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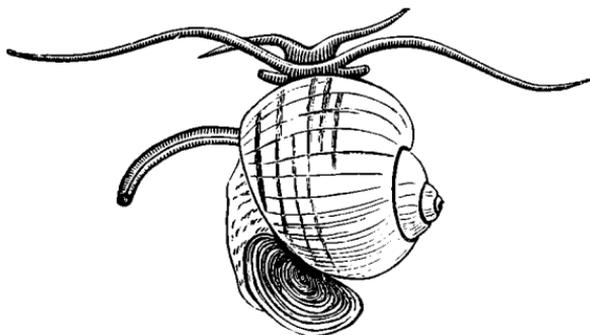
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FOSSIL PEARL-GROWTHS.

By R. BULLEN NEWTON, F.G.S.

Read 8th May, 1908.

PLATES IV AND V.

I. INTRODUCTION.

ALTHOUGH much has been written on the history of modern pearls, very few records appear to exist calling attention to the occurrence of such bodies in the fossil state. John Woodward, in 1723 ("An Essay towards a Natural History of the Earth," 3rd ed., p. 24), briefly referred to the fact that fossil shells, as well as recent, had "pearls and the like still actually growing upon them." In 1836 Goldfuss¹ figured a natural internal cast of an example of *Inoceramus Cripsii* (*non* Mantell) from the German Cretaceous deposits, with numerous pittings which were doubtless the result of pearly protuberances developed on the inner surface of the valve.

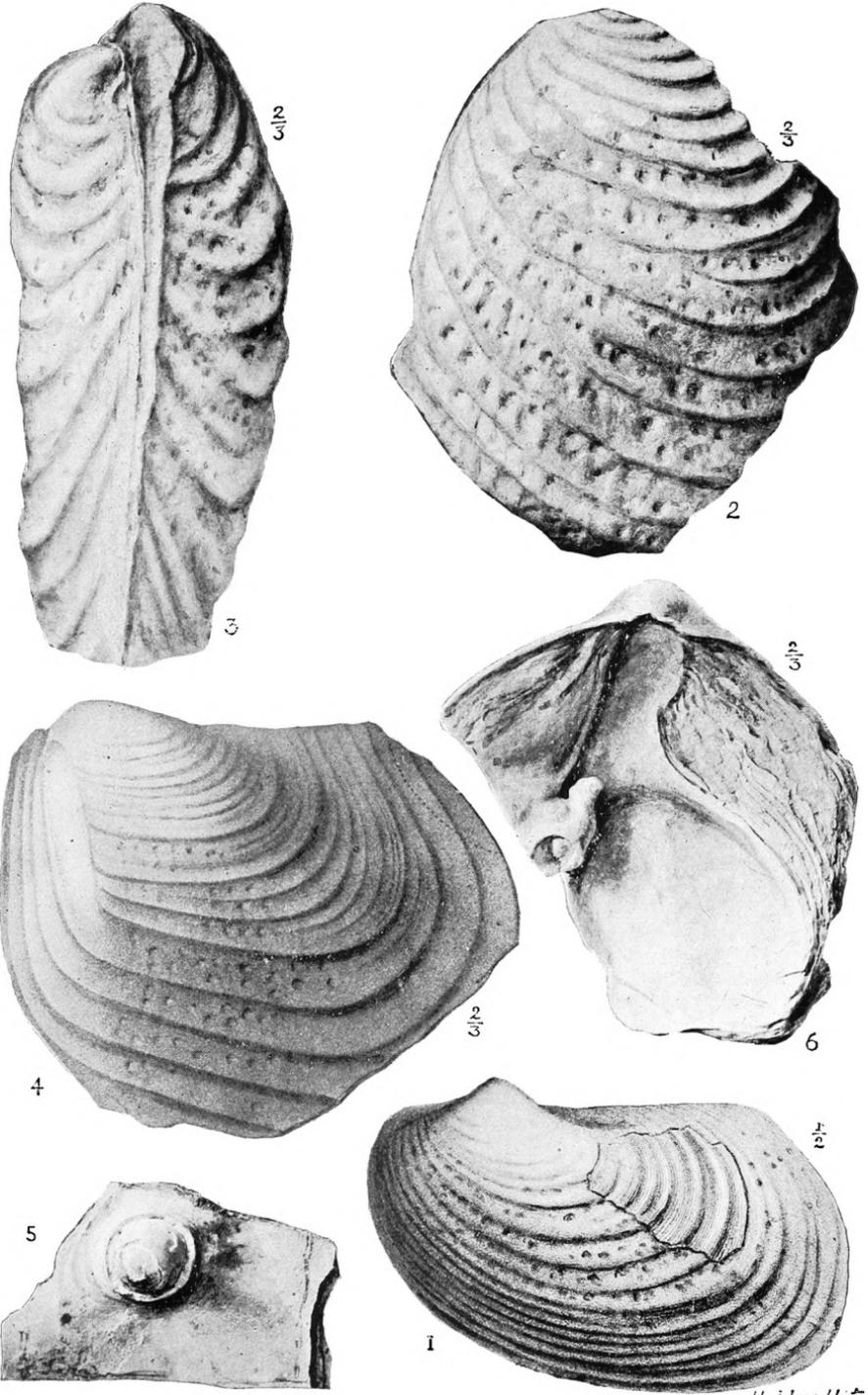
The late Professor John Morris² published some interesting notes in 1851, with illustrations, which are of sufficient interest to reproduce: "*Pearl-like bodies*.—Most persons are aware that some forms of the conchiferous mollusks are subject to certain abnormal secretions, assuming a more or less regular form, and composed of fibro-calcareous matter generally arranged in a concentric manner; sometimes it is solidly attached to the inner layer of the shell, of which it forms a portion; at others it is found perfectly free in the fleshy substance of the mollusk itself, of a symmetrical shape, as in the perfect pearl. Evidence of phenomena resulting from similar conditions has been detected in certain fossil genera, but few, if any, instances have been recorded. The collection of Mr. Wetherell contains many illustrative specimens; in one, a *Gryphaea* [*dilatata*] from the Drift of Muswell Hill, and probably coming from the Oxford Clay [really Kimeridge], is an irregular elongated body, free at both ends, but attached by a considerable portion of its surface, the external lamina being continuous with the shell; the outer layers do not, however, show the regular fibrous arrangement of a perlaceous body, but this may have been changed by subsequent mineralization. In another specimen the pearly body is attached to the interior of an *Inoceramus*, and shows the concentric arrangement of the fibrous substance, and which is better exhibited in the specimen showing a complete section of one of considerable size, quite unattached to any shell, from the Chalk of Kent." The material which formed the subject of Professor Morris' statements is now in the collection of the British Museum.

Ten years later (1861) Professor H. G. Seeley³ described *Perna oblonga*, the valves of which occurred as natural casts in the phosphatic

¹ Petrefacta Germaniæ, 1836, vol. ii, p. 116, pl. cxii, fig. 4d.

² Ann. Mag. Nat. Hist., 1851, vol. viii, p. 85, pl. iv, figs. 12, 13, 14, 16.

³ Ann. Mag. Nat. Hist., 1861, vol. vii, p. 121, pl. vi, fig. 6.



Higley photo

FOSSIL (MESOZOIC) PEARL REMAINS.

beds of the so-called Cambridge Greensand. The sides of these casts were found to be frequently covered with rounded pittings, the origin of which was fully acknowledged by the author to be due to the former presence of pearls on the original interiors of the valves.

Another internal cast of an *Inoceramus* (*Inoceramus sagensis*, var. *quadrans*) with rounded cavities, from the Cretaceous rocks of New Jersey, was figured by Professor R. P. Whitfield¹ in 1885. Somewhat similar pittings were figured by Professor Yokoyama² as being present on an *Inoceramus* cast from the Upper Cretaceous rocks of Japan, and mention may also be made of isolated pearls occurring in the marine Post-Pliocene deposits of the Clyde Basin at Garvel Park, which have been referred to by Mr. D. Robertson.³

As a final statement under this heading, reference may be made to numerous minute spherical bodies varying in diameter from $\frac{1}{100}$ to $\frac{1}{200}$ of an inch, which were detected in some examples of Chalk from Cherry Hinton near Cambridge, Swaffham in Norfolk, and other localities, by C. B. Rose⁴ during 1859, who mentioned their occurrence in connection with some observations on "Geological Pearls." Mr. Rose was of opinion that if these minute spheres were to be recognized as pearls, then they might be considered as 'seed-pearls.' Later investigations have, however, proved that such structures are not pearls, but represent the disunited cells of Globigerinæ and other Foraminiferal remains, a fact clearly demonstrated by Messrs. W. Hill and A. J. Jukes-Browne,⁵ whose microscopical researches have included the examination of specimens of chalk obtained from the same localities as those referred to by Mr. Rose.⁶

II. OCCURRENCE AND FORMATION OF THE PEARL.

According to S. P. Woodward's "Manual of the Mollusca," pearls are found in quite a number of shells, the chief of which are the Oriental pearl-oyster, *Margaritifera vulgaris*; the British river mussel, *Unio margaritiferus*; the common oyster, *Ostrea edulis*, *Anodonta cygnæa*, *Pinna nobilis*, *Mytilus edulis*, *Spondylus gæderopus*, *Arca noæ*, and *Anomia cæpa*. Similar prominences or concretions occur in the interiors of some porcellanous shells, as for instance in *Turbinella scolymus* and *Strombus gigas*, which are of pink colour, but these are not true pearls, not being nacreous, and are said to lose their colour in course of time.

A popular theory as to the origin of the pearl was that particles of sand were accidentally confined between the mantle and the shell,

¹ Mon. United States Geol. Survey, 1885, vol. ix, p. 79, pl. xiv, fig. 16.

² Palæontographica, 1890, vol. xxxvi, p. 175, pl. xviii, fig. 6.

³ Trans. Geol. Soc. Glasgow, 1883, vol. vii, pt. i, p. 31.

⁴ The Geologist, 1859, vol. ii, p. 295.

⁵ Quart. Journ. Geol. Soc., 1886, vol. xlii, p. 228; and "The Cretaceous Rocks of Britain (Upper Chalk)," vol. iii, Mem. Geol. Surv. United Kingdom, 1904, pp. 302-48.

⁶ I am indebted to Mr. C. D. Sherborn, F.G.S., for calling my attention to Mr. Rose's paper.

giving rise to irritation and the subsequent secretion by the animal of perlaceous growths. Although this view might occasionally hold good, it is distinctly proved by modern researches that the majority of pearls are derived from an organic nucleus due to certain parasitical worms which infest the soft parts of the mollusc. Such a discovery is by no means new, and we owe it to very early investigators, going back to Rondeletius in 1558 and even before his time. The more systematic work was, however, accomplished by Professor F. de Filippi¹ in the early fifties, who demonstrated that the Trematode parasite, *Distomum duplicatum*, was the cause of pearl-formation in the fresh-water mussel *Anodonta*. Küchenmeister,² working on the same lines, extended this view to other pearl-producing shells and to other parasites, and he found that pearls were most abundant in the quiet waters of the River Elster, Saxony, where water-mites (*Limnochares anodontæ*) existed most numerously. In 1857 Kelaart³ investigated the natural history of *Margaritifera vulgaris*, the pearl-oyster of Ceylon, and was probably the first to prove the presence of parasitical worms in the soft parts of that animal, to which he traced the origin of the pearl concretions. Without quoting the later writers on this subject, it is enough to refer the student to Professor Herdman's comprehensive "Report to the Government of Ceylon on the Pearl Oyster Fisheries of the Gulf of Manaar," published in five volumes by the Royal Society between the years 1903 and 1906. For this work Messrs. A. E. Shipley and James Hornell have contributed a most valuable memoir on "The Parasites of the Pearl Oyster," which are regarded by them as belonging to three groups of the Entozoa, viz. Cestodes, Trematodes, and Nematodes (1904, vol. iv, pp. 77-106, pls. i-iv), whilst Professor Herdman, in conjunction with Mr. J. Hornell, has written a special chapter on "Pearl Production," which is of the highest importance (1906, vol. v, pp. 1-42, pls. i-iii).

According to Dr. H. Lyster Jameson,⁴ the term 'blisters' is applied to "internal excrescences of the shell, caused by the intrusion of foreign bodies between the mantle and the shell, or by the secretion of a nacreous cicatrix to close the perforations of boring molluscs, worms, or sponges. These are sometimes referred to as 'attached pearls,' or even as 'pearls,' but have a totally different mode of origin, and should never be confused with the latter." Valves of *Mytilus edulis* are sometimes furnished with the so-called 'blisters,' which may have been produced in the manner indicated, as minute perforations are observable on the external surface of some examples in the zoological department of the British Museum.

¹ "Sull' origine delle Perle": Il Cimento (Torino), 1852, vol. i, pp. 429-37.

This paper was translated by Küchenmeister in Müller's Archiv Anat. Physiol., 1856, pp. 251-68.

² Müller's Archiv Anat. Physiol., 1856, pp. 269-81.

³ "Introductory Report on the Natural History of the Pearl Oyster of Ceylon": reviewed by J. S. Dallas in the Ann. Mag. Nat. Hist., 1858, vol. i, pp. 81-100.

⁴ "On the Origin of Pearls": Proc. Zool. Soc. London, 1902, vol. i, p. 147.

III. ARTIFICIAL PEARLS.

That pearls could be produced by artificial means has long been demonstrated by Linnæus and others. Even from the thirteenth century the Chinese adopted methods for the production of pearls in the valves of the large fresh-water mussel, *Barbala* (*Dipsas*) *plicata*, found in the rivers of their country. They inserted mother-of-pearl or metal plates of small size, so fashioned as to represent images of Buddha, which were cleverly introduced between the mantle of the animal and its shell, to the number of eleven or twelve, with their heads directed in one way, mostly postero-vertically. This mechanical device was accomplished during the life of the mollusc, the valves being returned to the river-beds, when, after some months, a nacreous secretion was found to cover the images, the valves in that condition being ultimately sold as curios by the natives. Dr. J. E. Gray¹ has written some interesting papers on this industry, as well as many other authors.

IV. FOSSIL PEARLS.

These calcareous concretions, or pearl-growths, found occasionally adherent on the inner surface of certain fossil pelecypod valves, or even in the free condition, may occur either in great numbers, when they would be moderately small, or singly, when they might be of considerable size. It is generally admitted that pearls are of similar structure to the shells in which they are found, and like them consist of three layers; in the case of adherent specimens the inner layer of the shell is easily seen to form the outer layer of the pearl.

So far as present researches have gone, it is worthy of note that fossil pearls have only been observed among the genera *Volsella* of the family Mytilidæ, *Inoceramus* and *Perna*, members of the Aviculidæ, and *Gryphæa*, one of the Ostreidæ. Such relics are apparently most rare, those known to the writer and which are referred to in this paper being chiefly of Mesozoic age. There is no reason why certain Palæozoic Pelecypods should not exhibit similar structures, yet no authentic account can at present be traced.² The British Pliocene (Crag) deposits have yielded pearl-structures, but these, in the opinion of the writer, are most probably derived and had their origin in the Chalk.

The various examples of pearl-growths found in the fossil state which have come under my notice during the preparation of this

¹ "On the Structure of Pearls, and on the Chinese mode of producing them of a large size and regular form": *Annals of Philosophy*, 1825, vol. ix, pp. 27-9. "Figured Pearls of the Chinese": *Ann. Mag. Nat. Hist.*, 1854, vol. xiii, p. 238.

² Allusion may be made here to certain minute spherical bodies described by Professor W. J. Sollas from the Wenlock Limestone near Cardiff, which were found associated with *Favosites fibrosus* (= a coral). From their pearly lustre and slight translucency, these spheres resembled a number of small pearls, but as they only showed a concentric structure without any trace of radiating fibres they were regarded as oolitic grains formed by a deposition of carbonate of lime from solution. (*Quart. Journ. Geol. Soc.*, 1879, vol. xxxv, pp. 501, 502.)

paper will now be referred to under the particular shell with which they are associated, some of the material being in the collection of the British Museum, which includes the 'Morris' specimens described in 1851.

Family MYTILIDÆ.

VOLSELLA MODIOLUS (Linnæus).

Mytilus modiolus, Linnæus: Syst. Nat., 1758, 10th ed., p. 706.

David Robertson: Trans. Geol. Soc. Glasgow, 1883, vol. vii, pt. i, p. 31.

The Geological Department of the British Museum possesses several small isolated pearl bodies which were presented by David Robertson, Esq., in 1883, who collected them in the marine Post-Pliocene deposits of the Clyde Basin at Garvel Park. Some of these attain a diameter of 3 millimetres, whereas others are very much smaller. Externally they present a shiny nacreous appearance, their inner structures being composed of concentric layers in combination with the usual radial structure. Similar specimens are listed by Mr. Robertson in his paper "On the Post-Tertiary Beds of Garvel Park" as belonging to *Mytilus modiolus* of Linnæus, a specific determination which is here retained, although placed under Scopoli's genus *Volsella*, that having priority of Lamarck's *Modiola*, with which the species is usually associated.

Geological age.—Post-Pliocene (marine glacial beds).

Locality.—Garvel Park, Clyde Basin, Scotland.

Collection.—British Museum (D. Robertson Coll.) [L. 980].

Family AVICULIDÆ.

INOCERAMUS GOLDFUSSIANUS, Orbigny. Pl. IV, Fig. 1.

Inoceramus Crispisii, Goldfuss (*non* Mantell): Petrefacta Germaniæ, 1836, vol. ii, p. 116, pl. cxii, fig. 4d.

Inoceramus Goldfussianus, Orbigny: Paléontologie Française, Terr. Crétacés, Lamellibranchia, 1845, p. 517, pl. 411; Prodrome Pal. Strat., 1850, vol. ii, p. 250.

The specimen figured by Goldfuss is a convex natural cast representing the interior of a left valve, studded with numerous small pittings, which are generally of uniform size. A patch of the original shell is still preserved, showing the nearly equidistant concentric ridges with their fine lineations, which extend as well over the surface of the sulcations. The pittings are of fairly regular arrangement, and follow the concentric character of the sculpture, appearing to be absent on the umbonal surface of the valve and on the region immediately below the dorsal line. As pointed out originally by Goldfuss, they represent cavities for the reception of wart-like prominences that would be present on the internal surface of the valve. No mention is made, however, of the fact that such tubercles would indicate pearl-growths, although there is no doubt that this is their true interpretation. The illustration published by Goldfuss forms probably the earliest known figure of a fossil shell showing the remains of pearl-structures. It has

been more or less customary for Continental palæontologists to regard this form as Mantell's *Inoceramus Cripsi*, whereas the English species has much more median umbones, being consequently of different contour, besides belonging to an older stage (Cenomanian) of the Cretaceous series. D'Orbigny recognized a distinction, and gave the name *Goldfussianus* to the shells figured and described by Goldfuss as *Inoceramus Cripsi* of Mantell. At a later date the same author in his "Prodrome" restricted the species *Goldfussianus* to the specimen represented by fig. 4d of Goldfuss's pl. cxii—figs. 4a, b, and c of that same plate being recognized as his *I. regularis*. Both these species, *Goldfussianus* and *regularis*, are of Upper Senonian (Campanian) age, being known to occur, at the time of description, in Westphalia (Haldem, Dulmen, etc.) and certain areas of France (Royan, etc.).

A preliminary note on the nomenclature of some of these Senonian *Inocerami* has been recently published by Dr. Joh. Böhm, who promises a more extended account on completion of his researches ("Über *Inoceramus Cripsi*, Mant.": Monatsber. Deutsch. Geol. Ges., 1907, No. 4, p. 113).

The specimen now referred to, as delineated in the original figure, measures 125 mm. in length and 65 mm. in height.

Geological age.—Cretaceous (Campanian).

Locality.—Haldem, Westphalia, Germany.

INOCERAMUS EXPANSUS, W. H. Baily. Pl. IV, Figs. 2, 3.

Inoceramus expansus, W. H. Baily: Quart. Journ. Geol. Soc., 1855, vol. xi, p. 462, pl. xiii, fig. 5; H. Woods, Annals South African Museum, 1906, vol. iv, p. 299.

This species of *Inoceramus* is one of the most characteristic Pelecypods of the Upper Cretaceous rocks of Pondoland in South Africa. It frequently occurs with the original shell-structure preserved, although just as often it is represented by convex natural casts of the interior. Some of these casts exhibit the equidistant concentric ridges, separated by wide sulcations, and an entirely smooth surface; others, as in the specimens figured (a left valve), bear numerous small rounded cavities of nearly equal size, arranged concentrically with the sculpture-markings, and agreeing in all respects with what has been observed in *Inoceramus Goldfussianus*. These pittings are present on both valves, as shown by the specimen representing a fragmentary cast, with parts of both valves exhibiting the postero-umbonal view. These specimens are also furnished with some feeble radial striations, emanating from the umbonal region, and extending to the ventral margin, being more obvious on the lateral areas than elsewhere.

A wax impression of the single valve yields a beautiful result, the rounded and elevated prominences showing out quite clearly, as well as the faint radial striations. No mention is made in Baily's original description of the pittings now called attention to, nor has Mr. H. Woods noticed this phenomenon in his more recent account of the shell. The single valve has a length of 95 mm. and a height of 105 mm., whilst the specimen with both valves in the closed condition shows a diameter of 60 mm. and a height of 130 mm.

Geological age.—Cretaceous (Campanian).

Locality.—Pondoland (Umtamvuna River district), South-East Africa.

Collection.—British Museum [L. 8644].

INOCERAMUS sp.

Inoceramus sp., Yokoyama: Palæontographica, 1890, vol. xxxvi, p. 175, pl. xviii, fig. 6.

An excellent figure of another internal natural cast of *Inoceramus*, said to have affinities with Mantell's *I. Cripsi* and showing similar rounded cavities between the grooves, has been published by Professor Yokoyama, from the Senonian of Japan. The author regards the pittings as the result of disease, without mentioning that they originated from the former presence of pearly protuberances on the inner surface of the valves. This specimen is a left valve having a length measurement of 120 mm.

Geological age.—Cretaceous (Senonian).

Locality.—Near Urakawa, Japan.

INOCERAMUS SAGENSIS, D. D. Owen, var. QUADRANS, R. P. Whitfield. Pl. IV, Fig. 4.

Inoceramus sagensis, var. *quadrans*, Whitfield: Mon. United States Geol. Survey, 1885, vol. ix, p. 79, pl. xiv, fig. 16.

“The middle of the cast, for about two-thirds the width, is marked by strong, rather deep pits, connected by shallow furrows, showing that the interior of the shell was covered by strong pearl-like protuberances, which progressed with the growth of the shell as does a muscular scar, and I presume they were connected in some way with the vascular system as were the lines of dots or interrupted striæ on other species of the genus.”

According to this statement Professor Whitfield appears to regard these perlaceous remains as part of the animal organization, and related in some way to the vascular system, but if we accept the view referred to by Mr. W. S. Dallas (Ann. Mag. Nat. Hist., 1858, vol. i, p. 95) that pearl-structures are abnormal growths brought about by certain causes unconnected with the mollusc itself, it is manifest that the former idea as to the origin of these bodies must be cancelled. Judging from Dr. Whitfield's figure, the dimensions of this specimen show a length of 103 mm. and a height of 85 mm.

Geological age.—Cretaceous (Senonian: Lower Marls).

Locality.—Near Burlington, New Jersey, United States.

INOCERAMUS LABIATUS (Schlotheim). Pl. V, Fig. 1.

Ostracit, Knorr: Die Naturgeschichte der Versteinerungen, 1768, vol. ii, p. 84, pl. B ii, b**, fig. 2.

Ostracites labiatus, Schlotheim: Taschenbuch Mineralogie, 1813, vol. vii, p. 93.

Mytulites problematicus, Schlotheim: Die Petrefactenkunde, 1820, p. 302.

Inoceramus mytilloides, Mantell: Fossils of the South Downs, or Illustrations of the Geology of Sussex, 1822, p. 215, pl. xxviii, fig. 2.

This example is an interior of a left valve with well-preserved shell-structure, on the surface of which is a series of small pearly tubercles, varying slightly in size, and situated chiefly on the anterior surface and some distance from the hinge-line, being arranged more or less concentrically as in the other shells previously mentioned.

Although fragmentary, being without the postero-ventral region, this specimen is important as showing the partial interior of an *Inoceramus* valve, a condition of some rarity among members of that genus. The early synonymy of the species may be thus explained: Schlotheim founded his species *labiatus* on a valve figured by Knorr from the Pirna sandstone of Saxony. The name *problematicus* was given subsequently by the same author for precisely the same shell, and cannot therefore be retained. The Mantellian name of *mytilloides* was established still later for a British form of *Inoceramus* which is now generally acknowledged to be identical with the *labiatus* of Schlotheim, and therefore this latter name should be adopted.

The species is a useful form from the horizontal point of view, being characteristic of the Turonian division of the Upper Cretaceous rocks, which includes that part of the 'Quaderstein' of Germany containing the Pirna sandstone, from whence Knorr's original specimen was obtained. This particular valve has a length of 70 mm. and a height of 105 mm.

Geological age.—Cretaceous (Turonian).

Locality.—Blue Bell Hill, Burham, Kent.

Collection.—British Museum (S. J. Hawkins Coll.) [L. 10384].

INOCERAMUS. Pl. IV, Fig. 5.

Inoceramus, J. Morris: Ann. Mag. Nat. Hist., 1851, vol. viii, p. 89, pl. iv, fig. 12.

The example here referred to and refigured is the original as described by John Morris. It represents a single rounded pearl concretion attached by the whole of its base to a portion of an *Inoceramus* shell. The various layers, being fractured in places, show the exposed edges and their fibrous structure. This is a fairly large relic of pearl-growth, and measures 13 mm. in diameter.

Geological age.—Cretaceous (Senonian).

Locality.—Northfleet, Kent.

Collection.—British Museum (N. T. Wetherell Coll.) [L. 20845].

INOCERAMUS. Pl. V, Figs. 2, 3.

This specimen consists of an elongate pearl-structure of pyriform contour, longitudinally adherent to a fragment of *Inoceramus* shell. It starts with being a rounded smooth body, and subsequently developing a narrow, elongate extension on each side. A section of this gives the concentric, radial structure in the rounded top of the concretion, whereas the more fibrous character is observed in the

lateral prolongations. Length of pearl-growth, 36 mm.; diameter of spherical part, 14 mm.

Geological age.—Cretaceous (Senonian).

Locality.—Charlton, Kent.

Collection.—British Museum (Rev. Norman Glass Coll.) [44676].

INOCERAMUS. Pl. V, Figs. 4-6.

Inoceramus, J. Morris: Ann. Mag. Nat. Hist., 1851, vol. viii, p. 89, pl. iv, figs. 13, 14.

Morris's section (his fig. 14) represents another pearl concretion of considerable size, its diameter measuring 20 mm., this measurement being obtained from the illustration, as its presence among British Museum specimens has not been satisfactorily determined. It is stated to be an unattached form, of which there are two or three other examples, although much smaller than exhibited by the 'Morris' section. One of these appears to be the original of fig. 13 of the 'Morris' plate, which exhibits an exactly similar radio-concentric structure to the attached form previously mentioned, and from its lithological resemblance would doubtless have originally belonged to an *Inoceramus* shell, being so regarded by John Morris. Under a strong lens the external surfaces of the concentric layers are observed to be of minute prismatic structure.

A magnificent section of a further example, figured on Pl. V, Figs. 4, 5, of this paper, from the same locality as those represented by figs. 13 and 14 of the 'Morris' plate, has been most kindly placed at my disposal for reference in this paper by its possessor, Mr. B. B. Woodward, F.L.S. It has a diameter of 11 mm., and not only shows the normal structure of the exquisitely fine and straight radial striations crossed by the periodical concentric lines, but the nucleus under a $\frac{1}{4}$ inch objective appears to be of cellular or prismatic structure. It seems probable that this cellular character of the nucleus may represent the encysted larval condition of Cestode or other parasitical worms, such as has been figured by Messrs. Herdman and Hornell in connection with modern pearl structures ("Pearl Production": Report to the Government of Ceylon, etc., 1906, pt v, pl. i, fig. 14).

Geological age.—Cretaceous (Senonian).

Locality.—Northfleet, Kent.

Collection.—British Museum (N. T. Wetherell Coll.), and collection of B. B. Woodward, Esq.

INOCERAMUS.

The British Museum collection also contains some isolated examples of spherical pearl bodies, which occur in the Crag deposits of Suffolk (Orford Castle district and Waldringfield), and which vary from 3 to 10 mm. in diameter. Sections exhibit the usual concentricity of formation, as well as the radial structure as seen in specimens from valves of *Inoceramus*. Externally the growth layers can be seen by their fractured edges, and sometimes the surface is pierced by minute and larger perforations, the work of a boring organism of some kind.

It is quite possible that these specimens were originally derived from the Chalk, because in general appearance and size they agree remarkably well with pearl-growths associated with the genus *Inoceramus* of Cretaceous rocks. Externally they are straw-coloured, but perfectly white inside; this, taken in connection with the presence of annelid or molluscan perforations, which were probably made long after their transportation from the Chalk sea, is strongly in favour of their derivative character.

Mr. F. W. Harmer, F.G.S., has shown me a similar pearly concretion of small size collected in the Waltonian zone of the Red Crag at Little Oakley, near Dovercourt, Essex, the same deposit having also yielded a fragmentary example of *Belemnitella*, a characteristic Cephalopod of Upper Cretaceous (Senonian) times. This occurrence would seem further to favour the derivative theory for these interesting spherical bodies. Several papers have been written on the derived fauna of the Crag beds, one of the earliest being by Searles V. Wood,¹ *Belemnites* being listed as originally coming from the Upper Cretaceous. Pearl-structures, however, from the Crag beds, whether regarded as derived or occurring *in situ*, do not appear to have been mentioned in connection with the Pliocene fauna.

Geological age.—Cretaceous (Senonian). Found in the Crag deposits as probably derivative fossils from the Chalk.

Localities.—Near Orford Castle, and Waldringfield, Suffolk.

Collection.—British Museum (Robert Bell and Edward Charlesworth Colls.) [L. 21228 and L. 21229].

PERNA OBLONGA, H. G. Seeley. Pl. V, Fig. 7.

Perna oblonga, H. G. Seeley: Ann. Mag. Nat. Hist., 1861, vol. vii, p. 121, pl. vi, fig. 6; H. Woods, Cretaceous Lamellibranchia England, Mon. Pal. Soc., 1905, vol. ii, pt. ii, figs. 19A, B, E, woodcuts on p. 94 (=reproduction of type figures).

Professor H. G. Seeley founded this species on some internal casts common to the phosphatic deposits of Cambridge. He noticed that the sides of the valves were frequently furnished with numerous small cavities, proving that the animal must have been a pearl-producer "in prodigious numbers." He further remarked that pearl-like bodies "are often met with detached, sometimes as large as peas: they mostly have a yellowish colour . . . but, besides the free pearls, pearls attached to the shell were far from uncommon, and in some individuals so numerous as to remind one more of artificial productions in the Chinese *Anodon* than of a natural growth. No nacreous specimens have been found which can satisfactorily be considered as attached pearls; but their impressions, left on phosphatic casts, are unmistakable."

¹ Wood, Searles V., "On the Extraneous Fossils of the Red Crag": Quart. Journ. Geol. Soc., 1859, vol. xv, p. 38.

Mr. Henry Wood refers, also, to this subject, and supplies woodcuts of two additional specimens (figs. B and E) as well as a new figure of Professor Seeley's type, the whole of which material is in the Sedgwick Museum at Cambridge.

Geological age.—Albian (commonly called the Cambridge Greensand, which is a phosphatic derivative deposit).

Locality.—Cambridge.

Collection.—British Museum [L. 9062].

Family OSTREIDÆ.

GRYPHÆA DILATATA, J. Sowerby. Pl. IV, Fig. 6.

Gryphæa dilatata, J. Sowerby: Min. Conch., 1816, vol. ii, pl. cxlix.

Gryphæa, J. Morris: Ann. Mag. Nat. Hist., 1851, vol. viii, p. 89, pl. iv, fig. 16.

A Jurassic example of pearl-growth is met with on the interior of a lower valve of *Gryphæa dilatata*, which assumes an elongate, irregular, somewhat pyriform body, measuring 20 by 13 mm., and adherent in great part to the adductor muscular scar region, and, as mentioned originally by Morris, it is free at both ends. The external lamina of this specimen is continuous with the shell, whilst the outer layers are said not to exhibit the usual fibrous character of a perlaceous concretion, having probably been altered by subsequent mineralization.

The valve on which this specimen is adherent has a length of 70 mm. and a height of 85 mm.

Geological age.—Jurassic (Kimeridgian), found in the Drift.

Locality.—Muswell Hill, near London.

Collection.—British Museum (N. T. Wetherell Coll.) [L. 21230].

EXPLANATION OF PLATES.

PLATE IV.

Inoceramus Goldfussianus, Orbigny.

Senonian (Campanian): Haldem, Westphalia.

FIG. 1.—Natural cast of the interior of a left valve with a fragment of original shell *in situ*, showing numerous rounded pittings caused by pearly protuberances on the original inner surface of the valve. Reduced $\frac{1}{2}$ from the original fig. 4*d* in the "Petrefacta Germaniæ."

Inoceramus expansus, W. H. Baily.

Senonian (Campanian): Pondoland, S.E. Africa.

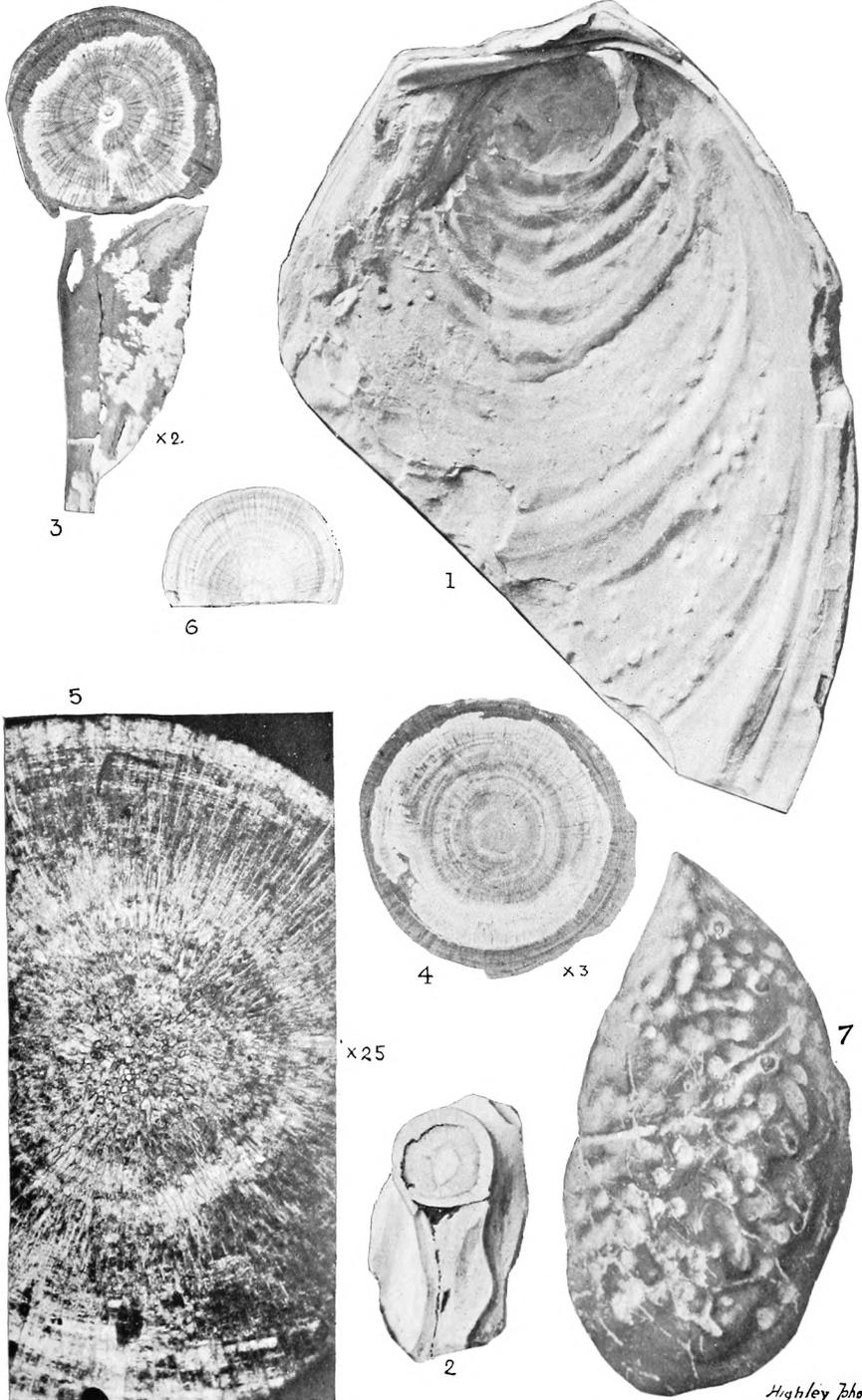
FIG. 2.—Natural cast of a fragmentary left valve showing a series of rounded pittings. $\frac{2}{3}$ nat. size. [British Museum, L. 8644.]

FIG. 3.—Natural cast of another specimen showing both valves in the closed condition, studded with numerous pittings as before. $\frac{2}{3}$ nat. size. [British Museum, L. 8644.]

Inoceramus sagensis, D. D. Owen, var. *quadrans*, R. P. Whitfield.

Senonian: near Burlington, New Jersey, United States.

FIG. 4.—Natural cast of the interior of a left valve, showing numerous rounded pittings and fine radial striations, copied from Whitfield's original fig. 16 published in 1885. $\frac{2}{3}$ nat. size.



FOSSIL (MESOZOIC) PEARL REMAINS.

Inoceramus.

Senonian (*Micraster cor-anguinum* zone): Northfleet, near Gravesend, Kent.

- FIG. 5.—An adherent pearl-structure on the inner surface of shell of *Inoceramus*, representing Morris's original specimen figured on pl. iv, fig. 12, of the "Annals" for 1851. [British Museum, L. 20845.]

Gryphæa dilatata, J. Sowerby.

Kimeridgian (Drift): Muswell Hill, near London.

- FIG. 6.—Interior of a lower valve, showing an elongate pearl-growth partially adherent to the adductor muscular scar, taken from the original specimen in the British Museum, which was figured by Morris in the "Annals" for 1851, but without the whole of the valve. $\frac{2}{3}$ nat. size. [British Museum, L. 21230.]

PLATE V.

Inoceramus labiatus, Schlotheim.

Turonian: Blue Bell Hill, Burham, Kent.

- FIG. 1.—Interior of a left valve, showing a part of its surface covered with small pearly tubercles. [British Museum, L. 10384.]

Inoceramus.

Senonian: Charlton, Kent.

- FIG. 2.—Sectioned surface of a pyriform pearl-structure adherent to a fragment of *Inoceramus*, showing lateral extensions proceeding from the spherical portion of the body. [British Museum, 44676.]
- FIG. 3.—A glass-section prepared from the same specimen (Fig. 2), showing the concentric and radial details. $\times 2$.

Inoceramus.

Senonian: Northfleet, Kent.

- FIG. 4.—A glass section made from an isolated pearl-structure, showing the concentric and radial characters, with an apparently cellular or prismatic nucleus. $\times 3$. In the collection of B. B. Woodward, Esq., F.L.S.
- FIG. 5.—An enlargement of the nuclear portion as seen in the same section, somewhat resembling the central structure of a modern pearl as figured by Messrs. Herdman and Hornell on pl. i, fig. 14, of part v of their report. $\times 25$.

Inoceramus.

Senonian: Northfleet, Kent.

- FIG. 6.—Section of an unattached pearl-like body of considerable size, showing the concentric and radial structure, copied from Morris's original fig. 14 of the "Annals" paper of 1851.

Perna oblonga, H. G. Seeley.

Albian ("Cambridge Greensand"): Cambridge.

- FIG. 7.—Natural cast of the interior of a left valve, exhibiting numerous rounded cavities formed by pearl protuberances. [British Museum, L. 9062.]

Note.—Unless mentioned to the contrary, the figures on the plates are represented of the natural size.