a Kimmeridge Clay form, which Blake records also from the Portlandian, but is much less inequilateral than this species.

Genus *Nuculana* Link, 1807.

Subgenus *Isonuculana*, nom. mut.

Proposed for *Isoleda* Rollier, 1923 (*Rev. Crit. Paléozool.* xxvii. p. 67) *non* de Ryckholt, 1853 ("Mélanges Paléontologiques." ii. p. 164).

Synonym :—*Nuculopsis* Rollier, 1912, *non* Girty, 1911.

Type :—*Nucula palmae* Sow.

M. Rollier has been unfortunate in proposing in turn two pre-occupied names for this section, which comprises Mesozoic species ovoid in form, compressed, only slightly prolonged posteriorly, with no distinct rostrum, and having internally very feeble muscle-impressions, and a pallial line with a very slight sinus.

Nuculana (Isonuculana) dammariensis (Buvignier)

Pl. I., figs. 2a, b.

Leda dammariensis Buvignier, 1852, p. 20, pl. xvi., figs. 18–21; de Loriol, 1868, p. 175, pl. xii., figs. 6–7 ; 1872, p. 320.

This species is represented by one specimen (L. 39023) which, to judge by Buvignier's figure, differs from the type, from the Portlandian of Dammarie, Meuse, in being slightly less elongate, and in having scarcely any appreciable posterior carination of the shell-flanks. The valves are slightly separated along the dorsal margins, so that the taxodont hinge-line characteristic of the genus can be observed.

Dimensions :—Length 6.5mm., height 3.9mm., inflation 2.8mm.

Distribution :—Portlandian of France. Not previously recorded from this country.

FAMILY ARCIDAE.

Genus *Barbatia* Gray, 1840.*Barbatia cavata* (de Loriol).

Pl. I., figs. 3-6.

Arca cavata de Loriol, 1875, p. 142, pl. xviii., figs. 5-6.? *Arca beaugrandi* de Loriol, 1875, p. 141, pl. xviii., fig. 4.

This species, very abundant in the shell-bed, shows considerable variation in its elongation, but all intermediate grades occur between the shortest (cf. L. 39024, pl. I., fig 3), and longest (cf. L. 39025, pl. I., fig. 4) varieties.

The chief diagnostic feature is the small notch in the tip of the umbo of the left valve—very well shown in some specimens, but scarcely visible in others. Of a large number of right valves which I have examined, not one has any trace of this furrow, even in two-valved specimens in which the left valve shows the feature very well. It therefore seems probable that it is always confined to the left valve—a fact not noticed by de Loriol. Certainly in his pl. xviii., fig. 6, he figures a two-valved specimen with both umbones furrowed, but I would suggest that here a slight mistake has been made by the artist. I would also suggest that his *A. beaugrandi* is the same species—the type is a right valve (apparently the second valve of fig. 4b is restored by symmetry), and hence does not show the notched umbo. Apart from a very slight difference in the intensity of the radial ribbing at the shell-extremities, probably of no significance, no further distinction can be drawn between the two forms. The dentition of the present specimens is undoubtedly that of a *Barbatia*, and agrees very well with that of the right valve of *A. beaugrandi* figured by de Loriol.

In their general form these shells recall the section *Fossularca* Cossmann.

Distribution :—Portlandian of the Boulonnais. The first record from this country.

Genus *Parallelodon* Meek & Worthen, 1866.

Synonyms :— *Macrodon* (Lycett MS.) Buckman, 1845, *non* Müller, 1842.

Macrodon Beushausen, 1895.

Beushausenia Cossmann, 1897.

Genotype :— *Parallelodon rugosus* (Buckman *sub Macrodon*).

As Lycett's *Macrodon* was first introduced into the literature by Buckman (1845, Murchison's "Handbook Geol. Cheltenham," p. 98) in connection with the single species *M. rugosus*, this must be regarded as the genotype. Although *M. rugosus* was considered by Lycett to be specifically distinct from the well-known Great Oolite species *Cucullaea hirsonensis* d'Archiac, there can be no doubt that they are closely-allied species of the same genus.

The name *Parallelodon* was suggested by Meek & Worthen as a substitute for *Macrodon* on account of the pre-occupation of this name, so that the genotype of *Parallelodon* must be the same as of *Macrodon*. The adoption of *Parallelodon* for Palæozoic species by various authors led Fischer and others into the mistake of regarding the Palæozoic species as typical of the genus. For this reason Cossmann suggested the name *Beushausenia* (type, *Cucullaea hirsonensis* d'Archiac) for the Mesozoic forms, which appear to differ from the Palæozoic ones in having their anterior teeth oblique, instead of parallel, to the hinge-margin. It follows from what has been said that *Beushausenia* is identical with *Parallelodon*, and that a new name must be found for the Palæozoic forms if they are sufficiently distinct.

Mr. H. Woods has regarded *Grammatodon* Meek and Hayden, 1860 (type, *Arca inornata* Meek and Hayden) as identical with *Parallelodon*. The hinge is certainly similar, but *Grammatodon* has not the more or less crenulated, widely gaping pallial margins of *Parallelodon*. The name *Grammatodon* may be conveniently employed for the regular, rectangular Mesozoic species which have the hinge-teeth of *Cucullaea*, but are more elongate in form than this genus.

Parallelodon dorsetensis, sp. nov.

Pl. I., figs. 7 a, b ; pl.II., figs. 1a, b, -2.

Diagnosis :—Shell fairly large, inflated, elongate-rectangular, about twice as long as high ; umbones about one-third shell-length from anterior extremity, rather sharp, slightly salient above hinge-margin, widely separated ; greatest inflation posterior to umbones, about half-way along shell ; hinge-margin long, straight, nearly as long as shell ; anterior margin slightly convex, in general direction perpendicular to hinge-margin ; lower margins more or less parallel to hinge-margin, embayed and gaping beneath umbo, forming a byssal gap ; posterior side of shell with a sharp carination running from umbo to postero-ventral corner ; posterior margin straight, meeting hinge-margin at an obtuse angle. Cardinal area wide, obtusely triangular, with its plane at right angles to plane of shell-margins, and its greatest width some way posterior to umbones ; ornamented with triangular grooving. Posterior area slightly concave, very oblique to flank of shell, with two or three major sulcae, running from umbo to posterior margin, V-shaped in cross-section ; ornamented also with numerous minor radial threads, the whole reticulated by growth-lines. Flanks of shell ornamented by numerous radial threads, crossed by well-marked growth-lines. Hinge with 2-3 anterior teeth parallel, the sub-umbonal teeth transverse, and the posterior teeth again parallel, to hinge-margin.

Material :—The holotype (L. 39028), and four paratypes.

Dimensions :—Holotype—Length 55mm., height 27mm., inflation 28mm. Paratype (L. 39029) :—Length 34mm., height 15 mm., inflation (twice single valve) 19mm.

Remarks :—The four smallest specimens are much alike in their proportions, being quite regularly rectangular in shape. The largest specimen, however, (L. 39028) tapers much more at its anterior extremity, and its lower margins gape very widely beneath the umbones.

In its general form and appearance this species resembles very closely several Recent forms of the group of *Arca* s. str. Such species have often a wide byssal gape, and individuals vary considerably in their shape. The widely separated umbones, with the wide, horizontal ligament-area, are also reminiscent of *Arca* s. str. If, however, the dentition is to be regarded as of primary importance in classification, it is seen that the present species must be placed in the genus *Parallelodon*.

The following species compare closely with the present form:—*Arca trisulcata* Goldf. (Corallian), *Arca quadrisulcata* J. de C. Sow. (Corallian), *Arca cepha* de Loriol (Corallian), and *Arca eudesi* Morris and Lycett (Bathonian).

The type of *A. trisulcata* Goldfuss, (1836, pl. cxxi., fig. 11) was evidently broken, and, to judge by the Nattheim specimens in the British Museum, and also by Quenstedt's figures (1858, p. 759, pl. xciii., figs 8–9), the usual state of preservation of specimens from this locality is very bad. According to Quenstedt (1852, p. 525) *A. trisulcata* "kann über 2" lang werden, klapft aber unten wenig." The byssal gape of the present species is very wide; the shell also seems to be more inflated than the Nattheim species. For these reasons, as well as the difference in horizon, the present form is best considered distinct.

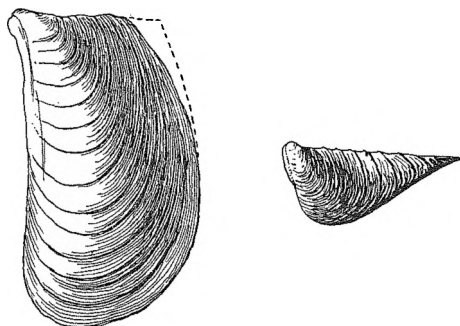
A. quadrisulcata and *A. cepha* differ in possessing much wider umbones, as well as in the ornamentation of their posterior areas.

The younger specimens of *P. dorsetensis* bear a very close resemblance to *A. eudesi*, as figured by Morris and Lycett (1853, pl. v., figs. 6, 6a) and by Cossmann (1915, pl. v., figs. 1–5). This species is, however, more flattened than the present form, and the umbones are wider and more rounded.

FAMILY PERNIDAE.

Genus *Inoceramus* J. Sowerby. 1819.

Inoceramus cunningtoni, sp. nov.



Text-figure 1.

Diagnosis :—Shell medium-sized, thin, rather inflated, sub-rectangular, with its height rather less than twice its length, and attaining its greatest inflation about one-third of distance from cardinal margin to lower extremity ; anterior side nearly straight, making an angle somewhat less than a right-angle with the hinge-margin ; lower margin at first curving downwards from anterior margin, so that longest line that can be drawn from umbo to lower margin makes only a small angle (about 20°) with the anterior margin, and passes across most inflated part of the shell ; posterior margin convex, curving so that greatest length of shell is attained about half-way between cardinal margin and lower margin, and meeting the cardinal margin at an obtuse angle ; length of cardinal margin somewhat less than greatest length of shell. Umbo acute, slightly salient above cardinal margin, situated nearly at anterior end of this margin, and bordered by a small, but distinct, anterior ear. Shell-surface ornamented by regularly spaced, concentric accentuations of growth-stages, but otherwise smooth. Hinge-area with numerous shallow ligament-sulcations, of varying width, about seven occurring within 1cm. from the umbo.

Material :—The holotype only (L. 39031), a left valve, with its anterior margin rather broken away.

Dimensions :—Length ca. 25mm., height 40.5mm., inflation (single valve) 12mm.

Remarks :—The general form and inflation of this specimen, its slightly salient umbo, the regular accentuation of its growth-stages, and its numerous ligamental grooves, justify its reference to the genus *Inoceramus*, rather than to *Perna*. It is not all at like any other U. Jurassic species of either genus, and is much more rectangular and inflated than *Perna mytiloides* Lamarck, a species which is fairly abundant in our Portlandian rocks. It is not unlike *Mytilus pernoides* Roemer (1836, p. 89, pl. v., fig. 2), a species which ranges in Germany from the Corallian to the Kimmeridgian. As far as we know, however, this species has not the multivincular ligament of a representative of the Pernidae. Rollier considers it to be a *Mytilus*, and places it in his subgenus *Pernomytilus*.

FAMILY OSTREIDAE.

Genus *Ostrea* Linné, 1758.*Ostrea expansa* J. Sowerby.

O. expansa J. Sowerby, 1819, "Min. Conch.", iii., p. 65, pl. ccxxxviii., fig. 1; de Loriol, 1867, p. 109, pl. xi., fig. 4; 1875, p. 210: Rollier, 1917, p. 594.

O. recurvirostra, *O. transversa* Benett, 1831, p. 4, pl. xvii., figs. 1-2.

O. falcata J. de C. Sowerby, 1836, p. 347, pl. xxiii., fig. 1.

Large specimens of this species abound in the bed, together with numerous smaller examples.

The specimens seem, on the whole, to be thinner and flatter than the typical *O. expansa*, and some have a pronounced posterior wing. They would thus serve as a link between the Kimmeridge Clay form *O. sowerbyana*, and the more inflated and massive specimens of *O. expansa* from higher beds of the Portland Stone.

A serious mistake made by Rollier with regard to these species must be corrected. He proposes (1917, p. 566) to separate the species of the group of *O. sowerbyana* Bronn (= *O. deltoidea* Sowerby, *non* Lamarck) as a distinct subgenus *Deltoideum*, in which he includes also *O. expansa*, and makes the remarkable statement that the oysters of this group are fixed by their right valves. Concerning *O. unciformis* Buvignier (closely allied to *O. sowerbyana*), he states (p. 584), "Si cette espèce est fixée par la valve gauche, comme toutes les Huîtres, elle est oblique et prolongée en avant, . . . , ce qui est inconnu dans le genre et donne lieu à la création d'un genre. . . nouveau, inverse des Exogyres. Autrement, si la partie acuminée et l'impression musculaire sont dirigées en arrière, la coquille aurait alors été fixée par la valve droite, ce qui l'éloigne également du genre *Ostrea*."

The original of Buvignier's figure of this species is a lower valve—not an upper valve, as Rollier states. I have examined a large number of specimens of *O. sowerbyana* and *O. expansa*,

and in every case the left valve is undoubtedly the fixed one. The first species is prolonged and attenuated posteriorly, as in *Exogyra*. The tip of the ligament-area is also twisted posteriorly, as in most other oysters. Possibly the sectional name *Deltordeum* might be retained for the oysters of this group, but fixation by the right valve is certainly not one of the diagnostic characters.

Ostrea blakei, sp. nov.

Pl. III., figs 4-6.

Diagnosis :—Shell small, lunate, curving posteriorly, fairly broad in its central region, and tapering to a sharp extremity ; attachment-area moderately large, at tip of lower valve ; attached valve moderately convex, upper valve flat. Surface without radial ornament.

Material :—The holotype (L. 39032), and about 10 paratypes.

Dimensions of Holotype :—" Length " 20.5mm., maximum width 11.8mm., inflation 5.0mm.

Remarks :—This small form is a well-marked species, and belongs to the same group of oyster as the Bathonian species *O. acuminata*. It is very abundant at the base of the shell-bed, at the junction with the Portland Sand, but ranges up to the top of the bed.

Subgenus *Lopha* Bolten, 1798.

Ostres (Lopha) damoni, sp. nov.

Pl. III., fig. 7.

Diagnosis :—Left valve small, only slightly inflated, inequilateral, irregularly trapezoidal, produced in a posterior direction ; attachment-area well-defined, rather small, oval, situated at the tip of the shell ; anterior side of shell almost smooth, central portion with a few rounded, not very conspicuous, irregularly dichotomising ribs, which appear at some distance from umbo and gain in intensity towards lower margin, near which they may project as short spines. Ligament-area small, obtusely triangular, twisted posteriorly. Right valve unknown.

Material :—The holotype only, L. 39035, a left valve.

Dimensions :—19.5mm. by 11.0mm. ; inflation 3.3mm.

Remarks :—Although only one specimen has been found, this is so distinct from any previously-known form that there is no doubt that it is to be considered new. The exterior of the valve at first sight suggests a *Plicatula*, but the ligament-area is that of an *Ostrea*. The ribbing of the shell is quite absent from the anterior region. The species has thus no affinity with the well-plicated species now referred to the section *Arctostrea* Pervinquière, to which nearly all the known Upper Jurassic plicated oysters belong.

The holotype was collected from the very base of the shell-bed, the horizon at which *O. blakei* is abundant.

FAMILY TRIGONIIDAE.

Genus *Trigonia* Bruguière, 1789.

Species of the *gibbosa*-Group are very abundant in the shell-bed. Like Blake, I fail to see any constant character by which it is possible to separate *T. damoniana* de Lorient from *T. gibbosa*, which is admittedly an extremely variable species. *T. manseli* Lycett has not been found by Col. Cunningham, and it is uncertain whether Lycett's types came from this, or from a higher horizon at Portland.

Although *T. incurva* Benett was recorded by Blake from this bed, it must be extremely rare, as no specimens have been obtained by Col. Cunningham, and we could not observe any *in situ*. Possibly the specimen figured by Lycett (1872, pl. ix., fig. 5), and two specimens in the County Museum at Dorchester were obtained from this horizon.

Trigonia portlandensis, sp. nov.

Pl. III., figs. 8 -9a, b.

Diagnosis :—Shell fairly large, oblong, elongate, with length slightly less than twice height, and with posterior taper gradual and slight; umbones anterior, prominent, somewhat recurved; anterior margin at first only slightly convex, then sweeping round in a broad, elliptical curve to meet the lower margin, the posterior portion of which curves upwards very gradually, with a regular sweep; cardinal margin long,

straight, nearly two-thirds total length of shell, plainly visible in lateral view of shell, and terminating at the oblique truncation of the area which forms the posterior margin of the shell. Escutcheon long, narrow, smooth, only slightly sunk. Area narrow, not very oblique, delimited by a marginal carina with only a slight curve; possessing a median furrow, and ornamented near umbo with transverse ridges, which later break up into three rows of tubercles, one on the carina bordering the escutcheon, the second below the mesial furrow, the third on the marginal carina, and persisting along the entire length of this carina, although rather obscure at the posterior end; angulation of shell at marginal carina fairly sharp near umbo, but rounded off at posterior end of shell. Flanks of shell ornamented by about 20 conspicuous, widely-spaced, continuous, and rather sinuous rows of irregular tubercles, which start immediately below marginal carina, then run obliquely downwards at an obtuse angle from carina, subsequently turn anteriorly, to a varying extent, until their direction is more nearly concentric, but finally tend to turn in the reverse direction again before reaching margin. Left valve with anterior tooth short, not very prominent; central tooth with anterior component small, posterior component very thick and prominent; groove for posterior tooth of right valve long and narrow, for anterior tooth wide, fairly deep, but not very long.

Material :—The holotype (L. 39036), and 5 paratypes.

Dimensions of holotype :—Height 53mm., length 91mm., inflation 34.5mm.

Remarks :—In their general form these specimens show little variation, the most variable feature being the sinuosity of the rows of tubercles. This sinuosity is more accentuated in the holotype than in any of the others, the 2-like curve of those rows which reach the antero-ventral corner of the shell being very pronounced. In the other specimens the bottom, reverse limb of this 2 is only feebly indicated, and the rows are only slightly curved.

This species resembles *Trigonia pellati* Munier-Chalmas in its size and proportions, and may have been mistaken for it in the past. *T. pellati* has been well figured by de Loriol (1867, p. 85, pl.viii., fig. 4; 1875, pl. xvii., fig. 2) and by Bigot 1893, p. 332, pl. xvi., fig. 4). Its umbones are more obtuse and depressed than those of *T. portlandensis*, and the elliptical curve at the junction of the anterior and lower margins is not

so open. Its marginal carina, although faintly tuberculate near the umbo, is quite smooth and rounded-off along most of its length. The ribbing on the flanks of the shell terminates some distance below the carina, leaving a fairly wide, smooth band. Along the carina demarking the escutcheon, however, the nodulation is very conspicuous, and often extends on to the escutcheon itself, as irregular, transverse ribbing. Thus *T. portlandensis*, although resembling *T. pellati* in its elongation and only slight curve, in the length and conspicuousness of the cardinal margin, and in the obtuseness and rounded character of the marginal carina, differs from this species in the nodulation of its marginal carina, in the absence of any smooth band beneath this carina, and in the slightly wider angle between the lower and anterior margins.

T. swindonensis Blake (1880, p. 233, pl. x., fig. 4) is a closely allied species of the same group. The holotype (Brit. Mus. L. 20344) is an imperfect specimen, but has the details of surface-ornamentation well preserved on the central portion of the shell. In general form this species is not so elongate as *T. pellati*, and the growth-lines indicate a slight posterior embayment of the ventral margin, such as is found in *T. irregularis* Seebach. As in the typical *T. pellati*, the ribbing terminates some distance from the marginal carina, leaving here an unornamented band. The marginal carina itself is ornamented with well-developed tubercles. The species from the Portland Limestone of Wilts, figured by Lycett (1872, p. 50, pl. ix., fig 1) as *T. muricata* Goldf., is also a closely related form. It is certainly not identical with the true Portuguese *T. muricata*, which has been well figured by Choffat (1885, pl. v-vi).

T. portlandensis resembles the well-known Corallian species *T. clavellata* very closely in its ornamentation and general appearance. It is much more elongate than this species.

Trigonia sp. aff. *T. concentrica* Agassiz.

Pl. I., fig. 8.

T. concentrica Agassiz, 1841, p. 20, pl. vi., fig. 10 : de Loriol, 1867, p. 80, pl. viii., fig. 2 ; 1872, p. 290, pl. xvi., fig. 26 ; 1875, p. 122 : Lycett, 1872, p. 52 ; 1879, p. 206.

T. subconcentrica Étallon and Thurmann, 1862, p. 203, pl. xxv., fig. 6.

One small specimen, L. 39038, rather broken posteriorly, is probably referable to this species, which Lycett (*op. cit.*, p. 206) does not recognise as belonging to the British fauna.

The inflation of the specimen, a right valve, is very slight ; the umbo is rather anterior, depressed, and not at all salient above the hinge-margin. The anterior margin is strongly convex. The marginal carina is sharp, but the angle between the area and the flank of the shell is very obtuse. The carina is indistinctly nodulated, and the area, which has the usual mesial furrow, is ornamented by numerous small, transverse, sharp ridges. The shell-flank is ornamented by closely-set rows of small, circular nodules, which curve round so as to be concentric at the umbo, and reach the anterior margin almost perpendicularly. About nine of these rows occur in the first cm. from the umbo.

Although the elongation of this specimen cannot be ascertained it is readily distinguishable from young specimens of *T. portlandensis* by the greater convexity of its anterior margin, by the more pronounced curvature of its marginal carina, and by the concentric arrangement of its rows of tubercles.

The type of *T. concentrica* came from the Swiss Portlandian, and the figures agree very well with the present specimens. The transverse ridging of the area is seen near the umbo, but is lost later on in growth. The specimens from the Boulonnais figured by de Loriol differ in the less concentric curve of the ribbing. The Corallian species *T. corallina* d'Orb., as figured by Lycett (1872, p. 45, pl. iii., figs. 7-11) resembles the present specimen very closely.

Trigonia radiata Benett

Pl. II., figs. 8a, b -9.

Trigonia radiata Benett, 1831, pl. xviii., fig. 3 ; de Loriol, 1867, p. 83, pl. viii., fig. 1 ; 1875, p. 117 ; Lycett, 1874, p. 73 ; 1879, p. 208.

Trigonia ferryi Munier-Chalmas, 1865, p. 415, pl. iv., fig. 1.

Although this species was first figured by Benett (without diagnosis) from the Portlandian of Tisbury, Wilts., no further example from this country was known to Lycett, when monographing the genus *Trigonia*. The holotype had gone with the Benett Collection to America, but, from the figure, was obviously a badly-preserved specimen. Thus, notwithstanding the fact that the French authors had figured the species, Lycett, in 1874, was inclined to doubt the validity of the chief diagnostic feature—the absence of any ornamentation on the anterior portion of the flanks of the shell, in the presence of strong ribbing of the posterior portion. He suggested, therefore, that their specimens were badly-preserved examples of other species, as the smooth anterior area was “ a feature to which we discover nothing analogous throughout the entire series of the genus *Trigonia* ” (p. 73).

It is worthy of note that he himself had examined a very large example of the species from the Boulonnais in the British Museum Collection (36913) and (p. 43) misidentified it as a specimen of *T. incurva* in which “ the anteal folds of growth have replaced all ornamentation.” Five years later he was prepared to admit the validity of the species, but stated that he had seen no example from this country.

A number of well-preserved specimens in different stages of growth have been found by Col. Cunningham, and show that the diagnoses of the French authors require supplementing in some important details, which give a clue to the affinities of the species.

Diagnosis :—Shell ovately trigonal, with ratio of length to height about 5 : 4; moderately inflated; umbones prominent, rather acute, fairly anterior; anterior margin very convex, curving round elliptically to lower margin, which curves upwards rapidly posteriorly; hinge margin short, about half total length of shell, terminating in the oblique truncation of the area which forms the posterior margin. Escutcheon narrow, moderately sunk. Area rather wide, set at a fairly large angle with flank of shell, and bordered by a marginal carina with a pronounced curve; with a mesial furrow, and ornamented near the umbo with small, closely-set transverse ridges which later break up into three rows of tubercles, one on the carina bordering the escutcheon, the second below the mesial furrow, and the third on the marginal carina. Flanks of shell ornamented near umbo with a few well-defined V-shaped ridges, extending from marginal carina almost to anterior margin; receding from the umbo the anterior limb of each successive V is less conspicuous, while the posterior limb becomes wider and more intense; beyond 1cm. from the umbo no ribbing is visible on the anterior portion of the flank, but the shell is here very thick, rugose, with pronounced growth-stages; posterior portion of the flank ornamented with a few parallel, transverse, conspicuous, irregularly nodulated ridges, beginning a short distance below the marginal carina, and dying out at the boundary of the unornamented anterior region, or at the lower margin of the shell.

Right valve with thick, prominent anterior tooth, set at a small angle with anterior margin, and with a less prominent, elongate, marginal posterior tooth. Relative sizes of teeth of left valve unknown.

Dimensions :—Holotype (Benett's figure), Length 91mm., height 78mm.; specimen from Portland shell-bed (L. 39039) l. 68.7mm., h. 52.3mm., inflation (single valve) 17.5mm. Large specimen from Boulonnais (Brit. Mus. 39613) l. 115mm., h. 92mm., infl. 65mm.

Remarks :—The demonstration of the V-ribbing on the umbones of this species is of importance, as it must have a phylogenetic significance, proving the descent of the species from a form with V-ribbing over its whole surface. The thickness of the shell in the unribbed anterior section would suggest that the anterior limb of the V is merely masked by the rugose folds of growth. In one specimen there is a very faint indication of the beginning of an anterior limb, from the end of the first rib which meets the lower margin of the shell. If,

however successive V's are studied, as we recede from the umbo, it is seen that the anterior limb actually dies out, and is not merely masked.

FAMILY PECTINIDAE.

Genus *Camptonectes* Agassiz, 1864.

The well-known species *C. lamellosus* (J. de C. Sow.) is very abundant in the shell-bed. It is seen to have the characteristic shell-structure of a *Camptonectes*, as has been pointed out by Philippi (1900, *Zeitschr. deutsch. geol. Gesellsch.*, lii., p. 90).

The second species, *C. suprajurensis* Buvign. (1843, *Mém. Soc. Phil. Verdun*, ii., p. 236, pl. v., figs. 1-3) is very similar to the better-known Middle Jurassic form, *C. lens*. It has recently been well figured by Cossmann (1915, p. 4., pl. iv., fig 1).

FAMILY SPONDYLIDAE.

Genus *Plicatula* Lamarck, 1801.

The most abundant species is *P. boisdini* de Lor. (1867, p. 109, pl. x., fig. 10). Specimens in which the rows of spines are more widely spaced are referable to *P. echinoides* Blake (1880, p. 233, pl. x., fig. 6). Some of these agree very well with Blake's figure. In certain others, *e.g.* L. 39042, pl. ii., fig. 4, the linear arrangement of the spines is more pronounced, the rows are further apart, and the spines are very long and prominent, some attaining a length of over 5mm. Although probably these also belong to Blake's species, their similarity to the Rauracian species *P. semiarmata* Étallon, as figured by de Loriol (1894, pl. viii., figs. 4-5) is worthy of notice.

A third type may be provisionally referred to as *P. cf. beaugrandi* de Loriol (1875, p. 207, pl. xxiii., fig 8), a species which comes typically from a much lower horizon (Lower Kimmeridgian). The one specimen so determined, L. 39043, pl. ii., fig. 3, is about 35mm. in diameter, and spread irregularly over the limestone-surface, its umbonal region being obscured

by a deposit of pyrites. The surface is ornamented by numerous irregular, fine, sinuous radial costæ, here and there swelling out into hollow spines, which scarcely protrude at all. Between these radial costæ finer radial threads are distributed irregularly.

FAMILY LIMIDAE.

Genus *Lima* Bruguière, 1792.

Subgenus *Plagiostoma*, J. Sowerby, 1812.

Lima (*Plagiostoma*) *rustica* (J. de C. Sowerby)

Plagiostoma rusticum J. de C. Sow., 1822, p. iii., pl. ccclxxxi.

Lima rustica de Loriol, 1867, p. 101, pl. ix., fig. 6.

Lima coodei Morris and Lycett in Damon, 1860, p. 172, p. 79, fig. 36 (and subsequent editions).

In this, as in most other Mesozoic representatives of the genus, specimens from different localities and horizons show considerable variation, both in the shape of the shell, and in the details of ornamentation. In the present ones, which are very well preserved, the umbonal angle is about 120°, and hence is considerably larger than that of the type-specimens from Shotover Hill. The shell is thus more inequilateral. There are, however, not sufficient grounds for distinguishing the Portland form as *Lima coodei*, the type of which probably came from this shell-bed.

The surface is ornamented with flattened, irregular, broad, sometimes bifurcating ribs, with minutely punctate interspaces. In some of the specimens there has been a marked pause in growth when a shell has reached a height of about 1cm., and this has been accompanied by a pronounced discontinuity in the ornamentation. In the youngest stage of the shell the radial ribs are much finer and more closely placed, and the interspaces are very distinctly punctate. Receding from the umbo, some of the interspaces disappear, and adjacent ribs coalesce, until the broad, flattened ribbing of the adult shell is reached. This feature is very peculiar, as, in a much later growth-stage, many of the ribs bifurcate again.

FAMILY MYTILIDAE.

Genus *Mytilus* Linné, 1758.*Mytilus suprajurensis*, sp. nov.

Pl. I., fig. 9, pl. III., fig. 2.

Mytilus unguiculatus J. Phillips, 1871, pl. xv., fig. 7. (*non* Salter, 1848).

Diagnosis :—Shell medium-sized, with considerable inflation, strongly curved, tapering anteriorly to an acute, terminal umbo; valves with very sharp angulation, which curves round in a quadrant from the umbo to the postero-ventral corner of the shell, and is so acute that the pallial margin can scarcely be seen in the lateral aspect of the shell; hinge-margin about half length of shell, nearly straight, meeting posterior margin in a gentle curve; posterior margin sweeping round in a quadrant almost concentric with the angulation, and then curving round to postero-ventral corner; buccal region not very gibbous, producing only a very slight convexity at anterior end of pallial margin. Shell-surface smooth.

Material :—The holotype (L. 39044), and 2 paratypes.

Dimensions of Holotype :—Length 47.5mm., height 38mm., inflation (single valve) 12mm.

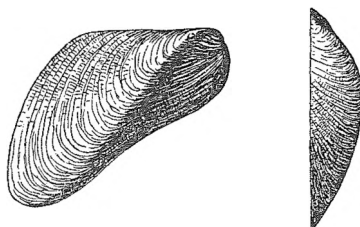
Remarks :—This species was figured very inadequately by Phillips, without diagnosis, from the Portlandian of the Oxford district. His trivial name *unguiculatus* was employed by Salter in 1848 for an Upper Silurian *Mytilus* (*Mem. Geol. Survey*, ii (i), p. 365), and hence cannot be used for the present species. A complete diagnosis is therefore given under the new name, taking the present well-preserved specimens as types.

M. suprajurensis is abundant in the Portlandian rocks of this country, numerous specimens being found in the *Trigonia*-beds and Freestones of Tisbury, Swindon, etc., usually distorted by pressure. Curiously enough, it is unknown from the French Portlandian.

By some collectors, to judge by the manuscript labels attached to specimens, it has been identified as *M. jurensis* Merian in Roemer (1836, p. 89, pl. iv., fig. 10), a typically Kimmeridgian species which ranges up from the Corallian. From this species it is distinguished by its greater curvature and the much sharper angulation of its flanks.

Genus *Modiolus* Lamarck, 1899.

Modiolus hudlestoni, sp. nov.



Text-figure 2.

Diagnosis :—Shell medium-sized, ovately reniform, wide, somewhat longer than high, fairly inflated; hinge-margin long, exceeding half length of shell; posterior margin about equal in length to hinge-margin, slightly convex, in general direction convergent with lower margin; buccal region gibbous, extending slightly anteriorly to umbones, and producing marked convexity at anterior end of lower margin; central gibbosity of shell producing a rounded-off angulation of shell-flanks running with a slight curve from umbo to posterior end of lower margin, and dividing flanks into two areas of which the posterior is much the larger and wider. Shell-surface ornamented with irregularly-spaced growth-lines crossed perpendicularly by very fine, at times bifurcating, radial threads, most conspicuous near the cardinal margin, and below the angulation of the shell-flanks.

Material :—The holotype (L. 39046), and one paratype.

Dimensions :—Length 27 mm.; height 22.7mm.; inflation (single valve) 9.3mm.

Remarks :—This *Modiolus* is one of a group of Upper Jurassic species characterised by a surface-ornamentation of fine radial threads crossing the growth-striæ. No recent *Modiolus* has any trace of ornamentation of this nature, but it is found in a number of species of *Lithodomus*. The radial threads of representatives of the Recent genus *Brachidontes* Swainson are much more conspicuous.

Other Portlandian species of the group are *M. boloniensis* de Loriol, which is much more inflated anteriorly, and *M. foucardi* Rollier (= *M. longaevus* de Loriol, 1868, p. 191, pl. xiii., fig. 3, *non* Contejean), which is much narrower, with a

shorter hinge-line, and a posterior margin nearly parallel to the lower margin. Much closer to the present form is the Corallian species figured by de Loriol (1872, p. 344, pl. xix, fig. 8) as *M. subaequiplicatus*, and later (1894a, p. 131, pl. ix., figs. 6-8), as *M. aequiplicatus*. The true *M. aequiplicatus* Strombeck, with which *M. subaequiplicatus* Roemer is synonymous, came from the Kimmeridgian of the Kahlenberg, near Echte, Hanover, and is a narrow, elongate species of the group of the well-known Liassic form, *M. scalprum*; de Loriol's specimens have certainly no connection with this species, and a new name must be found for them. *M. subornatus* Étallon, another Corallian form, figured by de Loriol (1888, p. 305, pl. xxxiv., figs. 6-8) is somewhat similar to *M. huddlestoni* in its proportions and surface ornamentation, but is much less gibbous in its buccal region.

Modiolus pallidus J. Sowerby

Modiola pallida J. Sowerby, 1812, "Min. Conch." 1, p. 30, pl. viii.; Damon, 1860, p. 79 (and subsequent editions).

Sowerby's type of this species, now in the British Museum, came from a cherty bed in the upper part of the Portland Stone at Fonthill, Wilts., this being probably the same horizon as the Roach of Portland I., in which very similar beds of chert are found. There is therefore little doubt that the specimen figured by Damon from the Roach is a representative of Sowerby's species, which was based on very badly preserved specimens.

One example, L. 39047, has been found in the present shell-bed, agreeing very closely in its proportions with Damon's figure. The surface is ornamented near the hinge-margin, and in the pallial region, with faint radial threads, crossing the growth-lines at right-angles, just as in *M. huddlestoni*. Probably such fine surface-details are not preserved in the Roach specimens, owing to erosion.

Genus *Modiolaria* Lovén, 1846*Modiolaria autissiodorensis* (Cotteau)

Pl. IV., fig. 11.

Mytilus autissiodorensis Cotteau, 1855, "Moll. foss. Yonne," p. 93 : de Loriol, 1868, p. 189, pl. xii., fig. 8 ; 1872, p. 334 ; 1875, p. 152, pl. xviii., fig. 14.

Modiola autissiodorensis Skeat and Madsen, 1898, p. 114, pl. iv., figs. 17-19.

Remarks :—This species is quite abundant in the bed, the specimens varying somewhat in their relative width. Radial threads ornament the entire surface of the shell, with the exception of the depression which runs from the umbo to the antero-central portion of the pallial margin. The resemblance to several Recent species of *Modiolaria* is very close.

Distribution of Species :—Kimmeridgian-Portlandian of France, England, Denmark (glacial boulders).

FAMILY MODIOLOPSIDAE.

Genus *Myoconcha* J. Sowerby, 1824.*Myoconcha portlandica* Blake

Pl. IV., figs. 10a, b.

M. portlandica Blake, 1880, p. 231, pl. ix., fig. 10.

Blake gave this name to the crushed and distorted internal casts of a *Myoconcha* abundant in the "creamy limestones" at Coney Hill, Bucks. The present specimens are extremely well-preserved shells, and, although larger than the Coney Hill specimens, there is little doubt that they are representatives of the same species.

The shell is very thick and rugose, modioliform, with hinge-margin slightly convex, and about two-thirds of total shell-length. It is not so oval in form as would be indicated by the distorted holotype of Blake, but tapers anteriorly to a marked extent. Probably, however, there is considerable variation

in different specimens, as is the case with other species of the genus.

Dimensions of largest specimen, L. 39048 (figured) :—length 140mm., height 75mm., inflation 51mm.

FAMILY ARCTICIDAE.

(Cyprinidae *olim*)

Genus *Venilicardia* Stoliczka, 1870.

Lamellibranchs of the type referred by de Loriol, Blake and other authors to the genera *Cyprina* and *Anisocardia* are very abundant in the shell-bed. A few specimens of *Cyprina elongata* Blake showing the hinge partially weathered out have been collected. The hinge appears to be more or less intermediate between that of *Anisocardia* (type, *A. elegans* Munier-Chalmas, 1863, *Journ. de Conch.* (3), iii., p. 290, pl. xi., figs. 5–8), and *Venilicardia* (Stoliczka, 1870, "Cret. Pelecypoda S. India," p. 190). The proportions and external ornamentation of the present shells favour their reference to the latter genus rather than to *Anisocardia*, and, until their hinge-structure can be further studied, I follow Rollier (1913, pp. 177–178) in so doing.

Specific delimitation of the various forms is rather difficult in view of the variations in shape and inflation. Of the larger specimens, some agree well with *V. implicata* (de Loriol) (1875, p. 43, pl. xiii., figs. 10–11). A few of the more elongate ones approach *V. elongata* (Blake) (1880, p. 232, pl. ix., fig. 14), although none is quite so elongate as the type of this species. The majority of the specimens are more or less intermediate between these two forms, so that it is possible that the latter are extremes of one species. *V. subquadrata*, sp. nov., differs considerably from either.

The smaller, less elongate representatives of the genus, e.g., L. 39049, pl. ii., figs 5a, b–6a, b, are mostly referable to *V. pulchella* (de Loriol) (1867, p. 55, pl. iv., figs. 10–11; 1875, p. 45, pl. xiii., figs. 13–15). Certain of the specimens have the posterior end of their ventral margin sinuous and embayed,

corresponding to a scarcely perceptible depression running down the flank of the shell. In this respect these specimens show an approach to the Sequanian species *V. legayi* (Sauvage), as figured by de Loriol (1875, pl. xiii., figs. 25-29). A much more inflated form, e.g., L. 39050, pl. ii., figs. 7a, b., is identifiable as *V. courcellensis* (de Loriol) (1872, p. 220, pl. xiii., fig. 8), while the least inflated specimens, e.g., L. 39051, pl. i., figs. 10a, b, probably represent the *V. intermedia* of the same author (1875, p. 46, pl. xiii., figs. 20-22). A fourth species, allied to *V. courcellensis*, is considered new (*V. cunningtoni*).

Venilicardia subquadrata, sp. nov.

P. IV., figs. 1a, b.

Diagnosis :—Shell medium-sized, moderately inflated, subrectangular, with length slightly exceeding height; umbones mesial, directed anteriorly, rising considerably above antero-dorsal margin, but scarcely salient above postero-dorsal margin; posterior extremity subquadrate, anterior extremity tapering somewhat. Ligament rather long, external, opisthodetic. Shell-surface smooth, with fine growth-lines. Interior unknown.

Material :—The holotype only (L. 39052).

Dimensions :—Length 18.7mm., height 15.6mm., inflation 10.4mm.

Remarks :—The mesial umbones, and subquadrate posterior extremity, serve readily to distinguish this species from *V. implicata* and *V. elongata*. It is, I think, a *Venilicardia* allied to these species. At first sight it suggests a *Thracia*, but the position of the ligament at once shows that it is the anterior end of the shell which tapers.

Venilicardia cunningtoni sp. nov.

Pl. IV., figs. 2a, b.

Diagnosis :—Shell rather small, considerably inflated, cuneiform, with ratio of length to height about 4 : 3; umbones in anterior sixth of shell and directed anteriorly; shell tapering posteriorly, with short posterior margin, and a very convex ventral margin with a slight

embayment towards its posterior extremity, corresponding to a scarcely perceptible furrow down posterior slope. Ligament short, external, opisthodontic. Shell-surface smooth, with fine growth-lines. Interior unknown.

Material :—The holotype only (L. 39053).

Dimensions :—Length 12.8mm., height 10.0mm., inflation 9.0mm.

Remarks :—This species is probably allied to *V. pulchella* (de Loriol), being readily distinguishable by its anterior umbones and tapering posterior extremity.

Genus *Isocyprina* Roeder, 1882.

This genus, type, *I. cyreniformis* (Buvignier *sub Cardium*) (1852, p. 15, pl. xiii., figs. 23–27) was originally proposed by Roeder (1882, "Terrain à Chailles," p. 91) as a subgenus of *Cyprina*. More recently it has been discussed by Boehm (1901, *Zeitschr. deutsch. geol. Ges.* liii., pp. 238–246) who refers to it a number of Lower Lias species, and further, by Rollier (1913, pp. 156–160), who gives a list of the known Jurassic species.

Although only one Portlandian species is included in Rollier's list, the genus is well represented in the present shell-bed, and it is possible to define four species, all new. In general form they are rotund, with rounded, obscure umbones and lunule unimpressed, although faintly circumscribed. The inflation is usually considerable. The ligament is external and opisthodontic. Two specimens of the species *I. pringlei* (L. 39070–1, pl. I., fig. 19) have the hinge partly weathered out. Although their preservation is not perfect, there is no doubt that these have the hinge of an *Isocyprina*, the resemblance to Roeder's figures being very close.

Isocyprina pringlei, sp. nov.

Pl. IV., figs. 3a, b ; Pl. I., fig. 19.

Diagnosis :—Shell medium-sized, ovate, slightly longer than high, with considerable inflation ; umbones wide, rounded, somewhat anterior to mesial, directed anteriorly ; lunule wide, not impressed, but distinctly

circumscribed by a faint cordate linear depression. Ligament long, external, opisthodontic. Shell-surface smooth, with fine growth-striae. Right valve with long anterior lateral tooth, parallel to margin, a small, curved, anterior cardinal, in general direction parallel to margin, and situated above end of anterior lateral, a conspicuous, bifid posterior cardinal, sloping at a very acute angle with margin, and possibly a rather small posterior lateral tooth. Right valve unknown in detail. Margins plain. Pallial line unknown.

Material :—The holotype (L. 39054), and about 8 paratypes.

Dimensions of holotype :—Length 22.7mm., height 20.3mm., inflation 15.8mm.

Remarks :—The hinge-details of this species (Pl. I., fig. 19) agree extremely well with those given by Roeder of the genotype of *Isocyprina*. In general form it is more inflated and rotund than any *Venilicardia*, except *V. courcellensis*, from which it is readily distinguishable externally by its broader, more mesial umbones, and its very convex pallial margin.

Isocyprina elongata, sp. nov.

Pl. IV., figs. 4a, b.

Diagnosis :—Shell-characters as defined for *I. pringlei*; differing only in larger size and greater elongation.

Material :—The holotype (L. 39055), and about 6 paratypes.

Dimensions of holotype :—Length 25.4mm., height 21.5mm., inflation (single valve) 8.5mm.

Isocyprina compressa, sp. nov.

Pl. IV., figs. 5a, b.

Diagnosis :—Shell rather small, ovate, with ratio of length to height about 5 : 4, and only slight inflation; umbones wide, rounded, depressed, somewhat anterior to mesial, directed anteriorly; lunule undefined. Ligament long, external, opisthodontic. Shell-surface smooth. Interior unknown.

Material :—The holotype (L. 39056), and 2 paratypes.

Dimensions of holotype :—Length 16.6mm., height 13.7mm., inflation 9.2mm.

Isocyprina obesa, sp. nov.

Pl. IV., figs. 6a, b.

Diagnosis :—Shell medium-sized, rotund, equilateral, very inflated ; umbones mesial, directed anteriorly, very wide, with shell very obese below them. Lunule wide, cordiform, not impressed, circumscribed by a linear depression. Shell-surface smooth, with fine growth-lines. Ligament and interior of valves unknown.

Material :—The holotype (L. 39057), and one paratype.

Dimensions of holotype :—Length 17.2mm., height 16.2mm., inflation (single valve) 9mm. The paratype (L. 39058) is larger, but too incomplete for measurement.

Genus *Anisocardia* Munier-Chalmas, 1863.*Anisocardia buckmani*, sp. nov.

Pl. IV., figs. 7a, b.

Diagnosis :—Shell triangular, very inflated, with height approximately equal to length ; umbones slightly anterior to mesial, acute, elevated, enrolled, prosogyrate ; anterior region excavated below umbones, but with no defined lunule ; pallial margin very convex ; posterior slope with a distinct angulation running from umbones to postero-ventral corner. Shell-surface smooth. Interior unknown.

Material :—The holotype (L. 39059), and 5 paratypes.

Dimensions of holotype :—Length 19.2mm., height 18.7mm., inflation 13.4mm.

Remarks :—This species differs from *A. autissiodorensis* (Cotteau) (figd. de Loriol, 1868, p. 109, pl. viii., figs. 8–9), the only other described Portlandian *Anisocardia*, in its smaller size, in the angulation of its posterior slope, and in its rather more equilateral contour. The Portlandian species referred by de Loriol to this genus are, as has been mentioned previously, better referred to *Venilicardia*.

FAMILY ASTARTIDAE.

Genus *Astarte* J. Sowerby, 1816.*Astarte kitchini*, sp. nov.

Pl. I., figs. 11a, b -12; Pl. IV., fig. 8.

Diagnosis :—Shell small, thick, moderately inflated, ovoid-quadrangular, with ratio of length to height about 5 : 4. Umbones fairly acute, directed anteriorly, and situated about one-fifth of shell-length from anterior end. Postero-dorsal margin slightly convex, forming an obtuse, but well-marked angle with posterior margin, which is nearly straight and meets ventral margin at a slightly obtuse angle; ventral margin straight posteriorly, curving round anteriorly to meet antero-dorsal margin. Escutcheon long, narrow, deep, smooth, separated from flanks by a sharp angulation; lunule well excavated. Shell-margins denticulate. Surface ornamented with 15-25 regularly-spaced concentric ribs, corresponding to pronounced pauses in growth, and showing at some stages the once marginal denticulations. Details of dentition unknown.

Material :—The holotype (L. 39060), and about 10 paratypes.

Dimensions of holotype :—Length 8.7mm., height 7.3mm., inflation 5.0mm.

Remarks :—This *Astarte* is one of a stock of species which exhibit what may be presumed to be senile characters. The shell is very thick, and the growth-stages so accentuated that the marginal denticulations at different stages may be preserved below the concentric ribs. In certain of the specimens, e.g. L. 39061 (P. I., fig 14), which I have hesitated to describe as a distinct species, the track of the marginal denticulations is preserved over almost the entire shell-surface, being especially visible on the posterior region, where the surface thus becomes ornamented with distinct radial ribs. On the specimens which exhibit this feature the concentric ribs are more numerous and closely-spaced than on the other specimens.

The most closely related species are the two Kimmeridgian forms, *A. scalaria* Roemer (1836, p. 114, pl. vii., fig 24), which is more elongate, with a less convex ventral margin, and *A. mysis* d'Orbigny, as interpreted by Dollfus (1863, pl. xi.

figs. 1-4). The latter, which is probably not the unfigured species of d'Orbigny, differs in shape from the present form, which best receives a new name.

Astarte salfeldi sp. nov.

P. I., figs. 13a, b.

Diagnosis :—Shell small, compressed, oblong, nearly twice as long as high ; umbones wide, scarcely salient, situated about a quarter of length from anterior end ; postero-dorsal margin long, straight ; posterior margin truncating shell at an obtuse angle ; pallial margin parallel to postero-dorsal margin ; anterior extremity rounded ; lunule scarcely defined. Shell-surface smooth. Interior unknown.

Material :—The holotype only (L. 39062).

Dimensions :—Length 10.7mm., height 6.2mm., inflation 3.9mm.

FAMILY UNICARDIIDAE.

Genus *Unicardium* d'Orbigny, 1850.

Unicardium verioti (Buvignier)

Pl. III., fig. 1.

Cardium verioti Buvignier, 1852, p. 16, pl. xvii., figs. 1-5 ; de Loriol, 1868, p. 125, pl. x., fig. 8 ; 1872, p. 234 ; 1875, p. 58.

Unicardium circulare Blake, 1880, p. 232, pl. x., fig. 1.

Several well-preserved specimens of this species have been collected by Col. Cunningham. In spite of Rollier's (1913, p. 236) opinion to the contrary, I have followed de Loriol in adopting Buvignier's name. The present specimens agree very well with those figured by de Loriol, the subrectangular, thick, globose shell, with umbones posterior to mesial, being readily recognised. Most probably d'Orbigny's *U. circulare*, with which Blake identified his crushed specimens from the rubbly limestones of Oxon and Bucks, is the same species. It has, however, never been figured or adequately described.

FAMILY VENERIDAE.

Genus *Venus* Linné, 1758 (s. lat.)*Venus portlandica*, sp. nov.

Pl. I., figs. 14a, b-15 ; Pl. IV., fig. 9.

Diagnosis :—Shell small, thin, moderately inflated, subrectangular, slightly longer than high ; posterior extremity subquadrate ; pallial margin very convex, sometimes biangulate ; umbones fairly anterior, directed anteriorly, continuous with postero-dorsal margin. Lunule very small, feebly excavated, not circumscribed ; escutcheon long, narrow, deep ; ligament deeply sunk, but exposed. Shell-surface with regularly spaced concentric undulations, best developed near umbo ; pallial margins denticulate. Hinge-plate well developed ; teeth radially disposed ; left valve with two cardinals, of which posterior is very prominent, and occupies a central position, running in a slightly posterior direction from umbo, and anterior is small, fairly thin, and runs from umbo at a very acute angle with lunular margin ; a faint, radial ridge occupying centre of triangular socket between the prominent central cardinal and the ligament possibly representing a third cardinal ; no lateral teeth. Pallial line unknown.

Material :—The holotype (L. 39064), and 3 paratypes.

Dimensions of holotype :—Length 7.5mm., height 6.8mm., inflation 5.2mm. Two specimens are slightly larger.

Remarks :—The dental characters of this species, although not completely known, indicate its reference to the Veneridae, sub-family Venerinae, but it is impossible to assign it to any hitherto-defined Mesozoic genus of the family. Should further specimens afford a complete knowledge of the dentition of both valves, it may be possible definitely to diagnose a new genus for its reception ; provisionally it is assigned to *Venus*. It resembles this genus, as at present restricted, in possessing in its left valve only two well-developed cardinals, and also in the denticulation of its margins. In its small size, fragile character, and rather small lunule, it is certainly not at all like any Recent species.

FAMILY CORBULIDAE.

Genus *Corbula* Bruguière, 1792.

The species *Corbula mosensis* (Buvignier) (1852, p. 10, pl. viii., figs. 26-28) is extremely abundant in the shell-bed. It is remarkable that it has not been previously recorded from this country, since it is a well-known species in the French and German Portlandian. The present specimens differ slightly from the typical form, being flattened, instead of convex, along their antero-dorsal margin. In this respect the Haute Marne specimens figured by de Loriol (1872, pl. x., figs. 2-3) are intermediate between the Meuse specimens and the present ones.

A second species is represented by a single left valve (L. 39066, pl. i., fig. 16), which, in contradistinction to the flat left valve of *C. mosensis*, is moderately inflated. This species is provisionally identified as *Corbula* cf. *ferruginea* de Loriol (1875, p. 7, pl. xi., figs. 2-5).

Fairly abundant is a small species, subtriangular in contour, fairly inflated, nearly equivalve, with a sharply angulated posterior slope (e.g. L. 39067, pl. i., figs. 17a, b.). There is little doubt that this species is *C. saltans* Blake (1880, p. 230, pl. ix., fig. 9), although most of the specimens are not so elongate as Blake's type. The specimens are not unlike those figured by de Loriol (1868, pl. v., figs. 8-9) as *C. dammariensis* Buvign. To judge by Buvignier's figure, the true *C. dammariensis* is more rotund, with a less pronounced angulation of the posterior slope.

A fourth species (e.g. L. 39068, pl. i., figs. 18a, b), small, very inflated, with the right valve larger than the left, with a short, narrow posterior rostrum, and surface concentrically crenulated, is referable to *C. bayani* de Loriol (1875, p. 9, pl. xi., figs. 8-11).

GASTROPODA.

FAMILY TROCHIDAE.

Genus *Proconulus* Cossmann, 1918

("Ess. Pal. Comp." xi., p. 276).

Proconulus foucardi (de Loriol).

Turbo foucardi de Loriol, 1868, p. 46, pl. iii., figs. 11-12 ;
Blake, 1880, p. 230, pl. ix., fig. 6.

Of some six specimens of this small species which have been collected from the shell-bed, two show the base and aperture rather imperfectly preserved. There is little doubt that the species attaches itself to Cossmann's genus *Proconulus*.

Genus *Eumargarita* Fischer, 1885.

Eumargarita durui (de Loriol)

Pl. V., figs. 1a, b, c.

Turbo durui de Loriol, 1868, p. 48, pl. iii., fig. 10.

The single specimen of this species which has been collected from the shell-bed (G. 34903) possesses a fairly wide, deep umbilicus, separated from the convex, concentrically striated base by a distinct angulation. Cossmann's suggestion (1915, "Ess. Pal. Comp.", x., p. 40) that the species belongs to the genus *Chartroniella* is therefore incorrect. The apertural details are not known ; I have tentatively referred it to *Eumargarita*.

The specimen is considerably larger than that figured by de Loriol. It is the first record of the species from this country.

Dimensions :—Height 8.3mm. ; diameter 10.5mm.

FAMILY DELPHINULIDAE.

Genus *Delphinula* Lamarck, 1803.

Delphinula portlandensis sp. nov.

Pl. V., figs. 2-4.

Diagnosis :—Shell thick, subdiscoidal, broadly umbilicate, with depressed, flattened spire. Whorls 3-4, concave above, with bicarinate periphery, and a spiral girdle of nodulations on their upper surface, next

to suture; upper peripheral carina very sharp, prominent, with fairly long, irregular spines; lower carina more rounded, nodulated; base convex, crossed by growth-lines, which produce distinct crenulations at margin of umbilicus, which is bounded by a distinct angle. Aperture circular; outer lip un-notched, procurrent at about 60° towards suture; inner lip somewhat reflected.

Material :—The holotype (G. 34904), and 5 paratypes.

Dimensions of holotype :—Height 9.2mm., diameter 13.3mm.

Genus *Nododelphinula* Cossmann, 1915.

(“ Ess. Pal. Comp.”, x., p. 225).

Nododelphinula vivauxea (Buvignier)

Delphinula vivauxea Buvignier, 1852, p. 36, pl. xxiv., figs. 35–36; de Loriol, 1867, p. 38, pl. iv., fig. 2.

The present specimens, about ten in number, agree well with de Loriol's figure of this species, but very little with Buvignier's original figure, which shows almost smooth peripheral carinae, and a spiral row of rounded tubercles below the suture, much more widely-spaced than in de Loriol's and in the present specimens. If de Loriol's identification is correct, Buvignier's figures must be very misleading.

Genus *Calliomphalus* Cossmann, 1888.

Subgenus *Metriomphalus* Cossmann, 1915.

(“ Ess. Pal. Comp.” x., p. 222).

Calliomphalus (*Metriomphalus*) *nodosus* sp. nov.

Pl. V., figs. 5a, b, c.

Diagnosis :—Shell small, perforate, trochiform, with height about equal to diameter. Whorls 4–5, convex, with sutures well impressed; the last rounded at periphery of base, which is convex; surface ornamented with spiral rows of spiny nodules, four on the flanks of the last whorl, and about six on the base; umbilicus open, curving regularly round from base. Aperture circular, very oblique; outer lip procurrent at about 45° towards suture, not crenulated internally; inner lip excavated, rather thick anteriorly, but without callus.

Material :—The holotype (G. 34905), and 5 paratypes.

Dimensions of holotype :—Height 10.3mm., diameter 9.5mm.

Remarks :—It is impossible to define any very obvious conchological distinction between this species and the Kimmeridgian form, *Delphinula muricata* Buvignier (1843 *Mém. Soc. Phil. Verdun*, ii., p. 19, pl. v., figs. 31–32; 1852, p. 35, pl. xxxii., figs. 19–21); the umbilicus, however, has not the well-marked bounding carina shown in Buvignier's figures. Still closer is the resemblance to de Loriol's figures (1874, p. 365, pl. ix., figs. 30–33) of a Sequanian form which Cossmann (1915, "Ess. Pal. Comp." x., p. 224) refers to as "une espèce voisine de *D. muricata*." The different species of the present subgenus are very similar to one another, and there is no doubt that the present species is best given a new name. *D. muricata* itself has never been recorded from a horizon as high as the Portlandian, and it is unknown from any horizon in this country.

FAMILY LITTORINIDAE.

Genus *Ooliticia* Cossmann, 1893.

(*Ann. géol. univ.* ix. p. 767; "Ess. Pal. Comp." x. 1915, p. 57)

Ooliticia cunningtoni sp. nov.

Pl. V., figs. 6a, b, c.

Diagnosis :—Shell thick, conical, imperforate, with ratio of height to diameter about 4:3, and aperture 1/3rd. total height. Whorls about six, with sharp peripheral angle just above anterior suture, flattened above this angle, and encircled by four spiral, serrated girdles, three on the shoulder, the fourth at the periphery, sometimes equal, but usually with the peripheral most intense; numerous regular, oblique threads crossing the interspaces in a subaxial direction, parallel to outer lip; sutures impressed; last whorl subangular at periphery, with slightly convex base, ornamented with about eight serrated spiral cords. Aperture circular, with outer lip expanded, crenulated by the spiral girdles, and procurrent at about 60° towards suture; inner lip reflected, with a strong fold at junction of columella with parietal wall.

Material :—The holotype (G. 34906), and about 6 paratypes.

Dimensions of holotype :—Height 11.8mm., diameter 8.2mm.

Remarks :—*O. cunningtoni* bears some resemblance to *Littorina paucisulcata* Phillips (1871, pl. xv., fig. 15), but the whorls have not the smooth, flattened shoulder of this species. As the aperture of *L. paucisulcata* is not figured, it is impossible to say whether the species is an *Ooliticia* or a *Eucyclus*. The present form is a very typical *Ooliticia*, the fold at the base of the parietal wall being well developed.

FAMILY CHENOPODIDAE.

Genus *Chenopus* Philippi, 1836.

Subgenus *Quadrinervus* Cossmann, 1904.

("Ess. Pal. Comp.", vi., p. 61).

Chenopus (Quadrinervus) beaugrandi (de Loriol)

Pl. V., figs. 7–8.

Alaria beaugrandi de Loriol, 1874, p. 136, pl. x., fig. 19; Piette, 1876, p. 202, pl. lxxxiv., figs. 7–8, lxxxv., fig. 11; Blake, 1880, p. 229.

Diagnosis :—Shell small, fusiform, apical angle 30° . Whorls 6–7, flattened above and below a strong peripheral carina, the portion above carina sloping up towards suture at about 45° , that below sloping inwards slightly towards axis; ornamented also with spiral threads above and below peripheral carina, with a fine axial imbrication on the earliest three or four, subsequently becoming obsolete; intensification of spiral bands producing on last whorl two additional carinae below peripheral carina, and a third on whorl-shoulder. Palmate expansion of outer lip with three lateral digitations corresponding to the peripheral and two more anterior whorl-carinae, which become rather spinous on last whorl, and a short posterior digitation which adheres to spire for at least two whorls above aperture; anterior rostrum fairly short, wide, slightly recurved, separated from expanded labrum by a wide embayment. Aperture long, narrow; inner lip with slight callosity.

Dimensions (G. 34907) :—Height 17mm., diameter (excluding expanded labrum) 4.5mm.

Remarks :—In the specimens of this species figured by de Loriol and Piette the labrum was broken away, so that the genus could only be doubtfully determined. Cossmann (1904, "Ess. Pal. Comp.", vi., p. 90) lists the species provisionally as

a *Dicroloma* (*Alaria olim*), no posterior digitation adherent to the spire having been figured. The present specimens seem undoubtedly to be the same species—the details of the spire are identical. The labrum is fairly well preserved in two specimens, and the species proves to be a very typical representative of the subgenus *Quadrinervus*, although the posterior digitation seems to be considerably shorter than that of the type-species, *Chenopus ornatus* (Buvign.).

Genus *Dicroloma* Gabb, 1868

(*Alaria* Morris & Lycett, 1850, *non* Schrank, 1788)

Dicroloma richardsoni sp. nov.

Pl. V., figs. 9–10

Diagnosis :—Shell fairly large, stout, fusiform, apical angle 40° . Whorls 7–8, rather high, rounded at first, subsequently laterally flattened, with a flat shoulder, bounded by an acute carina, and sloping upwards slightly towards suture; ornamented both on flanks and shoulder with acute spiral bands and intermediate threads; a second acute carina becoming apparent on penultimate and last whorls, separating base from flank. Outer lip with palmate expansion not known complete, but with two lateral digitations corresponding to the two whorl-carinæ, and a very short posterior digitation which only adheres to the lower portion of penultimate whorl. Base spirally banded; anterior rostrum long, thin, recurved. Aperture unknown.

Material :—The holotype (G. 34909), and 3 paratypes.

Dimensions of holotype :—Height 36mm., diameter 12.5mm.

Remarks :—The marked lateral flattening of the whorls of this species readily distinguishes it from any previously-described Portlandian form. The closest resemblance of the spire is to that of *Rostellaria raulinea* Buvign. (1852, pl. xxviii., fig. 27), which Cossmann refers to *Arrhoges* (*Monocyphus*), but in this species the whorls are carinated much lower down, so that the lateral flattening is not pronounced.

FAMILY PSEUDOMELANIIDAE.

Genus *Pseudomelania* Pict. & Camp., 1862.Subgenus *Oonia* Gemmellaro, 1878.*Pseudomelania* (*Oonia*) *chatwini* sp. nov.

Pl. V., figs. 11-12.

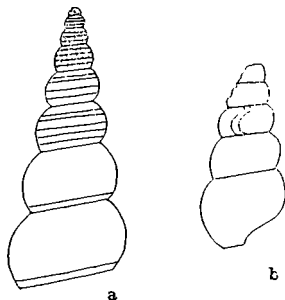
Diagnosis :—Shell of medium size, imperforate, conical, with apical angle 50° , and aperture about $2/5$ ths total height. Whorls eight, gently wound, slightly convex, smooth, or with faint spiral striæ; last whorl large, oval, regularly rounded at periphery of base, which is spirally striated. Aperture oval; outer lip thin, smooth interiorly, slightly sinuous, in general direction perpendicular to suture; columellar lip very slightly thickened and reflected.

Material :—The holotype (G. 34911), and 10 paratypes.

Dimensions of holotype :—Height 21mm., diameter 11mm.

Remarks :—*P. chatwini* bears a close resemblance to the Sequanian form, *P. collisa* de Loriol (1874, pl. vii., figs 30-31), but the greatest inflation of the shell is rather more anterior than in this species, so that the outer lip bulges out more.

FAMILY LOXONEMATIDAE.

Genus *Zygopleura* Koken, 1892.*Zygopleura portlandica* sp. nov.

Text-figures 3, a, b. (Cf. Pl. V., fig. 13).

Fig. 3. a, Apical whorls of paratype, G. 34913 (x 4).
b, Paratype, G. 34914, a broken specimen, showing curve of growth-lines.

Diagnosis :—Shell fairly large, imperforate, turricate, acute, apical angle 30° . Whorls about 12, twice as broad as high, with considerable

convexity, separated by deep sutures ; the first six ornamented with spiral bands, with traces of axial imbrication on the first four ; the spiral ornament becoming obsolete on the flanks of subsequent ones, which are smooth and unornamented ; last whorl relatively short, about one-third of total height of shell, rounded at periphery of base, which is spirally grooved, and slightly excavated. Growth-lines with an S-curve, the top embayment small and shallow, the bottom deep. Aperture unknown in detail ; columellar lip long and straight.

Material :—The holotype (G. 34912), and 5 paratypes.

Dimensions of holotype :—Height 37mm. ; diameter 18mm.

Remarks :—This species, with its convex, turriculate whorls, its spiral ornament, imbricated axially on the earliest whorls, and its growth-lines with a strong S-curve, obviously has no affinity with the genus *Pseudomelania*, and seems more appropriately placed in the Loxonematidae, a typically Triassic family to which Cossmann (1909, "Ess. Pal. Comp.," viii.) refers no species higher than the Callovian. It is referred to the genus *Zygopleura*, and probably belongs to a section of this genus near to *Anoptychia* Koken. The early extinction of both axial and spiral ornament on the shell-flanks shows that it is a very accelerated representative of the genus ; this one would expect in a species as high as the Portlandian.

FAMILY PROCERITHIIDAE.

Genus *Procerithium* Cossmann, 1902.

Subgenus *Rhabdocolpus* Cossmann, 1906.

("Ess. Pal. Comp.," vii., p. 27)

Procerithium (*Rhabdocolpus*) *manselli* (de Loriol).

Pl. V., figs. 14–15.

Cerithium manselli de Loriol, 1867. p. 22, pl. iii., figs. 3–4 ; 1874, p. 316, pl. vii., fig. 15.

Procerithium (*Rhabdocolpus*) *manselli* Cossmann, 1906, *loc. cit.*, p. 27, pl. v., fig. 23.

Cossmann's description and photograph of this species agree well with the present specimens. The whorls embrace one another very anteriorly, well below the periphery, and in one specimen the apertural region seems almost ready to detach

itself from the spire. The last whorl is consequently very high. The aperture is quite entire, without any anterior canal; the inner lip has a marked callosity.

Genus *Uchauxia* Cossmann, 1906.

("Ess. Pal. Comp.," vii., p. 56)

Uchauxia quadrigranosa sp. nov.

Pl. V., figs. 16a, b.

Diagnosis :—Shell small, acutely conical, apical angle 18° . Whorls numerous, with diameter exceeding twice height, flat, with deep sutures; regular granular ornament formed by the intersection of spiral bands, four in number on adult whorls, with sometimes a minor one intercalated, and regularly-spaced axial costæ, slightly concave towards aperture, about 24 to the whorl; last whorl biangular at periphery of base, the upper angle formed by most anterior of the four granular spiral bands, the lower by a conspicuous spiral girdle delimiting the base proper; base very excavated, with a short neck, and ornamented with spiral threads. Aperture oval, with a short, but distinct, twisted anterior canal, slightly salient beyond anterior margin; columella incurved, smooth, twisted at anterior extremity, which forms side of canal.

Material :—The holotype (G. 34916), and about 10 paratypes.

Dimensions of holotype :—Height 13.1mm., diameter 3.5mm.

Remarks :—This species has the general appearance of a *Procerithium*, but its well-defined anterior canal shows a marked advance beyond any species of this genus. Cossmann has shown that the typical Lower Jurassic species of *Procerithium* are almost holostomatous, and that the development of a true canal does not occur until later in the history of the family. It is well in keeping with his views that by Upper Jurassic times a small, but well-defined canal should have appeared. The typically Cretaceous genus *Uchauxia* comprises species very similar to *Procerithium* in their ornamentation and general appearance, but possessing a short, twisted canal. It is to this genus that the present species seems most appropriately referable.

FAMILY NATICIDAE.

Genus *Euspira* Agassiz, 1837.

Euspira ceres (de Loriol)

Natica ceres de Loriol, 1867, p. 31, pl. iii., figs. 16-17; Blake, 1880, p. 229, pl. ix., fig. 2.

This species is very abundant in the shell-bed, adult specimens being about 18mm. in height, with a peripheral diameter of 15mm. The periphery is pronouncedly angular, and the whorls slightly concave between this and the shoulder-angle. The growth-lines are very accentuated and rugose, although in most of the specimens the finer surface-details have been lost by erosion. The extreme apex is acute and salient, but the rest of the spire rather depressed. The umbilicus is very narrow, if not absent, and almost covered by the callous reflection of the inner lip. There is little doubt that the shell must be placed in the genus *Euspira*.

The features which distinguish this shell from the much larger form, *N. elegans*, have been dealt with by de Loriol (1867, p. 28). *E. ceres* occupies a somewhat intermediate position between this species and Blake's *N. incisa* (1880, p. 229, pl. ix., fig. 1).

FAMILY VANIKORIDAE.

Genus *Vanikoro* Quoy & Gaimard, 1832.

(*Narica* d'Orbigny, 1841)

Vanikoro fittoni sp. nov.

Pl. V., figs. 17a, b, c.

Diagnosis :—Shell globular, with diameter considerably exceeding height, perforate, with rounded, depressed spire ; whorls three, increasing rapidly in height and width, convex in contour, flattened above, and ornamented with spiral bands with narrower interspaces ; base separated from flank by a sharp angulation, and ornamented with spiral bands, less conspicuous than those of flanks ; umbilicus wide, bordered by a distinct carina ; aperture very large, dropping considerably below base in the ventral view, truncate-oval, with width slightly in excess of height ; outer lip procurrent at about 45° towards suture, but not known in detail. ; inner lip straight, very oblique to shell-axis, with a posterior callous reflection adhering to the penultimate whorl.

Material :—The holotype (G. 34917), and 2 paratypes.

Dimensions of holotype :—Height 15.5mm., diameter 18.5mm.

Remarks :—No species of this genus has hitherto been recorded from the Jurassic of this country, and the majority of Jurassic forms described from elsewhere have been

erroneously referred to *Neritopsis* and other genera, as Zittel (1873, p. 297) has pointed out.

The present species bears some resemblance to the Kimmeridgian form *V. delphinula* (d'Orbigny) (1853, pl. ccci., fig. 14), but differs in the much greater expansion of its last whorl and consequently less central spire.

FAMILY ACTAEONIDAE.

Genus *Actaeonina* d'Orbigny, 1847.

Section *Ovactaeonina* Cossmann, 1895.

("Ess. Pal. Comp.", i., p. 60)

Actaeonina (*Ovactaeonina*) *insularis* sp. nov.

P. V., fig. 18.

Diagnosis :—Shell oval, stout, with height about twice diameter ; spire conical, stepped. Whorls about $4\frac{1}{2}$, with narrow, rounded shoulders and slightly convex sides, spirally furrowed ; the last occupying $\frac{2}{3}$ total height, with convex, concentrically furrowed, scarcely excavated base. Aperture short, very wide, ovate ; curve of outer lip unknown ; columella fairly long, excavated, unPLICATED, with outer margin slightly callous and detached from base.

Material :—The holotype (G. 34918), and 3 paratypes.

Dimensions of holotype :—Height 11.4mm. ; diameter 6.1mm.

Remarks :—This species, with its short, wide aperture, and its spirally furrowed surface, has more the appearance of an *Actaeon* than of an *Actaeonina*. Its columella is, however, quite unPLICATED.

CEPHALOPODA.

Ammonites are not abundant in the shell-bed, but here and there the peripheries of large specimens may be observed protruding from the rock.

No reliable work can be done on the specific and generic relationships between these large ammonites until accurately collected specimens showing the complete succession of growth-stages can be examined. Hence for the present it is only possible to give tentative names to the different specimens.

This was the bed at Portland from which Blake (1880, p. 192) recorded his "*Ammonites pseudogigas*," (cf. C. 26228); but, in the absence of any adequate description, figure or designation of type-locality by the original author, we must now accept Buckman's interpretation of this species (1923, iv., pl. ccclxxxv). Unfortunately, the specimen of *Trophonites pseudogigas* figured by Buckman comes from a locality, Long Crendon, Bucks., where the sequence of beds is obscured considerably, has been interpreted differently by different workers. According to Buckman's interpretation (1922, pp. 26-27), the Hemera of *T. pseudogigas* is separated from that of *gorei* by nine hypothetical Hemeræ.

A large ammonite (C. 26220), collected by Col. Cunnington from the very base of the shell-bed, is nearly 12 inches in diameter, and has the type of ribbing of *Ammonites bononiensis* de Loriol. It is, however, more compressed than the true *bononiensis*. Tentatively it is assigned to Buckman's genus *Behemoth* (1922, pl. ccv.).

A second specimen (C. 26221), also collected *in situ* from the the very base of the shell-bed, although incomplete, seems to be a very typical example of "*Perisphinctes*" *gorei* Salfeld (founded on *Ammonites biplex* de Loriol, 1867, pl. ii., figs. 3-4, *non* Sow.).

A number of smaller specimens, referable to two species, have been collected by Col. Cunnington. The first of these species (C. 26222-4) is that figured by Blake (1880, p. 228, pl. x., fig. 7), and later by Pavlow (1889, p. 56, pl. ii., figs. 1-3) as *Ammonites triplicatus*. There is every reason to believe that this is a well-defined species and that the specimens approach adult size, and are not the young of larger forms. The true *A. triplicatus* is a Kimmeridge Clay form, and *A. trifidus*, with which the present species has also been identified, is of Corallian horizon. I therefore propose the new name KERBERITES PORTLANDENSIS for the present species, the type to be the original of Blake's figure, which came from the Portland Flinty Series, probably from the basal shell-bed.

The second small species (C. 26225-7, pl. v., fig. 19) is also probably a representative of the genus *Kerberites* Buckman (1924, v., pl. dxx.), although its ornamentation shows a striking similarity to a species of later age (Gigantitan) which Buckman (1923, v., pl. cdli.), places in his genus *Galbanites*. It is impossible to ascertain how nearly the specimens approach adult size. Round the periphery 3-5 secondary ribs occur between successive primary ribs extending on to the umbilical portion of the whorls.

POLYZOA

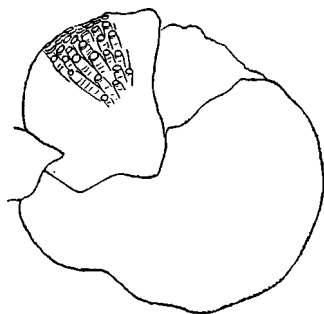
By W. D. LANG, M.A., Sc.D.,

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Genus *Berenicea*.

Berenicea :—J. Lamouroux (1821, Exposition Méthodique des genres de l'ordre des Polypiers, p. 80. Genotype, *B. prominens*, op. cit., p. 80, pl. lxxx., figs. 1, 2; Recent; Mediterranean Sea).

Berenicea damnatorum, new species. (Damnatus, a convict).



Text-figure 4.

Fig. 4. *Berenicea damnatorum*. Outline of asty of type-specimen with the details of a few oecia. x about 5 diameters.

Diagnosis :—Portlandian *Berenicea* with a thick asty, and with oecia widely spaced proximally, but crowded distally.

Description :—Asty circular, about 8mm. diameter, and thick. Oecia crowded distally, but rather widely spaced proximally, emergent, long (visible length about .5–.8mm.), cylindrical, transversely wrinkled, and with rather high peristomes.

Distribution :—Portlandian, Portland Stone, basal shell-bed. I. of Portland.

Holotype :—British Museum, No. D. 31734.

Remarks :—In *B. portlandica* J. W. Gregory (1896, Ann. Mag. Nat. Hist., ser. vi., vol. xvii., p. 43, and 1896, British Museum Catalogue of Jurassic Bryozoa, p. 83, pl. iii., fig. 5; type-specimen, British Museum, No. D. 1853, Portlandian, Tisbury, Wilts), the asty is thin, and the immersed oecia widely spaced throughout. In *Diastopora tenuis*, A. d'Orbigny (1850, Prodrome de Paléontologie, vol. ii., p. 55), the other *Berenicea* hitherto recorded from the Portlandian (H. E. Sauvage, 1889. Bull. Soc. Géol. de France, ser. iii., vol. xvii., p. 48, pl. iv., figs. 8, 9; Middle Portlandian; Boulogne), the asty is thin—"très mince"—according to Sauvage's description, and, according to Sauvage's figure, the oecia are emergent, not very widely-spaced, and not more crowded distally following Gregory's notation (1896, op. prox. cit., pp. 24, 83, 89), the formula for *B. portlandica* is $p0 -0, c0, l3, r d.$; and that for *B. tenuis* $p2, c1, l2, r d.$ The formula for *B. damnatorum* is the same as that of *B. tenuis*, except that $l = 2-0$, showing that the visible length of the oecia shortens as the periphery of the asty is reached.

Elaphopora, new genus.

(ἐλαφος, a stag, from the antler-like asty)

Diagnosis :—Entalophoridæ whose short oecia resemble those of *Haplooecia* in having flattened front walls with a ridge-like, and somewhat angular, margin, and in having apertures which are not strictly terminal; but, unlike *Haplooecia*, have thick, raised peristomes and

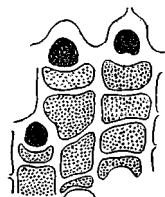
occasional transverse ridges connecting the marginal ridges across the front walls, thus superficially dividing the oecia into two, or sometimes three, or even more, areas; the asty consists of a flattened stem twice or thrice divided distally into flattened branches, and thus differing from the freely branched and cylindrical stems of other Entalophoridae. The oecia are irregularly arranged on both sides of the stem.

Genotype. *Elaphopora cervina*.

Elaphopora cervina, new species. Text-figs. 5, 6.
(cervinus, stag-like, in allusion to the antler-shaped asty).



5



6

Fig. 5. *Elaphopora cervina*. Outline of asty of type-specimen
x about 3 diameters.

Fig. 6. *Elaphopora cervina*. Three oecia of type-specimen.
x about 33 diameters.

Diagnosis :—As for the genus.

Description :—Asty erect, consisting of a flattened stem, several times irregularly bifurcate, and somewhat resembling palmate antlers. Oecia monomorphic, short, and tubular with a flattened front-wall; front-wall perforated with numerous pores, and surrounded with a raised rim, the sides of which are sometimes connected by transverse extensions across the front-wall; this rim embraces the proximal half of the peristome, which therefore appears to have a double rim proximally; apertures sub-circular in shape, often somewhat flattened on the proximal side, subterminal in position, surrounded with a very thick, but not very high peristome, and irregularly distributed on both sides of the flattened asty.

Distribution :—Portlandian, Portland Stone, basal shell-bed and Whit Bed. I. of Portland.

Holotype : British Museum No. D. 31729.

Remarks :—Of the four specimens, two (Nos. D. 31729–30) are from the basal shell-bed, and two (Nos. D. 31732–3) from the Whit-Bed. Only the type-specimen shows the details of the oecial characters. A fifth specimen (D. 31731), found in the basal shell-bed, may be of this species, but has a far more extensive asty, consisting of a clump of closely apposed antler-like branches which, viewed from above, present a mazy pattern.

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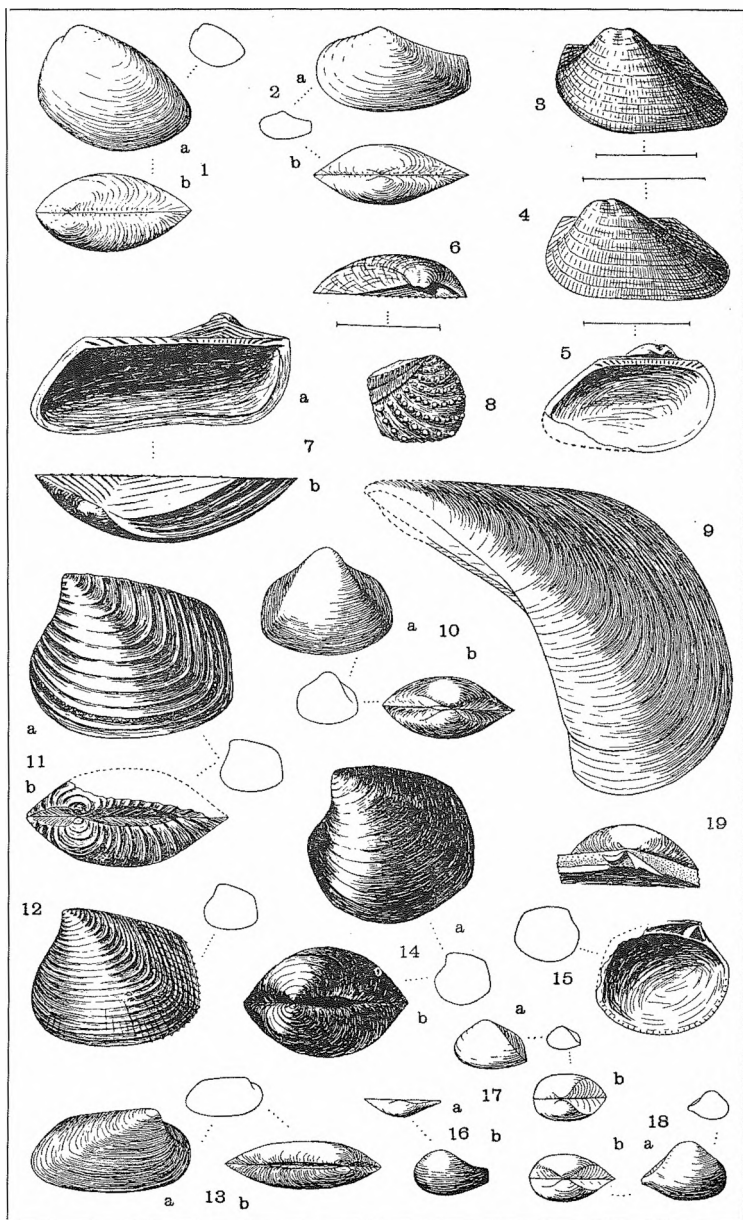


PLATE I.

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EXPLANATION OF PLATES.

(All figures natural size, unless otherwise stated)

PLATE I.

- Figs. 1 a, b. *Nucula lorioli*, sp. nov. Holotype, L. 39022. (x 3). p. 123.
- Figs. 2 a, b. *Nuculana (Isonuculana) dammariensis* (Buvignier), L. 39023
(x 3). p. 124.

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- Fig. 3. *Barbatia cavata* (de Loriol), L. 39024. (x 1½). p. 125.
- Fig. 4. *Barbatia cavata* (de Loriol), L. 39025. (x 1½). Elongate variety.
- Fig. 5. *Barbatia cavata* (de Loriol), L. 39026. (x 1½). Showing hinge.
- Fig. 6. *Barbatia cavata* (de Loriol), L. 39027. (x 1½). Showing area.
- Figs. 7 a, b. *Parallelodon dorsetensis*, sp. nov. Paratype, L. 39029. a, showing hinge; b, showing area and inflation. p. 127.
- Fig. 8. *Trigonia* aff. *concentrica* Agassiz, L. 39038. p. 135.
- Fig. 9. *Mytilus suprajurensis*, sp. nov. Holotype, L. 39044. p. 140.
- Figs. 10 a, b. *Venilicardia intermedia* (de Loriol), L. 39051. (x 2). p. 145.
- Figs. 11 a, b. *Astarte kitchini*, sp. nov. Holotype, L. 39060. (x 3). p. 149.
- Fig. 12. *Astarte kitchini*, sp. nov. Paratype, L. 39061. (x 3).
- Figs. 13 a, b. *Astarte salfeldi*, sp. nov. Holotype, L. 39062. (x 2). p. 150.
- Figs. 14 a, b. *Venus portlandica*, sp. nov. Holotype, L. 39064. (x 3). p. 151.
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- Fig. 16. *Corbula* cf. *ferruginea* de Loriol, L. 39066. p. 152.
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- Figs. 1 a, b. *Parallelodon dorsetensis*, sp. nov. Holotype, L. 39028; a, lateral view; b, ventral view, showing gaping margins. p. 127.
- Fig. 2. *Parallelodon dorsetensis*, sp. nov. Paratype, L. 39030.
- Fig. 3. *Plicatula* cf. *beaugrandi* de Loriol, L. 39043. p. 138.
- Fig. 4. *Plicatula echinoides* Blake, L. 39042. p. 138.
- Figs. 5 a, b. *Venilicardia pulchella* (de Loriol), L. 39049. p. 144.
- Figs. 6 a, b. *Venilicardia pulchella* (de Loriol), L. 39071.
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- Figs. 8 a, b. *Trigonia radiata* Benett, L. 39040; a, umbonal view, showing V-ribbed umbones (specimen not quite symmetrically posed); b, lateral view, showing unribbed anterior region. p. 136.
- Fig. 9. *Trigonia radiata* Benett, L. 39041.

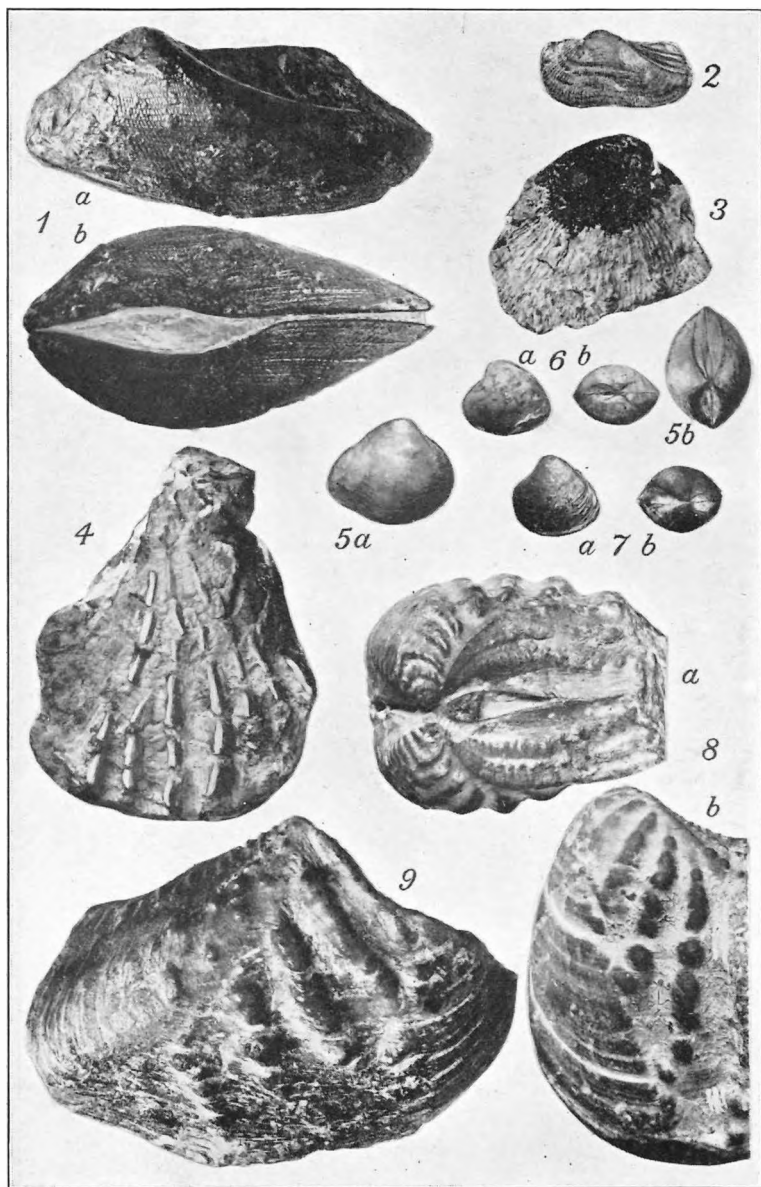


PLATE II.

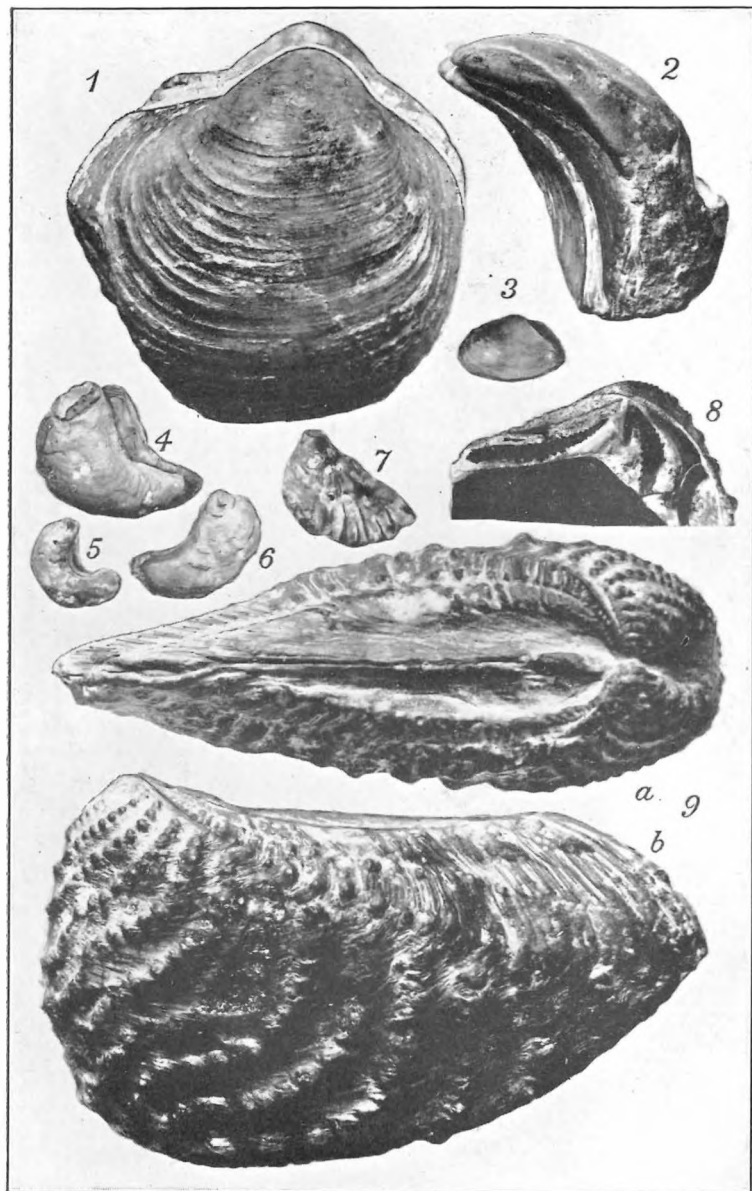


PLATE III.

EXPLANATION OF PLATES—continued.

PLATE III.

- Fig. 1. *Unicardium verioti* (Buvignier), L. 39063. p. 150.
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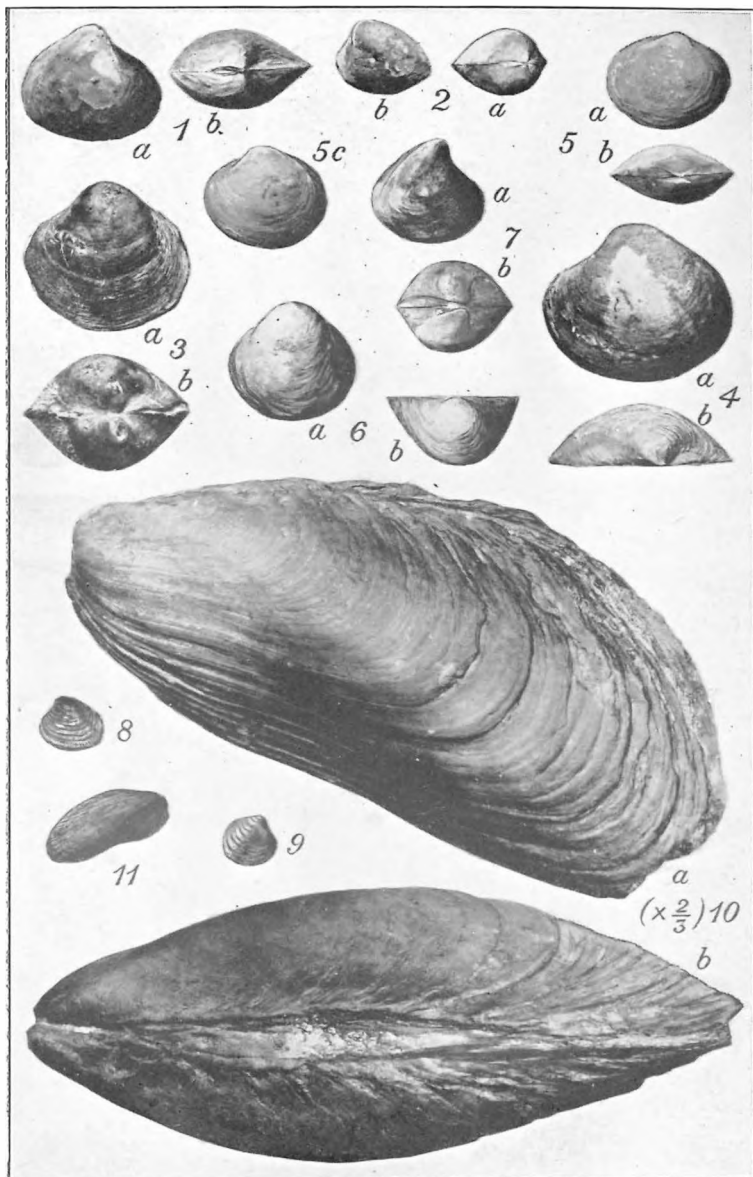


PLATE IV.

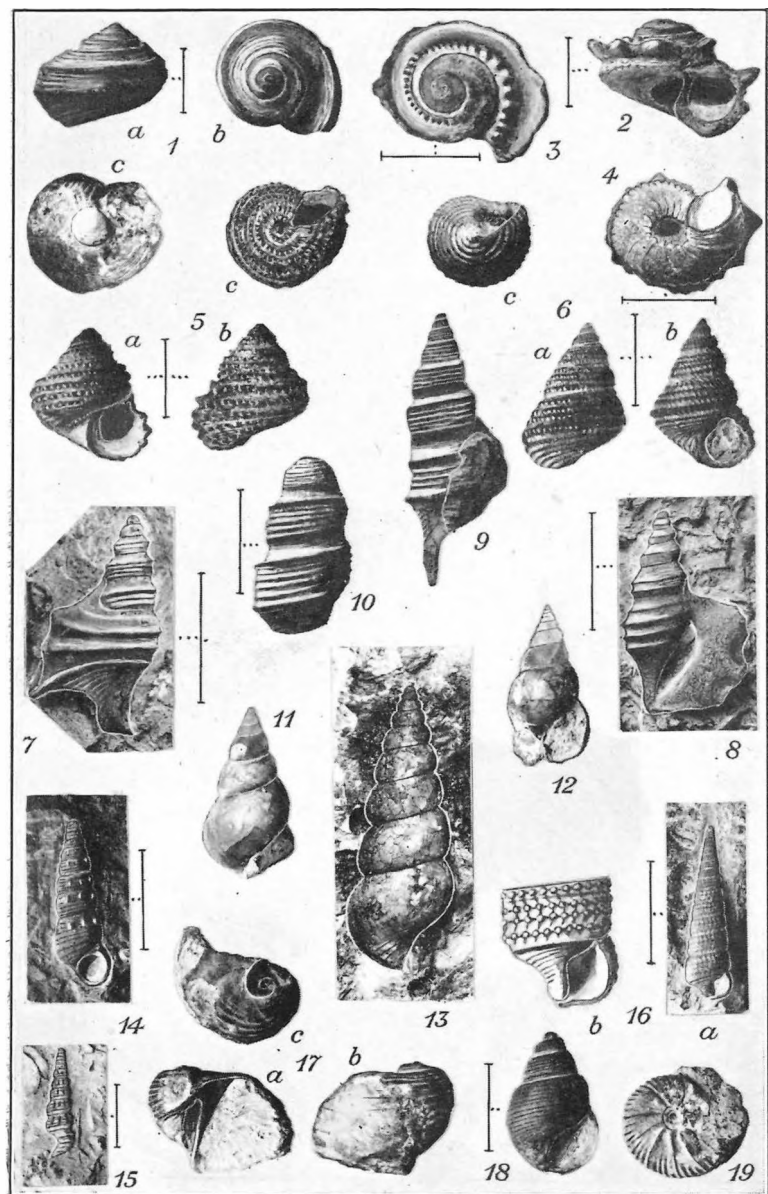


PLATE V.