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CATALOGUE

OF

THE FOSSIL BRYOZOA (POLYZOA)

IN THE

DEPARTMENT OF GEOLOGY,
BRITISH MUSEUM (NATURAL HISTORY).

THE CRETACEOUS BRYOZOA
(POLYZOA).

VOLUME IV.
THE CRIBRIMORPHS.—PART II.

BY

W. D. LANG, Sc.D., F.G.S.

WITH EIGHT PLATES.

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PREFACE.

The present volume is a direct continuation of the last, and completes the catalogue of the Cretaceous Cribrimorph Cheilostomata. The principles on which it has been prepared have already been explained in the Introduction to Vol. III.

The Author is much indebted to Dr. Bather for continual help and advice during the progress of the work and the revision of the proof-sheets. The drawings for the Plates have again been made by Miss Gertrude M. Woodward, and the diagrammatic text-figures have been drawn by the Author himself. Thanks are due to the Council of the Geological Society of London for the use of text-figure 1.

A. SMITH WOODWARD.

Department of Geology,
British Museum (Natural History).
March 1st, 1922.

ADDENDA AND CORRIGENDA, VOLS. III & IV.

Vol. III, throughout. For "*E. scutatus*" read "*E. scutata*."

—— p. li, in diagram. *For* "Morphasmoporinæ" *read* "Kelestominæ."

—— p. lxxix, after line 19. Add "*College Farm;* North Lancing, S. of College Farm, Pit 1 of Gaster. Senonian, zone of *A. quadratus*, subzone of *E. scutata* var. *depressa*, lower part. Horizon determined by C. T. A. Gaster."

—— p. lxxxi, after line 21. Add "*Grays;* E. of Tilbury, Essex. Senonian, zone of *M. coranguinum*."

—— p. lxxxiv, line 27. *For* "Moulinaux" *read* "Moulineaux."

—— p. lxxxv, before line 1. Add "*Néhou;* S. of Valognes, Manche, France. Senonian."

—— p. lxxxviii, after the last line. Add "*Villedieu;* Loir-et-Cher, E. of La Chartre-sur-le-Loir, Sarthe, France. Senonian, Coniacian."

—— p. xcii, at the head of the second column on lines 3 and 10. Add "*Pelmatopora somptingensis* (rare)."

—— p. cvii, 8th line from bottom. *For* "1858" *read* "1857."

—— p. cviii, 18th line from bottom. *For* "1880" *read* "1870."

—— p. 52, after line 2. Add "[*Lepralia;* Marsson, 1887, p. 97]."

—— p. 61, above 8th line from bottom. Add "*Lepralia pediculus* Reuss; Marsson, 1887, p. 97."

—— p. 133, after line 4. Add "*Reptescharella* [partim]; Marsson, 1887, p. 97."

—— p. 135, after line 7. Add "*Reptescharella pygmæa* d'Orbigny; Marsson, 1887, p. 97."

—— p. 176, line 3 and in diagram. For "*Tricolpora*" and "*Tricolpopora*" read "*Trilophopora*."

—— p. 210, 3rd line from bottom. For "*virgula*" read "*virgata*."

Vol. IV, p. 39, line 1. *For* "the type-specimen" *read* "specimen **D. 8005**."

—— p. 61, line 13. *For* "Ginitz" *read* "Geinitz."

—— p. 65, line 17. For "*Traicephlopora*" read "*Tricephalopora*."

—— p. 83, line 4 from bottom. For "*triplex*" read "*triceps*."

—— p. 205, at top of phylogenetic diagram. For "*guascuoi*" read "*guascoi*."

—— p. 226, lines 2 and 3 from bottom. For "*M.*" read "*U.*"

—— p. 228, line 11 from bottom. *For* "Pelmatoporinæ" *read* "Pelmatoporidæ."

—— p. 232, line 8 from bottom. For "*Reptascharipora*" read "*Raptascharipora*."

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SYSTEMATIC ACCOUNT (*continued from Vol. III*).

LIST OF ILLUSTRATIONS IN THE TEXT.

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SYSTEMATIC ACCOUNT OF THE CRIBRIMORPH SPECIES (*continued*).

K. PELMATOPORIDÆ, Lang, 1916.

Pelmatoporidæ, fam. nov.; Lang, 1916, p. 83.

Diagnosis.—Multiserial Cheilostome Polyzoa of moderate or large size (·5–1·5 mm., but usually about ·75 mm. long), with endozoœcial ovicells, and intraterminal front-walls built of hollow terminal spines bent over arch-wise, fused with one another in the middle line, then bent vertically and possibly continued as free spines *, the apparently broken ends of which form two rows of *pelmata* (if small, *pelmatidia*)—hobnail-like markings on the intraterminal front-wall; secondary pelmata or pelmatidia may arise, and then lateral costal fusions are generally developed in correlation with them; the apertural spines are generally four, but occasionally five, six, or even more; it is probable that six was the primitive number, occasionally retained, but generally reduced to four, and in some cases catagenetically increased from four to a higher number; a secondary aperture is generally attained, and by a variety of methods in the various lineages; the ultimate terms of several lineages acquire a more-or-less complete tertiary front-wall. The aviculœcia are primarily numerous, sporadically distributed, indifferently directed, monomorphic, small and with blunt apertures, but during evolution are liable to become fewer in number, definite in position, definite in orientation, dimorphic, larger in size and with pointed apertures; in some lineages there is a catagenetic tendency to monomorphism from a dimorphic condition; and in some cases aviculœcia are absent.

Distribution.—Turonian to Danian.

* In the Recent genus *Gephyrotes*, which appears to have pelmatidia, these do not resemble the broken ends of free-spines, but raised 'lumen-pores' (of Norman).

REMARKS.—

1. *A hypothetical Ancestral Pelmatoporid* (fig. 1).

Cheilostome Polyzoa of very different types are included in the family Pelmatoporidæ; and it may be found that there is no close relationship between some of the sub-families. The sub-families, however, all have certain features in common and common evolutionary tendencies; and it is possible to construct a theoretical common ancestor exhibiting the structural features of the Pelmatoporidæ in their primitive forms; and, by applying to each

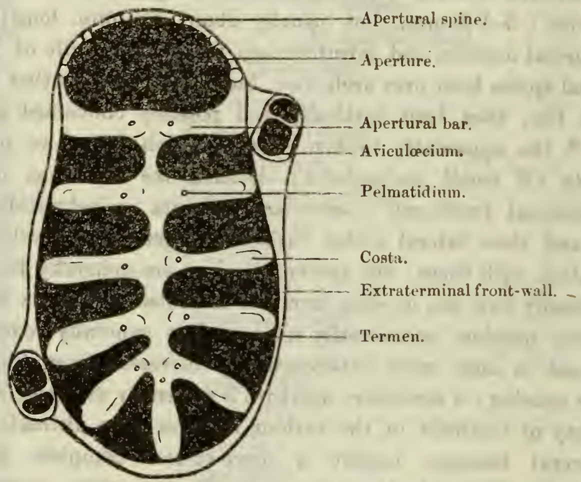


Fig. 1.—Diagram of a hypothetical primitive Pelmatoporid. × about 150 diameters.

character its evolutionary rôle as discovered in each sub-family, to derive the primitive members of the several sub-families from this common ancestor.

Such a supposed common ancestral form should possess the following characters:—

Asty incrusting, unilaminar; œcia dimorphic. Orthœcia about ·5 mm. long and ·2 mm. wide, elliptical; extraterminal front-wall of small extent and not obscured by interœcial secondary tissue; intraterminal front-wall well arched, consisting of nine or ten thin, well-spaced costæ each bearing a pelmatidium distally, with no lateral fusions, but with a weak median line of fusion; apertural bar thin, differing but little from the normal costæ and bearing a pair of pelmatidia, one on each side of the median line; aperture semicircular or sub-semicircular; apertural spines six; no secondary tissue in connection with the apertural spines or in connection with the aperture. Aviculœcia numerous, sporadically distributed, indifferently directed, monomorphic, small and with blunt apertures.

2. *The Evolution of each character from its primitive condition in the hypothetical Ancestral Pelmatoporid.*

To appreciate the evolution of the Pelmatoporidæ it is convenient to consider each of the above characters in its modifications in the various sub-families, and thus to arrive at two classes of modification, namely, on the one hand, those common to a given character in every sub-family, and therefore of no systematic value except as indicating the particular stage in evolution attained by that character, and, on the other hand, modifications of a given character peculiar to the sub-family considered, and, therefore, of systematic value.

The characters of the asty are first considered. All Pelmatoporidæ are multiserial in the arrangement of the œcia; and, during evolution, pass from an incrusting to an erect habit, and from a unilaminar to a bilaminar, multilaminar, or a cylindrical condition. The asty does not afford any characters of sub-family value.

The œcial characters may next be taken in order. The Pelmatoporid œcia are typically dimorphic, but some species of the Francoporinæ and Castanoporinæ apparently have no aviculœcia. In certian cases, *e. g.* in the genus *Rhiniopora*, it is evident that such forms are descended from aviculœcium-bearing ancestors, and it is probable that the total loss of aviculœcia is a contingency that may overtake any lineage; and, though this has not been observed in all the sub-families, the presence or absence of aviculœcia is of little value as a diagnostic character for these.

The size of the orthœcium, as a rule, increases during evolution, and, though occasionally a lineage may appear to be catagenetic with regard to size, *e. g.*, certain lineages of the genus *Pelmatopora*, the general rule holds good for the sub-families, and the orthœcial size is no diagnostic character of these.

The shape of the orthœcium really involves two characters—the proportion of the length to the breadth, and the parallelism or curvature of the sides. Generally speaking, there is a tendency for the orthœcium to become proportionally shorter during evolution, and for the sides to pass from a bowed shape to a parallel condition. In the Castanoporinæ, however, the parallel-sided orthœcium is never attained, and the almost almond-shaped orthœcium is characteristic, if not diagnostic, of the sub-family.

The extraterminal front-wall is nearly always of small extent, and, in so far as it shows an evolutionary tendency, it increases in size. Thus, in certain species of *Tricephalopora*, it is of considerable extent, and in these the well-developed extraterminal front-wall is manifestly an advanced character. Of course, the enlargement of the extraterminal front-wall is directly correlated with the diminution of the intraterminal front-wall. But the extent of the extraterminal front-wall cannot be used to diagnose a sub-family. In many genera, and in all the sub-families, the extraterminal front-wall becomes hidden during evolution beneath interœcial secondary tissue. The absence, or extreme scarcity (except in *Carydiopora myristica*), of interœcial secondary tissue appears to be a good diagnostic character for the sub-family Castanoporinæ, especially as in this sub-family secondary tissue is piled up to such an extent in other quarters that in certain genera a complete tertiary front-wall is acquired.

The amount of vaulting of the intraterminal front-wall appears to lessen during evolution. This character, however, is difficult to determine, as the apparent amount of vaulting is correlated with the amount of interœcial secondary tissue; when this is abundant, the vaulting appears less, because the whole intraterminal front-wall sinks towards, or becomes immersed beneath, the level of the interœcial tissue. In those forms in which the median area of fusion is wide, the top of the intraterminal front-wall is not vaulted, since the median area of fusion is comparatively flat. On the whole, then, the amount of vaulting, or apparent amount of vaulting, of the intraterminal front-wall is of little use in determining the sub-families.

The number of costæ tends to increase during evolution, but in some cases decreases catagenetically. Though of much use in tracing the evolution within a genus, as a character for determining a sub-family it can only be used very generally: for example, the Diacanthoporinæ are characterised by the small number of their costæ and the Castanoporinæ by a large number; but *Anornithopora*, a primitive Castanoporine, has only from eight to twelve costæ, which is about the range in the genus *Diacanthopora*.

With regard to pelmata and pelmatidia, the sub-families differ to a considerable extent. It is not possible to impose a very rigid line of demarcation between a pelma and a pelmatidium. Decided pelmata occur only in the Pelmatoporinæ and Diacanthoporinæ, and in the latter sub-family there are circumstances connected with them that make possible the claim that they are not strictly homologous with the pelmata of the Pelmatoporinæ. But even in the Pelmatoporinæ the advanced genera are not always readily distinguished in regard to this character from similarly advanced Castanoporine genera, though the respective claims of these genera to be placed in one or the other sub-family are substantiated by their general evolutionary history. Essentially the difference between a pelma and a pelmatidium is one of size, and, though generally obvious, cannot be taken as absolute. Moreover, in the Pelmatoporinæ, the secondary pelmata on their first appearance are pelmatidia, and gradually develop into pelmata. But, if the difference is conceded, the Pelmatoporidæ immediately fall into three subdivisions—namely, the Pelmatoporinæ with pelmata only, the Diacanthoporinæ with pelmata and pelmatidia, and the other sub-families with pelmatidia only. The question then arises: Did a pelma-bearing costa arise from one with a pelmatidium or *vice versâ*, or did both arise independently? If one of the first two alternatives is upheld, it seems more probable, in view of the development of secondary pelmata, that a pelma was derived from a pelmatidium than that the converse took place. But much may be said for the probability of an independent origin from Membranimorph ancestors of the sub-families bearing the pelmata from those bearing pelmatidia, and in this case the Pelmatoporidæ would consist of the single sub-family Pelmatoporinæ, the Diacanthoporinæ would form a second family, and the other sub-families would have to be combined in a new family. Until, however, more direct evidence is to hand, the Pelmatoporinæ and Diacanthoporinæ are best included with the other sub-families in a single group.

The consideration of the Diacanthoporine pelma is bound up with that of lateral costal fusions, and these are correlated with the development of secondary, tertiary, &c., pelmata and pelmatidia, which must next be considered. The origin of pelmata other than primary is clearly shown in the evolution of the Pelmatoporinæ. In primitive members of this sub-family each costa bears a single pelma at its distal end (fig. 2 *a*). In more advanced

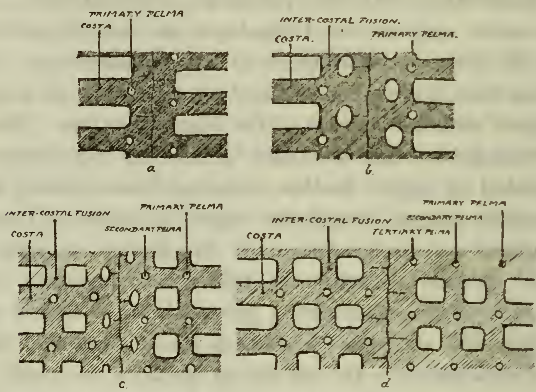


Fig. 2.—Diagrams showing the development of secondary and tertiary pelmata and of lateral costal fusions in the Pelmatoporine front-wall.

All the figures indicate the middle part of the intraterminal front-wall. In *a* and *b* there are primary pelmata only; in *a*, near the mid-line. In *b* the primary pelmata have moved away from the mid-line, and lateral costal fusions occur at their level. In *c*, secondary pelmata have arisen and began to move away from the mid-line, forming a second set of lateral fusions. In *d*, tertiary pelmata have arisen near the mid-line.

forms (fig. 2 *b*), clearly descended from the first kind, a second pelma appears on each costa. It is convenient to consider that the primary pelma has shifted proximally on the costa, carrying with it a part of the median line of fusion, and that the secondary pelma has been added at the distal end of the costa; for at the level of the supposed primary pelmata, there is a bridge of calcareous tissue joining each costa—a primary lateral costal fusion.

This process is repeated in more advanced species (fig. 2 *c*, *d*), until such a form as *Pelmatopora gregoryi* (Brydone) has three or four pelmata and two or three costal fusions to each costa. In the Castanoporinæ—for instance, in *Castanopora glandulosa*—there may be as many as seven or eight pelmatidia on each costa and a corresponding number of costal fusions, but in this sub-family only the later stages in the evolutionary scheme just described are demonstrable, since the most primitive known genus, *Carydiopora*, already has three pelmatidia and two or three lateral costal fusions to every costa. But there is every reason to suppose, both from analogy with the Pelmatoporinæ and with the later evolutionary history of the pelmatidia and the lateral costal fusions within the Castanoporinæ itself, that the early evolution of the pelmatidia and lateral costal fusions in this sub-family was similar to that indicated above. In the other sub-families, with the exception of the Diacanthoporinæ (to be considered later), and the Recent genus *Gephyrotes*, which is probably a Kelestomine (see under the Kelestominæ), there are primary pelmatidia only, and no lateral costal fusions. In certain Tricephaloporinæ, e. g. *T. saltdeanensis*, there are indications of possible secondary pelmatidia; but no lateral costal fusions accompany these—that is, there are no perforations between the costæ distal to the primary pelmatidia, but these lie on the edge of a solid, imperforate median band of fusion. But since the secondary pelmatidia, if they are such, are in the most rudimentary condition, it is probable that the perforations indicating the primary lateral costal fusions have not yet had time to evolve.

This consideration lends point to the suggestion that the pelmata of the Diacanthoporinæ are not strictly homologous with the Pelmatoporine pelmata—that is, their position at the proximal ends of the costæ is original, and not attained by the proximal shifting of an originally distal pelma. The Diacanthoporinæ (see figs. 71, 72) have on each costa a distal pelmatidium and a proximal pelma; the costæ are rather widely separated, and there are no lateral costal fusions. Had the proximal pelmata arisen, like those of the Pelmatoporinæ, by a process of shifting from a distal position, it would have been expected that they would have carried with them part of the median line of fusion as a lateral costal fusion, as the Pelmatoporine pelmata and, presumably, the

Castanoporine pelmatidia have done, though this has not occurred in the Recent Kelestomine genus *Gephyrotes*. It is possible, then, that the Diacanthoporine intraterminal front-wall was originally formed of spines branched at their proximal ends; that the lower branches fused in the mid-line, forming costæ, and prolonged their distal ends upwards as thin spines, which, broken, are the pelmatidia; that the upper branches projected freely as stout spines, and now appear, broken across, on the costæ as proximal pelmata. Or the apparent pelmata may rather have the nature of 'lumen-pores' of Norman (1903, p. 92), as they probably have in the Pliophlœinæ (vol. iii, p. 174). However, as remarked above, until the origin of various pelma- and pelmatidia-bearing sub-families is more definitely established, it is convenient to treat them together under the single family Pelmatoporidæ.

To sum up the consideration of pelmata, pelmatidia, and lateral costal fusions:—The number of pelmata or pelmatidia and costal fusions, though useful within a genus for showing specific relationships, is of no value for diagnosing a sub-family. On the other hand, the nature of the costal emergences, whether pelmata or pelmatidia, and the presence or absence of costal fusions is of primary diagnostic value in determining the sub-families of the Pelmatoporidæ.

The median area of fusion in all cases tends to become larger as development proceeds, and is of no diagnostic value as far as sub-families are concerned, except in the case of the Francoporinæ, in all known species of which the median fusion of the intraterminal front-wall is slight.

The apertural bar is formed by the fusion of the first pair of costæ, and is considered primitive in so far as it approximates in appearance to the normal costæ. Generally speaking, it affords fairly good diagnostic characters for the sub-families—except in the cases of the most primitive members of these. As the apertural bar increases in thickness and solidity it loses its resemblance to the normal costæ, and as secondary tissue is piled upon it, it forms, or takes part in forming, the proximal shield of the secondary aperture. Its most primitive expression among the Pelmatoporidæ is seen in the Castanoporinæ and to some extent in certain of the Pelmatoporinæ, where not only primary, but even secondary and tertiary pelmata and pelmatidia are often visible on the apertural bar; and in the Diacanthoporinæ, where the single pelmatidium and pelma on each costa are repeated on the apertural bar. In the Francoporinæ, Opisthornithoporinæ, and Pnictoporinæ, the apertural bar is solidly developed, but not highly modified. In the Kelestominæ it has a peculiar and characteristic bifid form. Finally, in the Tricephaloporinæ it is nearly always highly modified and complicated by taking part in forming the proximal shield of an elaborate secondary aperture. Thus, no general rule can be laid down for the development of the apertural bar in the Pelmatoporidæ, except a general elaboration of structure by the piling upon it of secondary calcareous tissue; but it is differently modified in several of the sub-families, and thus is a useful structure for their diagnosis.

Correlated with the secondary developments of the apertural bar is the character of the secondary aperture. The primary aperture has a general evolution in outline, changing from sub-semicircular or semicircular through semicircular to super-semicircular and finally to a cribriline shape (see vol. iii, p. xlvii, fig. 10). This evolution, however, is not very obvious or important except within certain genera, such as *Rhiniopora* and *Castanopora*. But in those sub-families in which a secondary aperture is developed, the formation of this is of the greatest importance in expressing their evolution. Since, however, the primitive members of these sub-families often have no secondary aperture, the nature of this structure is of no absolute value as a character on which to diagnose these sub-families. In the Francoporinæ and Opisthornithoporinæ no secondary aperture has been observed; and only a few forms of the Castanoporinæ and Pelmatoporinæ have a highly-developed secondary aperture. In the Diacanthoporinæ the secondary aperture consists of a plain rim of secondary tissue; while in the Kelestominæ, Tricephaloporinæ, and Pnictoporinæ it is generally a complex and well-developed structure formed differently in each case.

Correlated with the development of the secondary aperture is the secondary development of the apertural spines. Primarily, the apertural spines were probably six in number, as evidenced by the early neanastic stage of *Morphasmopora jukes-brownei* in the Kelestominæ and by the ephebastic stages of the primitive Castanoporine *Carydiopora*, which have six apertural spines; also by the ephebastic stages of the primitive Castanoporine *Hesperopora occidentalis* and possibly by the ephebastic stages of *Rhiniopora aspera*, which have five apertural spines; while the great majority of the Pelmatoporidæ have four apertural spines. It is probable that in the Castanoporinæ there is a catagenesis exhibited by this character. For the advanced species of *Rhiniopora* (*R. aspera*, *R. scabra*, and *R. aviculosa*), instead of the usual four, have five, six, and six apertural spines respectively; and the most primitive known species of *Castanopora*, namely *C. retrorsa*, as well as the comparatively advanced *C. nucifera*, *C. juglans*, and *C. castanea* and the ancestrœcium of another primitive species, *C. dibleyi*, have four, while ephebastic stages of *C. dibleyi*, and of the advanced species *C. glandulosa* have five apertural spines. Besides an evolution in respect of number, the apertural spines become secondarily thickened, and in certain sub-families take part in the formation of a secondary aperture. They exhibit no special adaptation in this direction in the sub-families Francoporinæ, Opisthornithoporinæ, and Pelmatoporinæ; and in the Castanoporinæ become involved in the secondary aperture in certain genera only. But in the Kelestominæ they play an important part in the formation of the proximal shield of the secondary aperture, and so they do in the primitive Tricephaloporinæ; while in the majority of species in this sub-family, secondary tissue is imposed upon the proximal apertural region to such an extent, that the primitive part played by the proximal pair of apertural spines in building the proximal shield of the secondary aperture is obscured by the secondary additions. In the Pnictoporinæ the secondary aperture is entirely composed of hoops made by the bifurcations and interfusions of the apertural spines, which, in this sub-family, are thoroughly diagnostic.

The aviculœcia remain to be considered. The character of their presence or absence has already been discussed (vol. iii, p. xxxiv); and it has been laid down as a general rule (p. 1, & vol. iii, pp. xxxii–iii) that throughout the sub-families of the Pelmatoporidæ they tend to pass from a numerous, sporadically distributed, indifferently directed, monomorphic, small, and blunt-apertured condition to one in which they are fewer in number, definitely distributed, definitely directed, dimorphic or polymorphic, larger, and with pointed apertures. Very few of these characters, however, can be postulated as diagnostic of individual sub-families, though many are characteristic. Thus, in the Francoporinæ, the aviculœcia, when present, are few, indefinitely distributed, indifferently directed, monomorphic, large, and with pointed apertures. In the Opisthornithoporinæ they are similar, but somewhat smaller and always more-or-less proximally directed. In the Kelestominæ, they are few, definitely placed, distally or proximally directed, monomorphic, small, and blunt or somewhat pointed. In the Tricephaloporinæ they have a considerable range of evolution, but characteristically are numerous, definitely placed, variously but definitely directed, monomorphic, small, and blunt. In the Pnictoporinæ they are few, definitely distributed, distally and laterally directed, monomorphic, small, and somewhat pointed. In the Castanoporinæ, when present, they are primarily remarkable for their dimorphism, and the subsequent history of each kind is different; the one kind, having long, pointed apertures, if persistent, tends during evolution to become fewer in number, to become definitely placed, and distally directed; and the other kind, having short, pointed apertures, tends to change but little, but often becomes rarer, and in some cases disappears. In the Pelmatoporinæ, the aviculœcia (apart from certain structures in advanced species of *Pelmatopora* that possibly are not aviculœcia) are fairly numerous, sporadically distributed, distally directed, small, and with blunt or shortly pointed apertures; and show but slight evolution in the directions indicated. The structures just mentioned as of doubtful homology and present in the advanced species of *Pelmatopora*, are a pair of aviculœcium-like projections from the distal rim of the secondary aperture, forming an imperfect distal shield; by exhibiting definite lines of development, they are of the greatest use in indicating the relationships of the higher forms of *Pelmatopora* (see figs. 73, 91–102).

3. *Characters diagnostic and not diagnostic of Sub-families.*

The development of each of the main characters has now been considered in relation to the diagnosis of sub-families. And it has been claimed that these characters, on the whole, will fall into two categories according as they exhibit a development common to all the sub-families or peculiar to each sub-family. In summarising the review of these developments, the characters are divided accordingly.

First, those characters whose modifications are similar in all the sub-families are as follows:—The arrangement of the orthœcia within the asty; the habit and condition of the asty; the presence or absence of aviculœcia; the size of the orthœcium; the shape of the orthœcium (diagnostic, however, for Castanoporinæ); the extent of the intraterminal front-wall and (except in the Castanoporinæ) the amount of its concealment by interœcial secondary tissue; the amount of vaulting of the intraterminal front-wall; the number of costæ (more or less diagnostic in Diacanthoporinæ and Castanoporinæ); the number of pelmata or pelmatidia (characteristic, but not absolutely diagnostic, except in Diacanthoporinæ); the breadth of the median area of fusion of the intraterminal front-wall (always, however, thin in Francoporinæ); the shape of the primary aperture; the number of the apertural spines; and aviculœcian features, often usefully characteristic but not truly diagnostic of the sub-families.

The characters whose modifications are peculiar to each sub-family, and therefore valuable for diagnostic purposes, are as follows:—The shape of the orthœcium (in Castanoporinæ only); the absence of interœcial secondary tissue (in Castanoporinæ only); the number of costæ (in Diacanthoporinæ and to some extent in Castanoporinæ); the number of pelmata or pelmatidia (in Diacanthoporinæ only); the nature of the costal emergences, whether pelmata or pelmatidia; the presence or absence of costal fusions; the thinness of the median area of fusion of the intraterminal front-wall (in Francoporinæ only); the primary character and secondary history of the apertural bar; the architecture of the secondary aperture; the secondary history of the apertural spines; and dimorphism of aviculœcia.

The best diagnostic characters for the sub-families are thus seen to be: (1) the nature of the costal emergences, whether pelmata or pelmatidia; (2) the presence or absence of costal fusions; and (3) the architecture of the secondary aperture, often including secondary developments of the apertural bar and of the apertural spines.

It is now possible to return to the hypothetical ancestral Pelmatoporid described above, and from it to derive a similar primitive member of each sub-family, from which in each case the known forms of each sub-family may be derived.

4. *Hypothetical Ancestral Forms of each Pelmatoporid Sub-family.*

Francoporinæ.—The Francoporinæ are undoubtedly the most primitive Pelmatoporidæ, and differ but little from the supposed ancestral Pelmatoporid. The chief modification is the deposition of interœcial secondary tissue, and a rim of secondary tissue round the aperture, swamping the apertural spines; the apertural bar also is strengthened with secondary tissue. Aviculœcia are larger than those of the primitive Pelmatoporid and pointed rather than

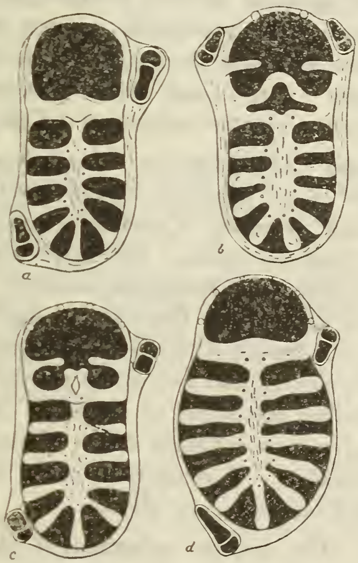


Fig. 3.—Hypothetical primitive forms of Pelmatoporid sub-families.
a. Francoporine. *b*. Kelestomine. *c*. Tricephaloporine. *d*. Castanoporine.

blunt. A comparison of fig. 3 *a*, representing in diagram a hypothetical primitive Francoporine, with fig. 1 of the primitive Pelmatoporid will make these differences clear.

Opisthornithoporinæ.—The Opisthornithoporinæ resemble the Francoporinæ in developing interœcial secondary tissue, and, to a certain extent, a secondary apertural rim; also a consolidated apertural bar; but they have advanced further than the Francoporinæ in that the costæ are more closely apposed and the median area of fusion of the intraterminal front-wall is wider and more compact; there is a tendency also for the aviculœcia to take up a definite station in relation to the aperture, and their orientation is definite, since they are always obliquely and proximally directed; the aviculœcia, however, are somewhat smaller than those of the Francoporinæ, and therefore more primitive. Fig. 7 indicates these points of divergence from the primitive Pelmatoporid, on the one hand, and the primitive Francoporinæ, on the other.

Kelestominæ.—The most characteristic Kelestomine modifications are the bifid apertural bar and enlarged proximal apertural spines; these features were, presumably, present in the ancestral Kelestomine, which also had the aviculœcia reduced to a pair placed laterally with regard to each orthœcial aperture. Fig. 3*b* represents in diagram a hypothetical ancestral Kelestomine.

Tricephaloporinæ.—The primitive Tricephaloporine advanced upon the structure of the primitive Pelmatoporid mainly in the apertural bar, which possessed a median process fused to the proximal pair of apertural spines. The costæ also exhibited an advance upon the primitive Pelmatoporid condition by being more closely apposed and more solidly fused in the median line. It is possible that the arrangement of the Tricephaloporine apertural bar is a further development of that seen in the primitive Kelestominæ by means of a further movement of the upper branches towards the middle line and a more complete fusion of these to form the single median protection. A comparison of fig. 3*c* with fig. 3*b* will make clear how this may come about.

Pnictoporinæ.—The extreme reduction of the Pnictoporine intraterminal front-wall renders the systematic position of the sub-family difficult of interpretation. But from what can be seen of this structure, it appears to resemble most closely the intraterminal front-wall of the Tricephaloporinæ. If this is the case, the Pnictoporinæ may have had a common ancestor with that sub-family. They differ from the Tricephaloporinæ chiefly in the great reduction of the intraterminal front-wall, in the great development of interœcial secondary tissue, in the few, pointed, and definitely-placed aviculœcia, and in the peculiar secondary aperture which is formed of the fused forks of bifid apertural spines, and in which the median process of the apertural bar takes no part. The ancestral Pnictoporine, however, cannot be considered as having acquired a secondary aperture, so that the characters of this structure can hardly be reckoned with in reconstructing such a supposed primitive form as that represented in fig. 4 *a*.

Castanoporinæ.—If, as seems probable, the Castanoporine front-wall ran a similar evolutionary course to that of the Pelmatoporinæ, the ancestral Castanoporine had but a single pelmatidium on each costa and no lateral costal fusions. It differed, however, from the primitive Pelmatoporid in having decidedly elliptical orthœcia whose sides were well-bowed with no approach to parallelism; and the aviculœcia were pointed with their points produced in varying degrees, soon to become differentiated into two kinds—long-pointed and short-pointed aviculœcia. A diagram of such a primitive form is shown in fig. 3 *d*.

Diacanthoporinæ.—It is probable that the ancestral Diacanthoporine possessed a pelma (originally a stout costal emergence or branch) at the proximal end of each costa, thus differing from the ancestral Pelmatoporid; and it is possible that this was a legacy from a Membranimorph ancestor, which thus differed from the Membranimorph ancestor of the Pelmatoporidæ. In this case the Diacanthoporinæ should not be included in the family Pelmatoporidæ. But until there is some more definite evidence that this was the case it is convenient to include the Diacanthoporinæ with the pelma- and pelmatidium-bearing forms in the single family Pelmatoporidæ; besides, it is possible that this costal branch arose from the unbranched costa of the primitive Pelmatoporid, or even that, like the secondary, tertiary, &c., pelmata of the Pelmatoporinæ, it migrated from an originally distal position on the costa. In either case, the proximally-placed pelma is diagnostic of the primitive Diacanthoporine and is its chief difference from the hypothetical generalised Pelmatoporid ancestor. The other differences are the presence of interœcial secondary tissue and of definitely placed, somewhat pointed aviculœcia. Fig. 72 is a diagram of *Diacanthopora abbotti* and shows these points.

Pelmatoporinæ.—The hypothetical primitive Pelmatoporine (fig. 4 *b*) hardly differed from the ancestral Pelmatoporid (fig. 1), but had decidedly stouter costæ and costal emergences (appearing in fossils as pelmata); the aviculœcia also were always distally directed.

5. *The inter-relationship of the Sub-families.*

It is now possible to review the comparative closeness of relationship between the sub-families. The most isolated group is undoubtedly the Diacanthoporinæ, which may have been independently evolved from a separate Membranimorph stock; and the Pelmatoporinæ, though closely approaching the ancestral Pelmatoporid in the primitive forms, differed fundamentally in having large costal prolongations, expressed in the fossil as pelmata.

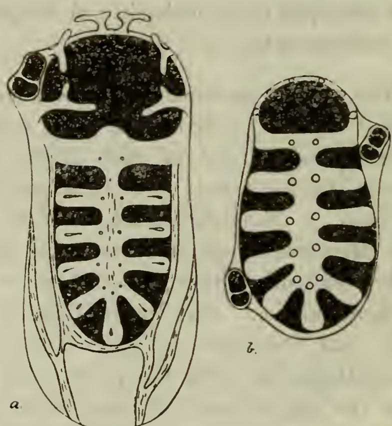


Fig. 4.—Hypothetical primitive (*a*) Pnictoporine, (*b*) Pelmatoporine.

All the other sub-families are characterised by the possession of pelmatidia, and probably are more nearly related to each other than to the Pelmatoporinæ or Diacanthoporinæ. Of these remaining sub-families, the Castanoporinæ are isolated from the rest by the characteristic orthœcial shape and by possessing (except in *Castanopora myristica*) little or no interœcial secondary tissue. The Francoporinæ, Opisthornithoporinæ, Kelestominæ, and Tricephaloporinæ are closely related, and separated by the differences already discussed. The Pnictoporinæ are probably more nearly related to the Tricephaloporinæ than to any other group—in fact, may have arisen from an extremely primitive Tricephaloporine.

Key to the Sub-families of Pelmatoporidæ.

A. Costæ bear primary pelmatidia only, or, if secondary pelmatidia are present, there are no lateral costal fusions at the level of the primary pelmatidia.

- I. Costæ separated by wide gaps; median band of fusion weak (figs. 5 & 6) .... a. Francoporinæ.
- II. Costæ touching or fairly close together.
  - a. Aviculœcia comparatively large, infrequent, occurring singly, and directed obliquely and proximally (fig. 7)........................ b. Opisthornithoporinæ.
  - b. Aviculœcia generally abundant, sometimes in pairs, and variously directed; when occurring singly, distally directed.
    - 1. Each half of the apertural bar bifid (figs. 10–13) .... c. Kelestominæ.
    - 2. Halves of apertural bar not bifid.
      - α. Aviculœcia generally blunt and generally with a circum-apertural arrangement; intraterminal front-wall not greatly reduced, or, if markedly reduced, the absence of a bark-like investing secondary tissue distinguishes this sub-family from the Pnictoporinæ (figs. 17–44) .... d. Tricephaloporinæ.
      - β. Aviculœcia pointed and few; intraterminal front-wall greatly reduced and tending to be obliterated by the general investment of a bark-like secondary tissue (fig. 46)............... e. Pnictoporinæ.

B. Costæ bear pelmatidia of several orders with lateral costal fusions corresponding in number and position to the pelmatidia (figs. 47–70)... f. Castanoporinæ.

C. Costæ bear each a proximal pelma and a distal pelmatidium; there are no lateral costal fusions (figs. 71–2) .... g. Diacanthoporinæ.

D. Costæ bear each one or more pelmata, and lateral costal fusions correspond in number and position to the pelmata (figs. 74–125)...... h. Pelmatoporinæ.

a. FRANCOPORINÆ, Lang, 1916.

Francoporinæ, subfam. nov.; Lang, 1916, pp. 83, 84.

Diagnosis.—Pelmatoporidæ with primary pelmatidia only; costæ widely separated and with no lateral fusions.

Distribution.—Senonian, Coniacian.

Remarks.—The Francoporinæ appear to have diverged from the main Pelmatoporid stock when this was in a very primitive condition, namely, when the costæ were slight, widely spaced, fused but weakly in the middle line, and bore primary pelmatidia only; when, moreover, there were no lateral fusions between neighbouring costæ. These primitive characters are retained by the Francoporinæ, which thus are the most primitive Pelmatoporids. They are elaborated by deposition of secondary calcium carbonate between the œcia and around the apertures; also, to a small extent, on the median line of fusion of the costæ.

These secondary skeletal deposits are not so developed in *Francopora* as in its derivative *Baptopora*. Thus, there is comparatively little interœcial secondary tissue in the former, so that the intraterminal front-walls are strongly arched and stand out boldly from the general surface of the asty; while in *Baptopora* they are sunk between ridges of interœcial secondary tissue. Nor is the aperture of *Francopora* secondarily thickened to the same extent as in *Baptopora*. Again, the pelmatidia of *Baptopora* are generally obliterated in the secondary thickening of the median line of fusion, while in *Francopora* they are often visible.

Two diverging lines of evolution are shown by the two genera: one, represented by *Francopora*, elaborates the colonial habit, while acquiring little secondary deposit; and the other, represented by *Baptopora*, while still in an incrusting or unilaminar, erect stage, has a considerable amount of interœcial secondary tissue as well as a more-or-less developed secondary aperture.

Key to the Genera of Francoporinæ.

A. Pelmatidia sometimes visible; intraterminal front-wall arched and not sunk in secondary tissue (fig. 5) ...... I. *Francopora*.

B. Pelmatidia nearly always more-or-less obliterated by secondary tissue; œcia tend to be immersed in interœcial secondary tissue (fig. 6) .... II. *Baptopora*.

I. FRANCOPORA, Lang, 1916.

Francopora, gen. nov.; Lang, 1916, p. 84.

Diagnosis.—Francoporinæ in which the intraterminal front-walls are strongly arched and stand out boldly from the general level of the asty; not sunk below ridges of secondary interœcial tissue as in *Baptopora*.

Genotype.—*Francopora canui*, Lang.

Distribution.—Senonian [Coniacian].

Remarks.—See under the sub-family Francoporinæ.

1. Francopora canui, Lang.

Francopora canui; Lang, 1916, p. 84; Senonian [Coniacian]; Fécamp, N.E. of Le Havre, France.

Diagnosis.—As for the genus.

Description.—Asty erect, cylindrical; œcia about ·5 mm. long, probably monomorphic; extraterminal front-wall covered with secondary tissue; intraterminal front-wall consisting of about fourteen thin, widely spaced costæ, somewhat weakly fused in the middle line and bearing pelmatidia, which are, however, often more-or-less covered with the secondary tissue present in small quantity on the median line of fusion of the costæ; aperture rather large.

Distribution.—Senonian, Emscherian [Coniacian]; Fécamp, Seine-Inférieure, France.

Type-specimen.—In Mr. F. Canu's collection, Versailles.

Remarks.—Besides the type-specimen, there are four other examples on a slide of fifteen specimens labelled "*Cribrilina* [*Escharipora*] *filiformis* d'O." in Mr. Canu's collection. Nine of the remainder are *Ichnopora filiformis* (d'Orbigny).

Figures.—Text-fig. 5. An orthœcium.

Specimens.—Only a photograph of the type-specimen.

II. BAPTOPORA, Lang, 1916.

Escharipora; d'Orbigny, 1852, p. 231; non 1852, pp. 220–230, pp. 232–235.

Escharipora; Coquand, 1860, p. 148.

Escharipora [partim]; Canu, 1900[2], p. 457.

Baptopora, gen. nov.; Lang, 1916, p. 84.

Diagnosis.—Francoporinæ with a large development of secondary tissue which generally more-or-less obliterates the pelmatidia in the median line of fusion, and is so abundant in the interœcial valleys that the originally arched intraterminal front-wall is immersed below the general level of the asty; a secondary aperture also is more-or-less developed.

GENOTYPE.—*Baptopora immersa*, Lang.

DISTRIBUTION.—Senonian, Coniacian.

REMARKS.—See under the sub-family Francoporinæ.

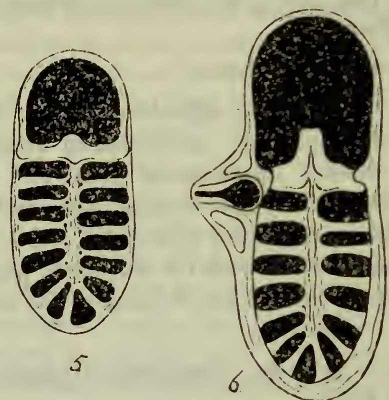


Fig. 5.—*Francopora canui.* Diagram of an orthœcium, from above. × about 75 diameters.

Fig. 6.—*Baptopora immersa.* Diagram of an orthœcium and an aviculœcium, from above. × about 75 diameters.

Key to the Species of *Baptopora*.

A. Smaller, about ·66 mm.; aperture comparatively larger; proximal part of the secondary aperture formed by a process of the apertural bar which probably fuses with the proximal pair of apertural spines to form hoop-like structures (fig. 6) .... 1. *B immersa.*

B. Larger, more than ·66 mm.; aperture comparatively smaller; a secondary aperture present, but its mode of formation is not clear .... 2. *B. insignis.*

1. Baptopora immersa, Lang.

Baptopora immersa, sp. n.; Lang, 1916, p. 84; Coniacian, Tours, France.

DIAGNOSIS.—*Baptopora* of comparatively small size, about ·66 mm. in length; apertural bar with a median process forming the proximal shield of a secondary aperture; this process probably fuses with the proximal pair of apertural spines to form a pair of hoop-like structures.

Description.—Asty erect, unilaminar; œcia dimorphic. Orthœcia about ·66 mm. long, and parallel-sided; extraterminal front-wall obliterated by secondary tissue; intraterminal front-wall consisting of about fourteen thin costæ which are rather irregularly spaced, meet in a narrow but firmly welded line of fusion, and bear pelmatidia, which are, however, generally obliterated by secondary tissue; apertural bar bearing a median process; apertures very large and rather longer than wide, with a high distal and lateral rim of secondary tissue obliterating any apertural spines that may have been present; it is probable that there was at least a proximal pair of spines, and that these fused with the median process of the apertural bar. Aviculœcia occasional, and placed in the interœcial secondary tissue with their long axes at right angles to those of the orthœcia; rather large, and with sharply pointed rostra.

Distribution.—Senonian, Coniacian; Tours, Indre-et-Loire, France.

Type-specimen.—D. 28419. In exchange with Mr. F. Canu, 1914.

Figures.—Text-fig. 6. Orthœcium and an aviculœcium.

Plate I, fig. 1. Part of the type-specimen, consisting of four orthœcia, and parts of others. × about 27 diameters.

Specimens.—The type-specimen. Distribution and collection as above.

2. Baptopora insignis (d'Orbigny).

Escharipora insignis, d'Orb., 1851; d'Orbigny, 1851, pl. 687, figs. 1–3, 1852, p. 231, 1854, p. 1097; Senonian; Rousselières, Charente.

Escharipora insignis, d'Orb.; Coquand, 1860, p. 148; Santonian; Rousselières.

Escharipora insignis; Canu, 1900 [2], p. 457; "ne correspond pas."

Baptopora insignis (d'Orbigny); Lang, 1916, p. 84; Senonian [Santonian]; France.

Diagnosis.—*Baptopora* of comparatively large size, more than ·66 mm. long; apertures comparatively smaller than those of *B. immersa*; a secondary aperture more-or-less developed.

Distribution.—Senonian [Coniacian]; Rousselières, S. of Mouthiers, S. of Angoulême, Charente, France.

Type-specimen.—That figured by d'Orbigny, 1851, pl. 687, fig. 2, is hereby selected.

Specimens.—None in the collection.

b. OPISTHORNITHOPORINÆ, Lang, 1916.

Opisthornithoporinæ; Lang, 1916, pp. 83, 84.

Diagnosis.—Pelmatoporidæ with primary pelmatidia only; the costæ lie fairly close together, without lateral fusions; aviculœcia rather large, occasional, and directed obliquely and proximally.

Distribution.—Senonian, Coniacian.

Remarks.—This sub-family was instituted to receive the remarkable form *Opisthornithopora flabellata* (d'Orbigny), a Pelmatoporid that does not seem to be closely related to any known form, but is best placed near the Francoporinæ on the one hand and the Tricephaloporinæ on the other. The costæ are closer together and more firmly fused in the median line than in the Francoporinæ; while the aviculœcia are suggestive of the transversely directed aviculœcia of *Baptopora immersa*, and are definitely fixed in their obliquely-proximal direction and not, as in *Tricephalopora ansata*, variously directed.

I. OPISTHORNITHOPORA, Lang, 1916.

Repteschareila; d'Orbigny, 1852, p. 469; non pp. 464–468, 470–1.
Repteschareila [partim]; Coquand, 1860, p. 183.
Repteschareila [partim]; Marsson, 1887, p. 97.
Repteschareila [partim]; Canu, 1902[2], p. 457.
Opisthornithopora, gen. nov.; Lang, 1916, p. 84.

Diagnosis.—As for the sub-family.

Genotype.—*Repteschareila flabellata*, d'Orbigny.

Distribution.—Senonian, Coniacian.

Remarks.—See under the sub-family Opisthornithoporinæ.

1. Opisthornithopora flabellata (d'Orbigny).

Reptescharella flabellata, d'Orb., 1851; d'Orbigny, 1852, pl. 716, figs. 9–12, 1853, pp. 469, 471, 1854, p. 1097; Sénonien; Tours (Indre-et-Loire), Sainte-Colombe (Manche), Pérignac (Charente-Inférieure).

Reptescharella flabellata, d'Orb.; Coquand, 1860, p. 183; Campanian; Pérignac.

Reptescharella flabellata d'Orbigny; Marsson, 1887, p. 97.

? Non *Cribrilina* (*Semieschara*) *flabellata*, d'Orb.; Vine, 1893, pp. 323, 336; zone of *B. mucronata*; Clarendon [E. of Salisbury]. Vine evidently confuses *Reptescharella flabellata*, d'Orbigny, with *Semieschara flabellata*, d'Orbigny, 1852, p. 367, pl. 708, figs. 1–4, which is not a Cribrimorph.

Reptescharella flabellata; Canu, 1900 [2], p. 457; "ne correspond pas."

? Non *Cribrilina flabellata*, d'Orb.; Jukes-Browne, 1904, p. 490; zones of *Marsupites*, *A. quadratus*, and *B. mucronata*; Salisbury.

Opisthornithopora flabellata (d'Orbigny); Lang, 1916, p. 84; Senonian; France.

Diagnosis.—As for the sub-family Opisthornithoporinæ.

Description.—Asty incrusting; œcia dimorphic. Orthœcia small, about ·4–·5 mm. long, elliptical with a tendency to slight constriction at the level of the apertural bar; extraterminal front-wall small in extent and hidden by interœcial secondary tissue, which does not, however, develop to any great extent; intraterminal front-wall rather arched and consisting of sixteen to eighteen costæ, fairly closely-set and firmly fused in the median line, having no lateral fusions, and each bearing a single pelmatidium at its distal end; aperture rather small, somewhat wider than long. Aviculœcia rather large, occasional, one often distally and somewhat laterally placed with regard to an orthœcial aperture, always obliquely and proximally directed, and sharply pointed.

Distribution.—Senonian, Coniacian; Les Phelippeaux, Charente.

Type-specimen.—The description and interpretation of this species are founded upon a specimen in the collection of Mr. F. Canu of Versailles, labelled "*Cribrilina* [*Reptescharella*] *flabellata*, d'Orb., p. 469, pl. 716, figs. 9–12." Mr. Canu in his "Revision" of d'Orbigny's Cheilostomes remarks of this species "ne correspond pas," from which it may be inferred either that d'Orbigny's type is lost and another specimen has been put in its tube, or that d'Orbigny's figure is unrecognisable as a likeness of the specimen. In either case we are justified in accepting Canu's interpretation of the species, and his specimen as replacing the type-specimen.

FIGURES.—Text-fig. 7. Orthœcium and aviculœcium.

REMARKS.—See under the sub-family Opisthornithoporinæ.

SPECIMENS.—Only a photograph of the specimen mentioned above as in Mr. Canu's collection.

Fig. 7.—*Opisthornithopora flabellata.* Diagram of an orthœcium and an aviculœcium, from above. × about 75 diameters.

c. KELESTOMINÆ, Lang, 1916.

Kelestominæ, sub-fam. nov.; Lang, 1916, pp. 83, 85.
Kelestominæ; Lang, 1919, pp. 206–11.

DIAGNOSIS.—Pelmatoporidæ with primary pelmatidia only, or, if secondary pelmatidia are present, there are no lateral costal fusions at the level of the primary pelmatidia; costæ not very widely separate; the costæ forming the apertural bar are bifid, with the distal prongs produced upwards and fused distally with each other and with the proximal pair of apertural spines to form the proximal shield of a secondary aperture; ovicells endozoœcial.

DISTRIBUTION.—Senonian, Campanian, zone of *B. mucronata*, to Recent.

REMARKS.—The Kelestominæ form a small and compact group, and present general affinities with the Tricephaloporinæ. Their main diagnostic character, however, is the bifid nature of the costæ composing the apertural bar (fig. 3 *b*, p. 13). In various stocks of the Pelmatoporidæ, as in other Cribrimorph families, it is not unusual to find a median process of the apertural bar produced distally to fuse with the proximal pair of apertural spines, and thus form the proximal shield of a secondary aperture (fig. 8, *a*, *b*); and in these there are indications that the median process is double—that is, composed of right and left halves fused in the middle line; there is also a tendency in such forms (shown particularly in the Pelmatoporidæ by the position of the pelmata or pelmatidia) for the apertural bar to be produced proximally in the median line of fusion as well as distally. These indications suggest either that the apertural bar with a median distal process is a further development of a bar like that of the Kelestominæ, the result of the gradually extended fusion of the distal forks with each other and with the proximal forks; or that, as is more probable, the bifid Kelestomine condition is produced by a further division of the distal ends of the costæ forming the apertural bar, so as to produce proximal and distal forks. A second diagnostic character of the Kelestominæ is the enlargement of the proximal pair of apertural spines. In *Kelestoma* this is not so marked as in *Morphasmopora*, in which genus the enlargement is so excessive that without knowing the previous condition of *Kelestoma* it would be difficult or impossible to recognise the nature of these structures.

The Kelestominæ, then, may be derived from a primitive Pelmatoporid stock with pelmatidia, with a bifid apertural bar, the distal forks of which are fused to the proximal pair of apertural spines, and with a pair of aviculœcia, one of which is situated just distally to each of the proximal apertural spines. From this form diverged three lineages: one, represented by *Kelestoma*, either increasing the number of costæ or retaining a primitively large number, and not greatly thickening the proximal pair of apertural spines; another, represented by *Morphasmopora*, either retaining primitively fewer or reducing a primitively large number of costæ, and enormously thickening the proximal pair of apertural spines. Both these lineages acquire much interœcial secondary tissue and have primary pelmatidia only. A third lineage is represented by the Tertiary (?) and Recent genus *Gephyrotes* (Norman, 1903, p. 100). In this genus, the proximal apertural spines are not greatly thickened, as they are in *Morphasmopora*, there is little or no interœcial secondary tissue, the costæ are few, and the intraterminal front-wall is more complex than in the Cretaceous Kelestomines, having primary pelmatidia near the

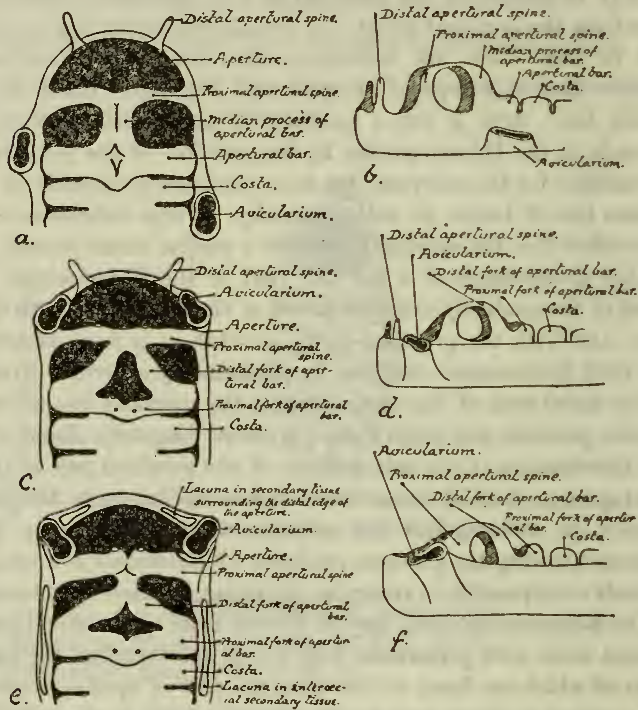


Fig. 8.—*a* & *b*. Diagrams of the distal end of an orthœcium of a hypothetical Cribrimorph, showing the fusion of a median process of the apertural bar with the proximal pair of apertural spines, an arrangement independently acquired in various Cribrimorph lineages.

c & *d*. Diagrams of the distal end of the orthœcium of a hypothetical Kelestomine, near *Kelestoma*, and from which that genus may be derived, showing an apertural bar of the type which may have arisen, by further division of the middle portion, from the type of bar represented in *a* & *b*.

e & *f*. Diagrams of the distal end of an orthœcium of a hypothetical Kelestomine, possibly derived from such a form as that represented in *c* & *d*, and intermediate between that form and the genus *Morphasmopora*.

a, *c*, & *e*, from above; *b*, *d*, & *f* from the side.

proximal end of each costa, but no lateral costal fusions at this level; secondary pelmatidia with lateral costal fusions near the mid-line; and even, occasionally, tertiary pelmatidia in the mid-line.

It is remarkable that so specialised a group as the Kelestominæ should have persisted until Recent times; and it would not cause much surprise should *Escharipora figularis* (Johnston), forma *nitido-punctata*, Smitt (1868, p. 4), the genotype of *Gephyrotes* (Norman, 1903, p. 100), prove to be a homœomorph of the Kelestomine forms. Through the kindness of my colleague, Mr. R. Kirkpatrick, I have been able to examine Norman's material of *Gephyrotes nitido-punctatus*, and I cannot see any reason for excluding it from the Kelestominæ, though it must have been derived from a *Kelestoma* more primitive in respect of interœcial secondary tissue than the known species of that genus.

Canu & Bassler (1920, pp. 301–4) describe five species of *Gephyrotes*, from the N. American Eocene; but only one of these, *G. spectabilis*, is figured with a bifurcated apertural bar (though it is possible that this may be present in *G. convexus* and *G. quadriserialis*); the secondary aperture appears to be formed as in *Tricephalopora*. The primary pelmata of *G. spectabilis* are seen in neanic œcia at the top of fig. 16 of pl. lxxxiv in Canu & Bassler's monograph; in the ephebic œcia they appear to be covered by the interœcial secondary tissue, the lacunæ of which are mazy, as in *Morphasmopora*. It is hazardous, without seeing the specimens, to assign this form definitely to *Gephyrotes*. The architecture of the Kelestomine aperture is shown in figs. 8, *c–f*. If, as is probable, distal apertural spines were present in all the Kelestominæ as they are in the neanastic orthœcia of *Morphasmopora jukes-brownei*, they are swamped and obliterated by secondary tissue growing up round the apertural rim.

Key to the Genera of Kelestominæ.

A. Only primary pelmatidia present.

- I. Costæ numerous (20–30), rather widely separate; proximal pair of apertural spines not greatly enlarged (fig. 10) .... I. *Kelestoma*.
- II. Costæ few (10–12), nearly touching; proximal pair of apertural spines enormously enlarged (figs. 11–13) .... II. *Morphasmopora*.

B. Primary, secondary, and even tertiary pelmatidia present, the first having no lateral costal fusions at their level; costæ few, rather widely separate; proximal pair of apertural spines not greatly enlarged (fig. 9) .... III. *Gephyrotes* (Recent).

Fig. 9.—*Gephyrotes nitido-punctatus* (Smitt). Diagram of an orthœcium and two aviculœcia, from above. × about 75 diameters.

I. KELESTOMA, Marsson, 1887.

Kelestoma nov. gen.; Marsson, 1887, pp. 99, 49, 103.
Kelestoma; Deecke, 1895, p. 80.
Cribrilina (*Kelestoma*); Canu, 1900 [2], p. 447.
Cribrilina (*Ketestoma*) [sic]; Canu, 1900 [2], legend to text-fig. 63 on p. 446.
Kelestoma, Marsson; Lang, 1916, p. 85.
Kelestoma Marsson; Lang, 1919, pp. 211, 204, 207, 209, 212–216, 218, 219.

Diagnosis.—Kelestominæ with relatively many costæ (20–30) which are rather widely separate; proximal pair of apertural spines not greatly enlarged.

Genotype.—*Kelestoma elongatum*, Marsson.

Distribution.—Senonian, Campanian, zone of *B. mucronata*.

Remarks.—Evolution within the genus appears to have affected colonial habit, orthœcial size, costal number, and aviculœcian shape. The asty progresses from incrusting, through erect and bi-laminar, to erect and cylindrical; the orthœcia increase in size; the costæ diminish in number, and the aviculœcia become more pointed.

Key to the Species of *Kelestoma*.

A. Incrusting; length of orthœcium about ·75 mm.; costæ 27–30 .... 1. *K. elongatum.*
B. Erect, bilaminar; length of orthœcium about ·9 mm.; costæ about 27 (fig. 10) .... 2. *K. gradatum.*
C. Erect, cylindrical; length of orthœcium about ·9 mm.; costæ 23–25 .... 3. *K. scalare.*

1. Kelestoma elongatum, Marsson.

Kelestoma elongatum n. sp.; Marsson, 1887, pp. 99, 109, pl. x, fig. 13; Weisse Schreibkreide; Rügen.
Kelestoma elongatum Marss.; Deecke, 1895, p. 80; Senon.; Rügen.
Cribrilina (*Kelestoma*) *elongatum* Marsson; Canu, 1900 [2], p. 447.
Cribrilina (*Ketestoma*) [sic] *elongatum* (Marss.); Canu, 1900 [2], legend of text-fig. 63 on p. 446 (a copy of Marsson's figure).
Kelestoma elongatum, Marsson; Lang, 1916, p. 85; *B. mucronata*-zone, Rügen.
Kelestoma elongatum Marsson; Lang, 1919, pp. 213, 204, 218.

Diagnosis.—*Kelestoma* with an incrusting asty; orthœcial length about ·75 mm.; costæ 27–30.

Distribution.—Senonian, Campanian, zone of *Belemnitella mucronata*; Rügen.

Type-specimen.—That figured by Marsson, 1887, pl. x, fig. 13, is hereby selected.

Remarks.—This species appears to be the most primitive of the three species of *Kelestoma* here recognised, though its characters are difficult to determine in detail from an examination of Marsson's description and figure only.

Specimens.—None in the Collection.

2. Kelestoma gradatum, Lang.

Kelestoma gradatum, sp. nov.; Lang, 1919, pp. 213–14, 218, fig. 8 on p. 14; Senonian, Campanian, zone of *B. mucronata*; Rügen.

Diagnosis.—*Kelestoma* with an erect, bilaminar asty; orthœcial length about ·9 mm.; number of costæ, about 27.

DESCRIPTION.—Asty erect, bilaminar; œcia dimorphic. Orthœcia about ·9 mm. long, and about ·36 mm. broad, elongate-lozenge-shaped and more pointed proximally than distally; extraterminal front-wall of very small extent and entirely hidden beneath interœcial secondary tissue; intraterminal front-wall hardly arched, consisting of about 27 thin costæ, rather widely-spaced, each bearing a pelmatidium distally, with no lateral fusions, and meeting medianly in a broad band of fusion; apertural bar formed

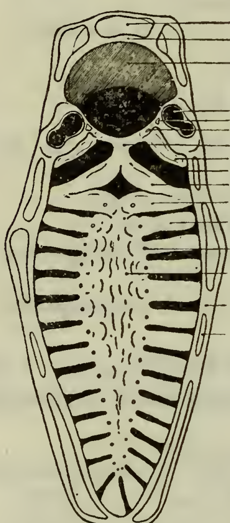


Fig. 10.—*Kelestoma gradatum.* Diagram of an orthœcium and two aviculœcia, from above. × about 75 diameters.

of bifid costæ, the distal forks of which fuse with each other and with the somewhat thickened proximal pair of apertural spines, which on their distal sides are each fused with one of a pair of aviculœcia (there is, however, a minute patch of secondary tissue with a more-or-less circular lacuna intercalated between the aviculœcium and the proximal apertural spine of each side); these paired fused structures, namely, proximally the distal fork of a bifid half of the apertural bar, in the middle a proximal apertural spine, then the minute patch of secondary tissue with its lacuna, and distally an aviculœcium, form the proximal shield of a secondary aperture; the distal shield is low (unless an ovicell is present), and is formed of secondary tissue growing up round and extending distally to the original apertural rim, at the same time obliterating the distal pair of apertural spines, if these, as is likely, were ever present; primary aperture semicircular; secondary aperture sub-circular, somewhat pointed proximally; interœcial secondary tissue with median lacunæ, often long, thin, and fairly straight. Aviculœcia, a pair to every orthœcium, one of each pair situated immediately distally to each proximal apertural spine, and forming the lateral wall of the proximal shield of the secondary aperture; apertures blunt, the rostrum being larger than the proximal portion, and directed upwards, obliquely and distally towards the mid-line of the orthœcium to which each is attached.

Distribution.—Senonian, Campanian, zone of *B. mucronata*; Rügen.

Type-specimen.—D. 15065. Agnes Laur Collection. 1909.

Remarks.—*Kelestoma gradatum* is intermediate in colonial habit and number of costæ between the other two species, and may be regarded as forming with these a single lineage.

Figures.—Text-fig. 10. Orthœcium and two aviculœcia.

Plate I, fig. 2. Part of the type-specimen, consisting of four complete orthœcia, each with a pair of aviculœcia. Two of the complete orthœcia bear ovicells. × about 27 diameters.

Specimens.—The type-specimen. Distribution and collection as above.

3. Kelestoma scalare, Lang.

Kelestoma scalaris, sp. n.; Lang, 1916, p. 85; *B. mucronata*-zone; Rügen.

Kelestoma scalare Lang; Lang, 1919, pp. 213, 218; Senonian, zone of *B. mucronata*, Rügen.

Diagnosis.—*Kelestoma* with an erect, cylindrical asty; orthœcial length about ·9 mm.; costæ 23–25.

Description.—Asty erect, cylindrical; œcia dimorphic. Orthœcia about ·9 mm. long and ·37 broad, widest at the level of the apertural bar and tapering proximally; extraterminal front-wall entirely obliterated by secondary tissue which has long, straight, median lacunæ; intraterminal front-wall very slightly arched, consisting of about 23–25 thin costæ, rather widely-spaced, each bearing a pelmatidium distally, with no lateral fusions and meeting in the middle line in a fairly broad band of fusion; apertural bar formed of bifid costæ, the distal forks of which fuse with each other and with the somewhat thickened proximal pair of apertural spines which on their distal sides are each fused with one of a pair of aviculœcia; these fused structures, namely, on each side, the distal fork of a bifid half of the apertural bar proximally, a proximal apertural spine in the middle, an aviculœcium distally, form the proximal shield of a secondary aperture; the distal shield is low (though when an ovicell is present, presumably it is high, as in *K. gradatum*), and is formed of secondary tissue growing up round and extending distally to the original apertural rim, and obliterating the distal pair of apertural spines, if these, as is likely, were ever present; primary aperture semicircular; secondary aperture sub-circular. Aviculœcia, a pair to every orthœcium, one of each pair situated immediately distally with regard to each proximal apertural spine and forming the lateral wall of the proximal shield of the secondary aperture; apertures somewhat pointed, constricted, and divided by a transverse bar into a proximal portion and a rostrum, of which the latter is the larger; directed upwards, obliquely and distally towards the median line of the orthœcium to which each is attached.

Distribution.—Senonian, Campanian, zone of *B. mucronata*; Rügen.

Type-specimen.—D. 18006. Agnes Laur Collection. 1906.

Remarks.—*Kelestoma scalare* differs from the other species of *Kelestoma* chiefly in colonial habit and number of costæ; it is also larger than *K. elongatum*; its orthœcial shape is somewhat different from that of *K. gradatum*, and its aviculœcia tend to be more pointed. It is probably derived from *K. gradatum*. See also remarks under the genus *Kelestoma*.

Specimens.—The type-specimen. Distribution and collection as above.

II. MORPHASMOPORA, Lang, 1916.

Cribrilina [partim]; Brydone, 1906, p. 297.
Membraniporella [partim]: Brydone, 1913, p. 438.
Morphasmopora, gen. nov.; Lang, 1916, p. 85.
Morphasmopora Lang; Lang, 1917, pp. 213–19, 204, 207–9, 211.

Diagnosis.—Kelestominæ with relatively few costæ (10–12), which are closely approximated; proximal pair of apertural spines greatly enlarged.

Genotype.—*Cribrilina jukes-brownei*, Brydone.

Distribution.—Senonian, Campanian, zone of *B. mucronata*.

Remarks.—Besides the diagnostic characters cited above, *Morphasmopora* differs from *Kelestoma* in the character of the lacunæ of the interœcial secondary tissue. These, when elongate, instead of running in more-or-less straight courses, often take on a mazy or serpentine form; moreover, lacunæ are present in a more obvious form on secondary tissue which lies immediately distal to, and, in *M. jukes-brownei* especially, proximal to, the secondary aperture. These lacunæ, when of appropriate shape, simulate aviculœcia. The proximal pair of apertural spines is more enlarged in *M. jukes-brownei*, and this species is probably more specialised in having fewer costæ. On the other hand, the aviculœcia of *M. brydonei* are more pointed, and this probably is an advance on the blunter aviculœcia of *M. jukes-brownei*; the aviculœcia of *M. brydonei* also are more raised than those of the other species, and a second pair is often present, lying below and rather proximally to the first pair; the aviculœcia of the first, or elevated, pair are directed upwards, proximally and obliquely towards the mid-line of the orthœcial aperture they accompany. The multiplicity of aviculœcia, again, is a primitive character. The two species, therefore, do not lie in one lineage, but diverge, *M. jukes-brownei* specialising in some characters and *M. brydonei* in others.

Key to the Species of *Morphasmopora*.

A. Two pairs of aviculœcia to each orthœcium, one pair raised high on the proximal shield; proximal pair of apertural spines not so enlarged as those of *M. jukes-brownei*; costæ about 12 (fig. 11)......... 1. *M. brydonei*.

B. One pair of aviculœcia to each orthœcium, involved in the proximal shield, but not raised so high upon it; proximal pair of ap. spines more enlarged than in *M. brydonei*; costæ about 10 (figs. 12, 13)...... 2. *M. jukes-brownei.*

1. Morphasmopora brydonei, Lang.

Morphasmopora brydonei, sp. n.; Lang, 1916, p. 85; *B. mucronata*-zone; Rügen.

Morphasmopora brydonei Lang; Lang, 1919, pp. 215–9, 204, 213, fig. 10 on p. 215; Senonian, zone of *B. mucronata*; Rügen.

Diagnosis.—*Morphasmopora* in which a pair of aviculœcia is raised high on to the proximal shield; the proximal pair of apertural spines is not so greatly enlarged as in *M. jukes-brownei*; the costæ are about 12 in number; the distal ends of the proximal pair of apertural spines reach the proximal rim of the secondary aperture, and, consequently, secondary tissue with median lacunæ is present on this rim only for a short distance, namely, between the apertural spine and the aviculœcium on each side.

Description.—Asty incrusting, unilaminar; œcia dimorphic. Orthœcia about ·61 mm. long and ·33 mm. broad; elliptical, and blunter distally; extraterminal front-wall entirely hidden by interœcial secondary tissue, which has mazy and serpentine median lacunæ, not as a rule, however, so lengthened as in *M. jukes-brownei*; intraterminal front-wall slightly arched, consisting of about 12 thin costæ, fairly closely placed, with no lateral fusions, each bearing a single pelmatidium towards its distal end, and firmly united in a broad median area of fusion, across which, however, the limits of the costæ can be traced until they meet in the mid-line; the median band of fusion thus occupies about half the total length of each costa; apertural bar formed of bifid costæ, the distal forks of which fuse with each other and with the greatly enlarged proximal pair of apertural spines, which, in turn, are fused in their distal-lateral parts each with one of a pair of aviculœcia; these fused structures—namely, on each side, the distal fork of a bifid half of the apertural bar proximally, a proximal apertural spine in the middle, and an aviculœcium distally and laterally—together form the proximal shield of a secondary aperture; the part of the rim of the proximal shield between the distal ends of the proximal apertural spine and the aviculœcium on each side is covered with a patch of secondary tissue with a median, often triangular, lacuna; the distal shield of the secondary aperture is low (presumably high, as in *M. jukes-brownei*, if an ovicell is present) and composed of secondary tissue growing round the distal rim of the primary aperture, and obliterating the distal apertural spines that were, presumably, present as in *M. jukes-brownei*; secondary tissue between the aperture and the next distal orthœcium often has two somewhat elongate-triangular lacunæ that simulate aviculœcia, as in *M. jukes-brownei*; secondary aperture rather wider than high, oval, but with the outline of the proximal half pushed in laterally by the paired aviculœcia and somewhat produced proximally. Aviculœcia, a pair to every orthœcium, placed high, one

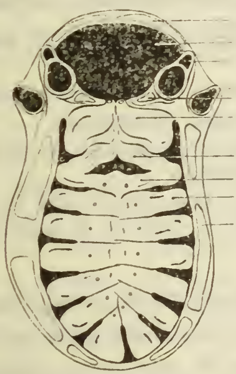


Fig. 11.—*Morphasmopora brydonei.* Diagram of an orthœcium and four aviculœcia, from above. × about 75 diameters.

on each lateral portion of the proximal shield of the secondary aperture, and occasionally a second pair placed low in the interœcial tissue lateral to the first pair; small, somewhat pointed, divided by a transverse bar into a larger rostrum and smaller proximal portion, those of the higher pair directed obliquely, somewhat upwards, proximally, and towards the median line of the orthœcium to which they are attached.

Distribution.—Senonian, Campanian, zone of *B. mucronata*; Rügen.

Type-specimen.—D. 15122. Agnes Laur collection.

REMARKS.—Besides the diagnostic characters given above, the difference in shape of the aviculœcia of *M. brydonei* and *M. jukes-brownei* is noteworthy. See also remarks under the genus *Morphasmopora.*

FIGURES.—Text-fig. 11. Orthœcium and two pairs of aviculœcia.

Plate I, fig. 3. Part of the type-specimen, showing three complete orthœcia with aviculœcia. × about 27 diameters.

SPECIMENS.—The type-specimen. Distribution and collection as above.

2. Morphasmopora jukes-brownei (Brydone).

Cribrilina Jukes-Brownei, sp. nov.; Brydone, 1906, p. 297, text-fig. 9 on p. 298; Senonian; Trimmingham.

Membraniporella Jukes-Brownei, mihi sp.; Brydone, 1913, p. 438, pl. xiv, fig. 11; Senonian, zone of *B. mucronata*; Trimingham.

Morphasmopora jukes-brownei (Brydone); Lang, 1916, p. 85; Senonian, *B. mucronata*-zone; Trimingham, Norfolk.

Morphasmopora jukes-brownei (Brydone); Lang, 1919, pp. 216–19, 204, 208–9, 211, 213, figs. 11 & 12 on pp. 216–7; zone of *B. mucronata*; Trimingham, Norfolk.

DIAGNOSIS.—*Morphasmopora* in which the aviculœcia, although involved in the apertural ring, are not raised high on to it; the proximal pair of apertural spines is very much enlarged; the costæ are about 10 in number; and secondary tissue with median lacunæ is laid down along the proximal edge of the secondary aperture, distal to the enlarged apertural spines, and between the aviculœcia and the median line.

DESCRIPTION: (a) *Ephebœcia.*—Asty incrusting, unilaminar; œcia dimorphic. Orthœcia about ·6 mm. long and ·32 mm. broad; elliptical with blunt ends, especially distally; extraterminal front-wall entirely hidden beneath interœcial secondary tissue, which has mazy and serpentine median lacunæ; intraterminal front-wall slightly arched laterally, flat or concave on the median area of fusion, consisting of about 10 thin costæ, fairly closely placed, with no lateral fusions, each bearing a single pelmatidium towards its distal end, and firmly united in a broad median area of fusion that occupies nearly half the total length of the costa; the outlines of each costa can generally be traced across the area of fusion to the mid-line; apertural bar formed of bifid costæ, the distal forks of which fuse with each other and with the enormously enlarged proximal pair of apertural spines, which, in turn, are fused in their distal-lateral parts each with one of a pair of aviculœcia; these fused structures—namely, on each side, the distal fork of a bifid half of the apertural bar proximally, a proximal apertural spine in the middle, and an aviculœcium distally and laterally—form the proximal shield of a secondary aperture; the median part of the rim of the proximal shield is covered with secondary tissue, whose median lacunæ often simulate a pair of aviculœcia with very long mandibles; there is a similar band of secondary tissue along the distal rim of the secondary aperture (that is, the rim of the distal shield), but this is not high unless an ovicell is present; the distal shield is formed by secondary tissue growing round the distal rim of the primary aperture, producing it in an obliquely upward and distal direction, and swamping the distal pair of apertural spines seen in the neanastic orthœcia; the secondary aperture has the shape of a long transversely-elongated ellipse, about twice as wide as high. Aviculœcia, a pair to every orthœcium, and, possibly, an occasional sporadic aviculœcium in the interœcial tissue; small, blunt, divided by a transverse bar into a rather larger rostrum and a rather smaller proximal portion, directed obliquely upwards, proximally, and towards the mid-line of the orthœcium to which they are attached. (b) *Neanœcia* (the first neanœcium was figured as the ancestrœcium; Lang, 1919, p. 218, fig. 12 on p. 217)—length from about ·30 mm. in early stages to about ·50 mm. in later ones; similarly, breadth from about ·20 mm. to about ·28 mm.; oval with blunter distal ends; extraterminal front-wall very wide proximally and fairly wide laterally in early, and less so in later, neanœcia; arched and not covered with secondary tissue; intraterminal front-wall as in the ephebastic stages, but with fewer costæ, 6 in the earlier and 8 in the later neanœcia; proximal shield of secondary aperture apparently as in ephebœcia, but the proximal apertural spines are not so large and the aviculœcia are absent in the earlier neanœcia; distal shield of secondary aperture absent, but there are two distal pairs of apertural spines in the earlier neanœcia, and, apparently, only one pair in the later neanœcia. Aviculœcia, first appearing among the later neanœcia, have a structure and position like those of the ephebastic stages.

Distribution.—Senonian, Campanian, zone of *B. mucronata*; Trimingham, Norfolk.

Type-specimen.—That figured by Brydone, 1906, text-fig. 9 on p. 298, is hereby selected.

Remarks.—The general relationships of *M. jukes-brownei* and *M. brydonei* have already been discussed under the genus *Morphasmopora*. One of the most interesting features of *M. jukes-brownei*, however, is the presence of two pairs of distal apertural spines in the earlier neanœeia and of the disappearance of one of these pairs in the later neanœcia. It is probable, from comparison

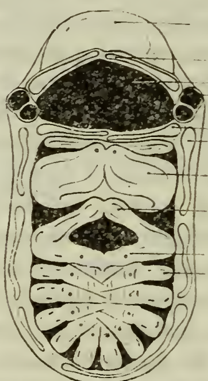


Fig. 12.—*Morphasmopora jukes-brownei.* Diagram of an ephebastic orthœcium, with an ovicell and two aviculœcia, from above. × about 75 diameters.

with other families, that six apertural spines were originally present, but in most families and in all the Pelmatoporidæ, except the Castanoporinæ, one of the distal pairs is lost during evolution, leaving one proximal and one distal pair. The astogeny of *M. jukes-brownei*, therefore, falls in with this supposed evolutionary tendency.

Figures.—Text-fig. 12. An ephebœcium. Text-fig. 13. An early neanœcium.

Plate I, fig. 4. Part of the type-specimen, showing four complete orthœcia and the accompanying aviculœcia. × about 27 diameters.

LIST OF SPECIMENS.

D. 8005. A single asty, consisting of two ribbon-shaped branches and showing neanastic stages, incrusting an Echinoid. Senonian, zone of *B. mucronata*, highest Chalk exposed. Trimingham, Norfolk. Metatype *. Presented by R. M. Brydone, Esq., 1907.

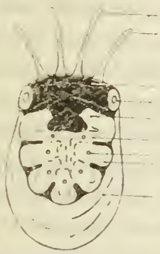


Fig. 13.—*Morphasmopora jukes-brownei.* Diagram of an early neanastic orthœcium, from above. × about 75 diameters.

d. TRICEPHALOPORINÆ, Lang, 1916.

Tricephaloporinæ, subfam. nov.; Lang, 1916, pp. 83, 85.

Diagnosis.—Pelmatoporidæ with primary pelmatidia only: costæ not very widely separated, and with no lateral fusions; apertural bar not bifid (though a bifid median process may be apparent); secondary tissue, if present in abundance, may form a tertiary front-wall, but, when abundant, the secondary tissue is not rugose or bark-like.

Distribution.—Senonian, Coniacian, to Danian.

Remarks.—The Tricephaloporinæ form a fairly well-marked group, with affinities to the Pnictoporinæ and Castanoporinæ (to both of which they probably gave rise), the Opisthornithoporinæ, and the Kelestominæ. In the more primitive forms the

* "A topotype identified by the nomenclator himself" (Schuchert & Buckman, 1905, p. 104).

orientation of the aviculœcia is quite undetermined, and many of them are frequently directed proximally, a primitive character that has become fixed in the Opisthornithoporinæ, though the aviculœcia of that sub-family, being pointed (see fig. 7, p. 24), are more specialised in shape than those of the more primitive forms of the Tricephaloporinæ, which are blunt. Again, it was suggested in the remarks on the Kelestominæ (p. 25) that the bifid apertural bar, to which the proximal pair of apertural spines is joined, might have arisen from an apertural bar with a forked median projection similarly joined to the proximal pair of apertural spines (see fig. 8, p. 26)—a condition common in other groups of Cretaceous Cribrimorph Polyzoa. Now *Tricephalopora ansata*, one of the most primitive Tricephaloporines, undoubtedly had an apertural bar of the latter kind; and it seems probable that this was the fundamental structure of the lower part of the proximal shield of the secondary aperture in all Tricephaloporines, though during evolution the paired fenestræ, enclosed by the median process of the apertural bar and the proximal apertural spines, became blocked with secondary tissue, and appear (if at all) either as blind pits or as but small perforations.

In the primitive Tricephaloporine, then, the costæ were less widely spaced than in the Francoporinæ, the aviculœcia were small, numerous, sporadically distributed, variously directed, and blunt in shape; not few, definitely placed, definitely directed, and pointed, as in the Opisthornithoporinæ; the apertural bar was not bifid, as in the Kelestominæ, but bore a wide median process, which was bifid distally and each half was fused with the nearer apertural spine of the proximal pair, forming a pair of fenestræ (see fig. 3 *c*, p. 13). It is convenient, starting with such a form, to trace the general evolution of each character, in so far as this is common to several lineages. And where the evolutionary history of a character is various, there will the generic distinctions be found.

As in the other groups of Cretaceous Cribrimorphs, the result of evolution is expressed in the secretion of more calcium carbonate, and is seen in the filling up of the interœcial valleys with secondary tissue, in the solidifying of the intraterminal front-wall both by the firmer fusion of its parts and by the covering of secondary tissue that it acquires, and in the building up of a secondary aperture. The aviculœcia also in this group are valuable guides to its evolution.

The evolutionary history of the particular characters is as follows:—

The Asty.—The asty, as is usual with other Cribrimorphs, proceeds from an incrusting to an erect habit, from a unilaminar to a bilaminar or multilaminar condition, and from an expanded to a cylindrical shape.

The size of the Orthœcia.—The orthœcia increase gradually in size, and in one genus (*Cœlopora*) rather suddenly, forming a lineage of comparatively gigantic forms.

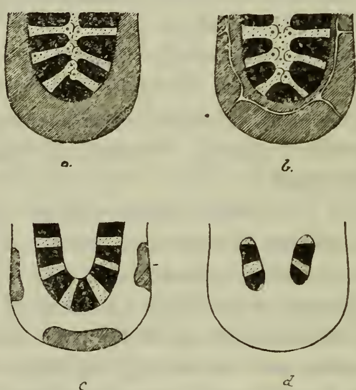
The shape of the Orthœcia.—The orthœcia become comparatively wider as evolution proceeds—that is to say, they pass from generally elliptical to oval in shape.

The Extraterminal Front-wall.—This is not extensive, except in the advanced species of *Tricephalopora* and its derivative *Haplocephalopora*, in which forms the area occupied by the extraterminal front-wall is greatly increased at the expense of the intraterminal front-wall.

The Interœcial Secondary Tissue.—Early in evolution, however, the surface of the extraterminal front-wall becomes covered with interœcial secondary tissue; this first appears as ridges, generally running more-or-less along a contour of the extraterminal front-wall, and occasionally throwing off buttress-like connections between œcium and œcium (fig. 14, *b*); as these ridges and buttresses grow in thickness, the interœcial secondary tissue appears to fill up the interœcial valley, except for larger or smaller lacunæ (fig. 14, *c*), which themselves become more-or-less obliterated as the deposit of secondary tissue increases. Finally, the interœcial secondary tissue overlaps the intraterminal front-wall, reaches towards the secondary tissue covering the median area of fusion of the intraterminal front-wall, and may (fig. 14, *d*) fuse with it in places, forming a tertiary front-wall, or lamina peristomica, and generally, if not always, leaving one or more fenestræ through which the intraterminal front-wall may be seen.

Number of Costæ.—The number of costæ of the intraterminal front-wall decreases slightly during evolution, and the relative thickness of the costæ and their spacing varies somewhat, but with no apparent regularity.

Fusion of the Costæ.—The costæ of Tricephaloporinæ have no lateral fusions, yet the intraterminal front-wall shows progressive solidification by extending the median area of fusion. In the more primitive forms (fig. 15, *a*), the distal ends of the costæ are clearly defined and meet or nearly meet in the middle line, close to which, therefore, the pelmatidia lie. But, as evolution proceeds, the pelmatidia tend to retreat from the middle line (as do the pelmata in the Pelmatoporinæ, *cf.* fig. 2, p. 6), and the distal end of each costa is prolonged and becomes more merged in the connecting tissue, so that its outline is more difficult to trace (fig. 15, *b*). In one or two instances (e. g. *Tricephalopora saltdeanensis*) there are suggestions of secondary pelmatidia near the



Text-fig. 14.—Diagrams to show the development of secondary tissue to form a tertiary front-wall, or lamina peristomica, in the Tricephaloporinæ. The extraterminal front-wall is shaded with oblique lines, the intraterminal front-wall is spotted, and secondary tissue is left unshaded.

In *a* there is no secondary tissue.

In *b* interœcial secondary tissue appears as a ridge and buttresses on the extraterminal front-wall.

In *c* interœcial secondary tissue has thickened, so that the extraterminal front-wall can be seen only at the base of large median lacunæ.

In *d* the interœcial secondary tissue and the median tongue have fused to form a tertiary front-wall, or lamina peristomica, leaving fenestræ, through which the intraterminal front-wall may partly be seen.

middle line; but these are indistinct, and, however far the primary pelmatidia retreat from the middle line, the median area of fusion follows them, and no perforations occur (as in the Castanoporinæ and Pelmatoporinæ, see fig. 2, p. 6) forming lateral fusions between the costæ. In this way, as much as a half, or even more than a half of each costa becomes merged in the median area of fusion. Finally, a tongue-shaped projection of secondary tissue from the area of the apertural bar spreads proximally and covers over and fuses with the median area of fusion (fig. 14, *c*, *d*).

The Apertural Bar.—As has already been stated, the most primitive Tricephaloporinæ have a median projection of the apertural bar, which fuses with the proximal pair of apertural spines (as shown in fig. 17, *a* & *b*, p. 58) to form the proximal shield of a

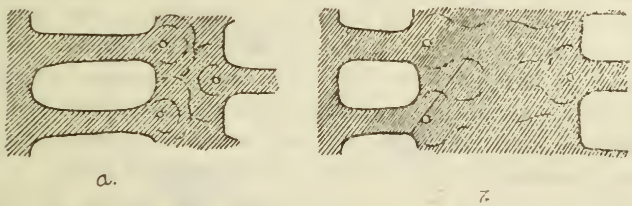


Fig. 15.—Diagrams of part of the Tricephaloporine intraterminal front-wall, showing, in *a*, the narrow median area of fusion with pelmatidia close to the mid-line; and, in *b*, a wide median area of fusion, and the pelmatidia at a considerable distance from the mid-line.

secondary aperture. Thus two fenestræ are formed, one on each side of the median process. In many Tricephaloporinæ there are pits, more-or-less perforated or blind, to right and left at the extreme base of the proximal shield of the secondary aperture, and it is probable that these are all that remain of the fenestræ of an earlier structure like that described—a structure, reduced to insignificance by the building up of further structures upon it, and obliterated by the further development of secondary tissue about it. Other modifications of the apertural bar are best considered in connection with these further structures—that is, with the further development of the proximal shield.

The Proximal Shield and Apertural Ring of the Secondary Aperture.—The earliest form of proximal shield has already been described; it consists (fig. 17, *a* & *b*, p. 58) of a fusion of the median process of the apertural bar with the proximal pair of apertural spines, forming a proximal shield with two fenestræ. Next, four further complications arise, which are not all common to any one lineage, though more than one may be found on some lineages. In the first place (fig. 14, *c*), the lower part of the proximal shield spreads proximally as a tongue-shaped projection, covering and fusing with the median area of fusion of the intra-terminal front-wall, and ultimately (fig. 14, *d*) fusing with the overlapping interœcial secondary tissue to form a tertiary front-wall with lateral fenestræ, as already described.

Secondly, in many forms, a pair of aviculœcia grows up one on each side of the aperture, obliterating the proximal apertural spines, and connects the proximal and distal shields, thus completing the apertural ring. Since these aviculœcia are generally rather proximally than distally placed with regard to the aperture, they are more conveniently considered as part of the proximal shield. In some species of *Tricephalopora* the two lateral apertural aviculœcia (fig. 16, *a*) are directed somewhat towards one another, and their distal ends, overarching the proximal rim of the aperture, fuse and form a median fenestra at the top of the proximal shield.

Thirdly (fig. 16, *b*), in other forms, the median fenestra is situated in the central part of the proximal shield—that is, it has moved proximally; and the two apertural aviculœcia, carried up with the further growth of the apertural ring, no longer appear to fuse above the fenestræ, since they are separated from it by a wide tract of tissue. Simultaneously, the apertural bar tends to rise above and, moving proximally, to over-ride the intraterminal front-wall. This last phenomenon is met with in *Tricephalopora sherborni* (fig. 23, p. 83), and, combined with a proximal movement of the median fenestra, is seen in the neanastic stages of *T. cerberus* (fig. 25, p. 89). In the ephebastic stages of that species, the median fenestra of the proximal shield lies over the middle or even the proximal end of the intraterminal front-wall (fig. 16, *c*), and, were it not for the neanastic stages, its identity in this species with that in such forms as *Tricephalopora triceps* would never be suspected. Yet it is even more probable that the proximally shifting median fenestra gets filled in, as do the lateral fenestræ formed by the fusion of the median process of the apertural bar with the proximal apertural spines; and that the apparent fenestra results from the closing in from all sides of interœcial secondary tissue over-riding the intraterminal front-wall. Presumably a similar origin obtains for the fenestra in those other forms in which it is situated over the proximal end of the intraterminal front-wall. In this way a

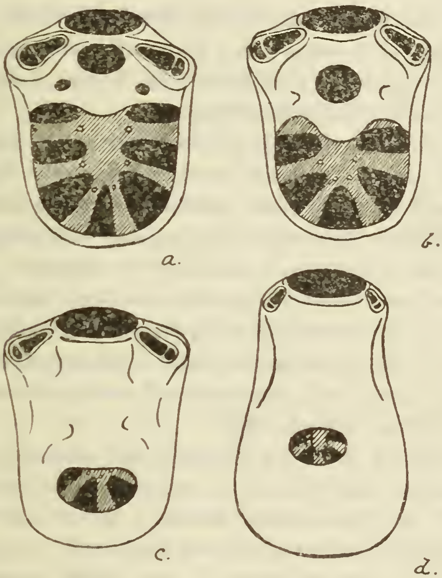


Fig. 16.—Diagrams to show the developments of the proximal shield of the secondary aperture in Tricephaloporinæ.

The intraterminal front-wall (except the apertural bar) is shaded with oblique lines; the apertures, fenestræ (except where the intraterminal front-wall is seen through a fenestra), and intercostal spaces black. The apertural bar, interœcial secondary tissue, and proximal and distal shields white.

In *a*, the apertural aviculœcia meet over the apertural bar, forming a median fenestra.

In *b*, this fenestra has retreated proximal-wards and the apertural bar over-rides the intraterminal front-wall.

In *c*, the fenestra has probably been filled in and a second fenestra formed by the closing in from all sides of secondary tissue; or possibly the original fenestra has retreated to the proximal end of the œcium, over the top of the intraterminal front-wall.

In *d*, the apertural ring is greatly prolonged, forming a tubular secondary aperture.

tertiary front-wall is formed (fig. 16, *d*), chiefly composed of the proximal shield, and is quite different in its origin from that described above (p. 44), formed mostly by the tongue-shaped extension of tissue in the neighbourhood of the apertural bar (fig. 14, *d*).

Finally, the distal end of the proximal shield—in fact, the apertural ring, as a whole—may be greatly produced (fig. 16, *d*), carrying the apertural aviculœcia with it, and forming a tubular secondary aperture (*Haplocephalopora*).

The Aviculœcia.—During evolution, the aviculœcia tend to pass from being sporadically distributed, indifferently directed, monomorphic, small, and with blunt apertures, to being definitely placed, definitely directed, polymorphic, larger, and with pointed apertures. Early in their evolution, a tendency to arrange themselves in definite positions around the aperture may be observed, a tendency first involving two aviculœcia only, placed proximally and laterally with regard to the aperture, and later involving three, four, or five aviculœcia. Forms with two apertural aviculœcia may ultimately give rise to forms with one only.

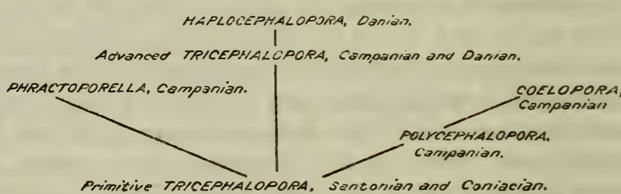
To sum up—as evolution proceeds, the tendency of the asty is to become erect, multilaminar, and cylindrical, the orthœcia increase gradually (in one case rather suddenly) in size and become comparatively wider; the extraterminal front-wall in some cases is of wide extent, but generally is small and hidden beneath interœcial secondary tissue, which increases in amount and in extent, and, with other secondary tissue, ultimately forms a tertiary front-wall, or lamina peristomica; the number of costæ decreases slightly; the median area of fusion of the intraterminal front-wall increases and becomes more firmly welded, and the pelmatidia correlatively move away from the mid-line; the fate of the apertural bar and structures surrounding the secondary aperture is various, and often complicated, but structures in the neighbourhood of and even involving the proximal shield always tend to shift proximally and, at least partially, to form a tertiary front-wall, or lamina peristomica—this tertiary front-wall is formed in at least two different ways; finally, the aviculœcia, while showing several common trends, vary as to whether a pair only or an indefinite number ultimately group themselves in definite positions around the aperture.

It will now be clear that the evolutionary history is various in the case of the following characters :—(*a*) the size of the orthœcia, generally increasing gradually, but in one case suddenly; (*b*) the size of the extraterminal front-wall; (*c*) the form of the apertural bar and structures surrounding the secondary aperture; and (*d*) the number of aviculœcia that group themselves around the aperture. It is to these points that we must turn for generic distinctions.

The first divergence in evolution is in the grouping of the aviculœcia. A general tendency for certain aviculœcia to become grouped around the aperture is early shown, and in certain forms two aviculœcia only are found in connection with the aperture, laterally and somewhat proximally placed, and carried up on the apertural ring as this develops; in other forms a variable number of aviculœcia, though a number more-or-less constant for a given species, are added to the pair already established in connection with the aperture. These diverging groups are the genera *Tricephalopora* and *Polycephalopora* respectively. It is probably not merely a matter of convenience to place in *Tricephalopora* those primitive species that do not yet show a definite leaning to either of these arrangements, for there are hints that the extra apertural aviculœcia of *Polycephalopora* are added to a pair formerly present—in other words, that *Polycephalopora* is derived from *Tricephalopora*. But, by the time that these genera have definitely diverged, and in the latest phases of their evolution, a second critical character becomes manifest. For in *Polycephalopora* and its derivative *Cœlopora*, as well as in *Phractoporella* a derivative of a comparatively simple *Tricephalopora*, a secondary front-wall, in so far as it is developed, is formed in the first manner described above, namely, by means of a tongue of secondary tissue creeping proximally from the neighbourhood of the apertural bar, covering and joining with the median area of fusion of the intraterminal front-wall, fusing with the spreading lamina of interœcial secondary tissue, and leaving one or more (generally a lateral pair) of fenestræ. In *Tricephalopora* and its late derivative *Haplocephalopora*, on the other hand, the secondary front-wall is formed in the second manner above described, namely, chiefly by the proximal migration of the proximal shield with its median fenestra over the intraterminal front-wall; and these have finally a proximally placed median fenestra, possibly the homologue of the median fenestra of the proximal shield, but probably a new fenestra formed by the closing in from all sides of interœcial secondary tissue over-riding the intraterminal front-wall. The extraterminal front-wall, too, in advanced forms of *Tricephalopora*, becomes very pronounced at the expense of the intraterminal front-wall.

As has been briefly mentioned above, a comparatively simple form of *Tricephalopora* gave rise to a lineage that ultimately developed a complete secondary front-wall by a different method from that employed by the more complex species of *Tricephalopora*. To this lineage the name *Phractoporella* is applied. *Haplocephalopora* is a *Tricephalopora* with a tubular secondary aperture, and the pair of aviculœcia, carried high up with the growth of the apertural ring, of comparatively small size. Finally, *Cœlopora* is a genus resembling *Polycephalopora*, but of comparatively gigantic size, and, in its advanced members, with a fairly complete tertiary front-wall formed as in *Phractoporella*.

The following diagram illustrates this phylogeny :—



Key to the Genera of Tricephaloporinæ.

A. Aviculœcia sporadic, or, if definitely placed, a pair only of apertural aviculœcia (or even a single one), placed to right and left (or if one, indifferently), and, as a rule, a little proximally with regard to the aperture.

I. Tertiary front-wall, if present, formed mainly by the proximal extension of the proximal shield and its median foramen.

a. Apertural aviculœcia comparatively large ; secondary aperture not tubular (figs. 17–27). I. *Tricephalopora*.

b. Apertural aviculœcia comparatively small ; secondary aperture tubular (fig. 28)......... II. *Haplocephalopora*.

II. Tertiary front-wall always more or less developed, formed mainly by a tongue of secondary tissue, which covers the median area of fusion of the intraterminal front-wall (figs. 29–31) . III. *Phractoporella*.

B. Three, four, or five apertural aviculœcia.

- I. Orthœcia comparatively small; secondary front-wall never very complete, aviculœcia seldom markedly dimorphic (figs. 32–38)...... IV. *Polycephalopora.*
- II. Orthœcia comparatively gigantic; secondary front-wall often complete, aviculœcia typically markedly dimorphic (figs. 39–44) .... V. *Cœlopora.*

I. TRICEPHALOPORA, Lang, 1916.

[*Cellepora* [partim]; von Hagenow, 1839, p. 275.]
[*Cellepora* [partim]; von Hagenow, 1840, p. 639.]
[*Escharina* (*Cellepora*) [partim]; Römer, 1840, p. 14.]
[*Cellepora* [partim]; Boll, 1846, p. 207.]
[*Cellepora* [partim]; Geinitz, 1846, pp. 612, 613.]
[*Cellepora* [partim]; Bronn, 1841, pp. 254, 256.]
[*Escharina* [partim]; Bronn, 1848, p. 472.]
[*Cellepora* [partim]; Bronn, 1849, pp. 132, 133.]
[*Escharina* [partim]; Bronn, 1849, p. 131.]
[*Cellepora* [partim]; Geinitz, 1849–50, pp. 248–9.]
[*Escharina* [partim]; d'Orbigny, 1850, p. 262.]
Cellepora (*Escharoïdes*) [partim]; von Hagenow, 1851, pp. 88, 107.]
[*Eschara* [partim]; von Hagenow, 1851, pp. 64, 108.]
Adeone; Leymerie, 1851, pp. 191–2, 201.
[*Eschara* [partim]; d'Orbigny, 1853, p. 435.]
[*Multescharipora* [partim]; d'Orbigny, 1853, p. 496.]
[*Semiescharipora*; d'Orbigny, 1853, p. 485, [partim] 1854, p. 1098.]
[*Multescharipora* [partim]; Pictet, 1857, p. 112.]
[*Eschara* [partim]; Binkhorst van den Binkhorst, 1859, p. 87.]
[*Repteschareltina*; Gabb & Horn, 1862, p. 146.]
[*Escharellina*; Meek, 1864, p. 3.]
[*Cellepora* [partim]; Schlüter, 1870, p. 940.]
[*Cellepora* [partim]; Ubaghs, 1879, p. 217.]
[*Escharifora* [partim]; Ubaghs, 1879, p. 218.]
[*Multescharipora*; Ubaghs, 1879, p. 217.]
[*Cellepora* [partim]; Mourlon, 1881, p. 116.]
[*Escharifora* [partim]; Mourlon, 1881, pp. 95, 116.]
[*Multescharipora*; Mourlon, 1881, p. 116.]
[*Cellepora* [partim]; de Morgan, 1882, p. 39.]
[*Cellepora* (*Escharoides*) [partim]; Vine, 1885, p. 164.]
[*Eschara* [partim]; Vine, 1885, p. 163.]
[*Reptocelleporaria* (*Repteschareltina*); Vine, 1885, p. 168.]
[*Semiescharipora* [partim]; Vine, 1885, pp. 116, 156.]
[*Cellepora*; Marsson, 1887, p. 99.]

[*Cribrilina* [partim]; Marsson, 1887, pp. 97, 98, 109.]
[*Lagodiopsis* [partim]; Marsson, 1887, p. 99.]
[*Porina* [partim]; Marsson, 1887, pp. 86, 108.]
[*Cellepora* [partim]; Lundgren, 1888, p. 10.]
[*Reptescharellina*; Vine, 1891, p. 381.]
[*Cellepora* [partim]; Hennig, 1892, p. 3.]
[*Cribillina* [sic] [partim]; Deecke, 1895, p. 80.]
[*Porina* [partim]; Deecke, 1895, p. 79.]
[*Cribrilina* (*Cribrilina*) [partim]; Canu, 1900 [2], pp. 445, 449.]
[*Semieschariporа* [partim]; Canu, 1900 [2], p. 449.]
[*Reptescharenilla* [sic] [partim]; Nickles & Bassler, 1900, p. 156.]
[*Cribrilina*; Deecke, 1902, p. 113.]
[*Reptescharellina*; Johnson, 1905, p. 5.]
[*Cellepora*; Brydone, 1906, p. 297.]
Cribrilina; Brydone, 1906, p. 296.
[*Reptescharellina*; Weller, 1907, pp. 167, 346.]
[*Membraniporella* [partim]; Brydone, 1909, pp. 398, 400.]
[*Membraniporella*; Levinsen, 1909, p. 83.]
[*Cellepora*; Brydone, 1910, p. 483.]
[*Membraniporella* [partim]; Brydone, 1910, p. 483.]
[*Hoplocheilina* [partim]; Canu, 1911, p. 261.]
[*Reptescharellina*; Canu, 1911, pp. 261, 282.]
[*Membraniporella*; Canu, 1911, pp. 251, 286.]
Membraniporella [partim]; Brydone, 1913, pp. 437–8.
Membraniporella [partim]; Brydone, 1916, p. 100.
Tricephalopora, gen. nov.; Lang, 1916, pp. 86–89.
Phractopora [partim]; Lang, 1916, pp. 86, 89.
[*Cellepora* [partim]; Lang, 1917, p. 171.]
Cribrilina; Lang, 1917, p. 171.
Tricephalopora; Lang, 1917, p. 171.
Membraniporella [partim]; Brydone, 1917, pp. 145, 147–8, 492, 494, 496.
[*Cribrilina* [partim]; Brydone, 1917, pp. 147, 492–3. 496.]
[*Membraniporella* [partim]; Brydone, 1918, pp. 2–4.]
Cribrilina; Brydone, 1918, p. 3.
Tricephalopora [partim]; Lang, 1919 [3], pp. 105, 106.
Beisselina [partim]; Canu, 1920, pp. 197–8.
Non *Beisselina*; Canu, 1913, p. 138.

Diagnosis.—Tricephaloporinæ in which the aviculœcia are sporadically distributed, or in which there is a pair of aviculœcia or a single one, placed laterally and, as a rule, somewhat proximally to the aperture, and no other apertural aviculœcia; tertiary front-wall, if present, formed, at least partly, by a backward migration of the proximal shield of the secondary aperture, bearing a median foramen through which the intraterminal front-wall may be visible; the secondary aperture is not tubular.

Genotype.—*Cribrilina triceps*, Marsson.

Distribution.—Senonian, Coniacian, to Danian. Also Eocene.

Remarks.—It is convenient to regard as *Tricephalopora* those primitive forms from which both *Polycephalopora* and the more typical *Tricephalopora* can be derived, forms in which the aviculœcia are sporadically distributed and indifferently directed. Such species are *T. prænuncia* and its probable derivative *T. ansata*. In the latter species the aviculœcia vary a good deal in size, some becoming rather large; and some are proximally directed. In all the derivatives of *T. ansata* there is a tendency for a pair of aviculœcia to take up a position near the proximal-lateral corners of the aperture. In *T. pustulosa* and its derivative with more pointed aviculœcia, *T. saltdeanensis*, a pair of proximally-directed aviculœcia thus takes up an apertural position; and this is also the case in [*T.*] *coronata*. In other species the apertural pair is distally directed. The sporadically-distributed aviculœcia remain numerous in the lineage [*T.*] *T-formis*–[*T.*] *bramfordensis*, but in other lineages tend to vanish. During further evolution, the aviculœcia become more pointed, those of the apertural pair become raised on the apertural rim, and their distal ends, finally fusing each with the other, leave a median fenestra in the proximal shield of the secondary aperture. This is, however, to anticipate the evolution of the secondary aperture. In the more primitive species it is probable that already a median process of the apertural bar has fused with the proximal pair of apertural spines to form two lateral fenestræ over the apertural bar (fig. 8 *a*, *b*, p. 26)—this is certainly the case in *T. ansata*, [*T.*] *T-formis*, [*T.*] *bramfordensis*, *T. somptingensis*, and *T. saltdeanensis*; but in the more advanced species, like *T. castrum*, *T. triceps*, and *T. sherborni*, in which the aviculœcia ride high on the rim of the secondary aperture, and, fusing above the median process of the apertural bar, form a median fenestra in the proximal shield of the secondary aperture (fig. 16 *a*), the primary lateral fenestræ formed by the fusion of the median process of the apertural bar with the proximal pair of apertural spines, become filled with secondary tissue, cease to be perforate, and appear as mere pits (fig. 16, *b*). Next, in the advanced species, *T. prolifera*, the median fenestra is situated proximally, and lies over the distal end of the intraterminal front-wall. Finally, in such species as *T. cerberus* and *T. obducta*, the median fenestra has travelled right back to the proximal end of the intraterminal front-wall, being merely a hole in a secondary front-wall formed by the general up-growth of interœcial secondary tissue fused with the extension of secondary tissue from the neighbourhood of the apertural bar (fig. 16, *c*). It is possible, however, as suggested on p. 44, that, in those advanced forms in which the apparent fenestra lies quite at the proximal end of the œcium, this fenestra is really formed by the advance from all sides of interœcial secondary tissue, which over-spreads the intraterminal front-wall; and that the original fenestra in the proximal apertural shield becomes infilled.

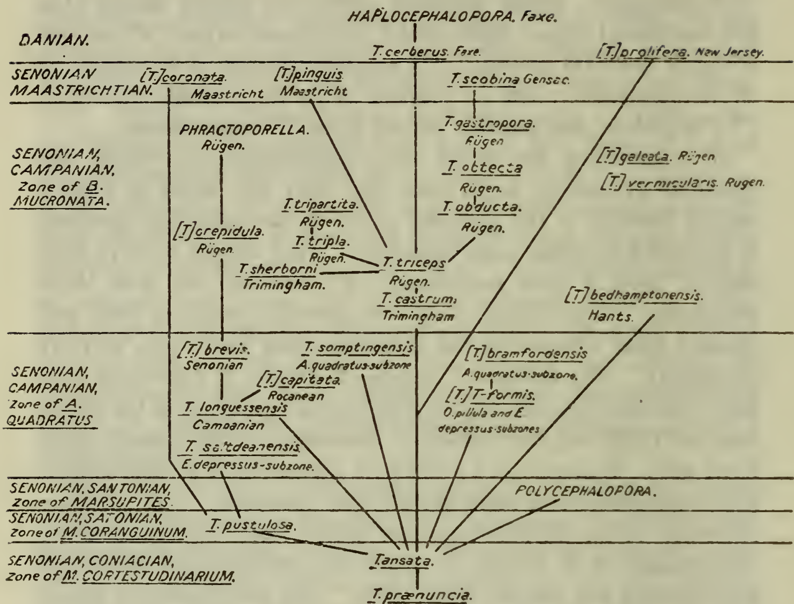
Thus the species of *Tricephalopora* may be divided into three categories according to the stage of development reached by the proximal shield, namely (*a*) those in which a median fenestra is not yet formed; (*b*) those with a median fenestra in a normal position; and (*c*) those with a proximally-shifted median fenestra. In the first category are those with sporadically-distributed aviculœcia only (*T. prænuncia* and *T. ansata*); those with a pair of aviculœcia which have not yet attained eminence on the rim of the secondary aperture, such as *T. somptingensis* with only occasional sporadically-distributed aviculœcia, and the lineage [*T.*] *T-formis*–[*T.*] *bramfordensis*, in which the sporadically-distributed aviculœcia have remained numerous; and those whose apertural aviculœcia are borne high on the rim of the secondary aperture. Of the last there are probably many forms. Certainly there is the lineage *T. pustulosa*–*T. saltdeanensis*, already considered as having retained proximally-directed aviculœcia; and [*T.*] *coronata*, possibly connected with this lineage; [*T.*] *bedhamptonensis*, in which the tendency to dimorphism of aviculœcia seen in the primitive *T. ansata* is carried further; and *T. longuessensis*, whose aviculœcia are not markedly dimorphic, and in which the apertural pair is distally directed. But, besides these, there are numerous ill-described and ill-figured forms, some only doubtfully referred to

Tricephalopora, which probably should be placed among the last-mentioned forms. Such are [*T.*] *vermicularis* and [*T.*] *galeata* of quite doubtful affinity; [*T.*] *capitata*, possibly a derivative of *T. longuessensis*; and [*T.*] *brevis* with its probable derivative [*T.*] *crepidula*, also possibly derived from *T. longuessensis*.

In considering the forms of *Tricephalopora* in which the apertural aviculœcia have fused one with the other to form a median fenestra in the proximal shield of the secondary aperture, it is possible to speak more definitely. They appear to have been derived from a form resembling [*T.*] *castrum*, but with blunt aviculœcia. *T. prolifera* comes very near this primitive form, but shows a great advance in the fenestra, which has begun to shift proximally. The lineage *T. triceps*–*T. tripla*–*T. tripartita* may have been derived from [*T.*] *castrum* by the expansion of the extra-terminal front-wall and correlative diminution of the intraterminal front-wall. *T. sherborni* is probably a derivative of *T. triceps* with larger aviculœcia and more aviculœcian buttresses. [*T.*] *pinguis* obviously is an advanced species, which looks like an extreme development of *T. triceps*, in which the intraterminal front-wall has dwindled and become nearly solid. But von Hagenow's figure shows no decided median fenestra, and it is therefore doubtful if the species should be placed here, or even in the genus *Tricephalopora*.

In the remaining species the median fenestra has shifted proximally so as to lie over the intraterminal front-wall, often at its proximal end. In *T. cerberus* lacunæ still persist in the interœcial secondary tissue; in the lineage *T. obducta*–*T. obtecta*–*T. gastropora* the interœcial valleys are entirely levelled, and a plain, more-or-less flat, tertiary front-wall covers the whole asty, perforated only by (1) the apertures of the orthœcia, (2) those of the apertural aviculœcia, and (3) the proximally-shifted median fenestra of the proximal apertural shield. Finally, by the suppression of one aviculœcium of the apertural pair, *T. scobina* is attained.

These relationships are suggested in the following diagram:—



Key to the Species of *Tricephalopora*.

A. Aviculœcia sporadically distributed.

- I. Smaller, about ·4 mm. long (fig. 17 *a*) ...... 1. *T. prænuncia.*
- II. Larger, about ·6 mm. long; sporadic aviculœcia of varying size, and some proximally directed (fig. 17 *b*) .... 2. *T. ansata.*

B. Aviculœcia consisting of (generally) an apertural pair and numerous sporadically-distributed individuals.

- I. Smaller, about ·55 mm. long; costæ about 16 .... 3. [*T.*] *T-formis.*
- II. Larger, about ·8 mm. long; costæ 20 or more .... 4. [*T.*] *bramfordensis.*

C. Aviculœcia generally consisting of an apertural pair, in some species with an occasional sporadic individual.

- I. No median fenestra in the proximal apertural shield.
  - *a.* Intraterminal front-wall not much reduced.
    - 1. Apertures transversely elongate .... 5. [*T.*] *vermicularis.*
    - 2. Apertures more or less circular.

- *a.* Aviculœcia, though they may be elongate, are yet blunt, and distally directed.
  - *a.* Orthœcia twice as long as wide ... 6. [*T.*] *galeata.*
  - *b.* Orthœcia not twice as long as wide.
    - I. Aviculœcia not highly raised on the apertural rim (fig. 18) ...... 7. *T. somptingensis.*
    - II. Aviculœcia apparently well-raised on the apertural rim.
      - *α.* Median area of costal fusion narrower.
        - *a.* Less interœcial secondary tissue; orthœcia oval-elliptical (fig. 19) .... 8. *T. longuessensis.*
        - *b.* More interœcial secondary tissue; orthœcia elliptical. 9. [*T.*] *capitata.*
      - *β.* Median area of fusion wider.
        - *a.* Little or no interœcial secondary tissue .... 10. [*T.*] *brevis.*
        - *b.* Much interœcial secondary tissue, or orthœcia widely spaced.
          - 1. No tongue-shaped projection of secondary tissue proximal to the apertural bar.
            - *α.* Aviculœcia monomorphic .... 11. [*T.*] *crepidula.*
            - *β.* Aviculœcia dimorphic . 12. [*T.*] *bedhamptonensis.*
          - 2. A tongue-shaped projection from the apertural bar over the median area of fusion of the intraterminal front-wall present in at least some œcia .... [*Phractoporella sub-castrum* and *P. tri-faux.*]
- *β.* Aviculœcia proximally directed.
  - *a.* Intraterminal front-wall in evidence.
    - 1. Apertural aviculœcia smaller, shorter, and rather blunt ...... 13. *T. pustulosa.*
    - 2. Apertural aviculœcia larger, long, and pointed (fig. 20) .... 14. *T. saltdeanensis.*
  - *b.* Intraterminal front-wall more or less obscured by secondary tissue; aviculœcia short and slightly pointed .... 15. [*T.*] *coronata.*

- *b*. Intraterminal front-wall much reduced; extraterminal front-wall much enlarged . 16. [*T.*] *pinguis*.

II. A median fenestra present in the proximal apertural shield; it may, perhaps by migrating proximally, come to lie over the intraterminal front-wall.

- *a*. Aviculœcia blunter; fenestra situated over the distal end of the intraterminal front-wall (fig. 21 .... 17. [*T.*] *prolifera*.
- *b*. Aviculœcia more pointed.
  - 1. Fenestra not proximally shifted as far as the intraterminal front-wall.
    - *α*. Extraterminal front-wall not expanded .... 18. [*T.*] *castrum*.
    - *β*. Extraterminal front-wall well expanded and intraterminal front-wall correlatively reduced.
      - *a*. Aviculœcia smaller; 2–3 aviculœcian buttresses.
        - 1. Incrusting .... 19. *T. triceps*.
        - 2. Erect, unilaminar .... 20. *T. tripla*.
        - 3. Erect, multilaminar (fig. 22) ... 21. *T. tripartita*.
      - *b*. Aviculœcia larger; 3–4 aviculœcian buttresses (fig. 23)......... 22. *T. sherborni*.
  - 2. Fenestra situated over the intraterminal front-wall.
    - *α*. Interœcial tissue still contains lacunæ, so that deep interœcial valleys are present, and tertiary intraterminal front-wall is not complete (figs. 24, 25) .... 23. *T. cerberus*.
    - *β*. Interœcial tissue has no lacunæ, there are no deep interœcial valleys, and except for the median fenestra, the tertiary intraterminal front-wall is complete.
      - *a*. Two aviculœcia to every aperture.
        - 1. Incrusting (fig. 26) .... 24. *T. obducta*.
        - 2. Erect, unilaminar (fig. 27) ...... 25. *T. obtecta*.
        - 3. Erect, cylindrical .... 26. *T. gastropora*.
      - *b*. One aviculœcium only or occasionally two aviculœcia to every aperture ... . 27. *T scobina*.

1. Tricephalopora prænuncia, Lang.

Tricephalopora prænuncia, sp. n.; Lang, 1916, pp. 86, 87; Coniacian; Fécamp, N.E. of Le Havre, France.

Diagnosis.—*Tricephalopora* in which the aviculœcia are sporadically distributed and the orthœcia very small, being about ·4 mm. long.

Description.—Asty incrusting, unilaminar; œcia dimorphic. Orthœcia about ·4 mm. long and ·22 mm. wide, elliptical; extra-terminal front-wall hidden beneath interœcial secondary tissue which is well developed; intraterminal front-wall rather flat, consisting of about fifteen thin costæ with no lateral fusions, each bearing a single pelmatidium towards its distal end and firmly fused medianly in a rather narrow band of fusion; apertural bar with a broad median process that probably fused with the proximal pair of apertural spines to form the proximal shield of a secondary aperture (this fusion does not appear in the type-specimen, owing, presumably, to breakage); the distal shield is not continuous laterally with the proximal shield, so the secondary apertural ring is laterally incomplete. Aviculœcia sporadic, small, with blunt apertures, and variously directed.

Distribution.—Senonian, Coniacian. Fécamp.

Type-specimen.—In Mr. F. Canu's collection, Versailles.

Remarks.—That *T. prænuncia* is the most primitive of all the known Tricephaloporinæ is shown in its size, in the number of costæ, in the comparatively small amount of fusion of the intraterminal front-wall, in the condition of the apertural bar and proximal shield of the secondary aperture, in the incomplete apertural ring, and in the aviculœcia, which are sporadically distributed, indifferently directed, small, and with blunt apertures. Also, with the next species, it occurs lowest in stratigraphical sequence.

Figures.—Text-fig. 17 *a*. Orthœcium and two aviculœcia.

Specimens.—Only a photograph of the type-specimen.

2. Tricephalopora ansata, Lang.

Tricephalopora ansata, sp. n.; Lang, 1916, pp. 86, 87; Coniacian; Fécamp, N.E. of Le Havre, France.

DIAGNOSIS.—*Tricephalopora* in which the aviculœcia are sporadically distributed and indifferently directed, and the orthœcia comparatively large, about ·6 mm. long.

DESCRIPTION.—Asty incrusting, unilaminar; œcia dimorphic. Orthœcia about ·6 mm. long and about ·29 wide, elliptical, slightly constricted laterally; extraterminal front-wall hidden by interœcial secondary tissue, which is fairly plentiful and contains irregularly-shaped lacunæ; intraterminal front-wall well arched, consisting of about fifteen thin, rather widely-separated costæ, with no lateral fusions, each bearing a single pelmatidium at its distal end, and firmly fused in the middle line, forming a rather narrow

Fig. 17 *a*.—*Tricephalopora prænuncia.* Diagram of an orthœcium and two aviculœcia, from above. × about 75 diameters.
Fig. 17 *b*.—*Tricephalopora ansata.* Diagram of an orthœcium and three aviculœcia, from above. × about 75 diameters.

band of fusion; apertural bar with a broad, flattened median process, which fuses with the much-enlarged proximal pair of apertural spines to form a high proximal shield of a secondary aperture; the distal shield is similarly a high rim of secondary tissue, which overwhelms the distal pair of apertural spines, so that these are only to be seen in neanic (and, presumably, in neanastic) individuals; between the proximal and distal shields is a low gap—in other words, the rim of the secondary aperture is incomplete laterally,—and this is doubtless correlated with the imperfect development of definite apertural aviculœcia; the generally subcircular outline of the secondary aperture is impressed proximally by a median bulging of the proximal shield, and elongated laterally by the gaps in the apertural ring. Aviculœcia varying in size, position, and direction, but generally rather large, often an apertural pair rather distally placed, and more often than not with a general proximal orientation; apertures blunt, rather elongate, widest distally, and somewhat constricted laterally, divided by a transverse bar into a very large rostrum and a much smaller proximal portion.

DISTRIBUTION.—Coniacian; Fécamp.

TYPE-SPECIMEN.—**D. 28468.**

REMARKS.—*Tricephalopora ansata* differs from *T. prænuncia* in its considerably larger size and in having a larger proximal shield; and from all other undoubted congeners in the sporadically-distributed aviculœcia and in the incomplete apertural ring. It is, presumably, derived from *T. prænuncia*, and probably gave rise to all the following forms.

FIGURES.—Text-fig. 17 *b*. Orthœcium and three aviculœcia.

Plate I, fig. 5. Part of the type-specimen showing four complete orthœcia, one of which bears an ovicell; the aperture and ovicell of a fourth orthœcium; and three aviculœcia. × about 27 diameters.

LIST OF SPECIMENS.

D. 28468. D. 28467. D. 28469–71. D. 28458. Type-specimen and five paratypes. Fragmentary asties, none, except **D. 28458**, obviously incrusting. **D. 28467** shows well the fenestræ formed by the fusion of the median process of the apertural bar with the proximal pair of apertural spines. Senonian, Coniacian. Fécamp, N.E. of Le Havre, Seine Inférieure, France. In exchange with Mr. F. Canu. 1914.

3. [Tricephalopora] T-formis (Brydone).

Cribrilina T-formis, sp. nov.; Brydone, 1917, pp. 493, 496, pl. xxxii, figs. 2, 3; subzones of *O. pillula* and *E. scutatus* var. *depressa*; Hants and Sussex.

DIAGNOSIS.—[*Tricephalopora*] about ·55 mm. long; with about 16 costæ; with numerous sporadically-distributed aviculœcia, as well as an apertural pair.

Distribution.—Senonian, Campanian, zone of *A. quadratus*, subzones of *O. pillula* and *E. scutata* var. *depressa*; Hants, and Rottingdean, E. of Brighton, Sussex.

Type-specimen.—That figured by Brydone, 1917, pl. xxxii, fig. 2, is hereby selected.

Remarks.—[*Tricephalopora*] *T-formis* and [*T.*] *bramfordensis* form a lineage peculiar in possessing numerous sporadically-distributed aviculœcia, as well as an apertural pair. [*T.*] *bramfordensis* is an advance on [*T.*] *T-formis*, having more costæ and larger orthœcia.

Specimens.—None in the Collection.

4. [Tricephalopora] bramfordensis (Brydone).

Cribrilina Bramfordensis, sp. nov.; Brydone, 1917, pp. 493, 496, pl. xxxii, figs. 4, 5; subzone of *A. quadratus*; Suffolk.

Diagnosis.—[*Tricephalopora*] about ·8 mm. long; with 20 or more costæ; with numerous sporadically-distributed aviculœcia, as well as an apertural pair.

Distribution.—Senonian, Campanian, zone of *A. quadratus*, subzone of *A. quadratus*; Bramford, Suffolk.

Type-specimen.—That figured by Brydone, 1917, pl. xxxii, fig. 4, is hereby selected.

Remarks. — See remarks under [*Tricephalopora*] *T-formis* (Brydone).

Specimens.—None in the Collection.

5. [Tricephalopora] vermicularis (Geinitz).

Cellepora vermicularis v. Hag.; Geinitz, 1846, p. 613, pl. xxiii *b*, fig. 35; Obere Kreide; Rügen.

Cellepora vermicularis Hag.; Bronn, 1848, p. 256.

Cellepora vermicularis Hag.; Bronn, 1849, p. 133; Kreide.

Cellepora vermicularis v. H.; Geinitz, 1849–50, pp. 248–9; Kreide; Rügen.

Tricephalopora vermicularis (Geinitz); Lang, 1916, pp. 86, 87; *B. mucronata*-zone; Rügen.

Diagnosis.—[*Tricephalopora*] in which there is a pair of apertural aviculœcia, but no median fenestra in the proximal apertural shield; the intraterminal front-wall is not reduced, and the apertures are considerably widened in a transverse direction.

Description.—Asty incrusting; intraterminal front-wall consisting of from ten to twelve costæ.

Distribution.—Senonian, Campanian, zone of *B. mucronata.* Rügen.

Type-specimen.—That figured by Geinitz, 1846, pl. xxiii *b*, fig. 35, is hereby selected.

Remarks.—The diagnostic and descriptive characters given above are all that can be deduced from the figures by Geinitz and his description of this doubtful species.

Specimens.—None in the Collection.

6. [Tricephalopora] galea ta (Ginitz).

Cellepora galeata v. Hag.; Geinitz, 1846, p. 613, pl. xxiii *b*, fig. 34; Obere Kreide; Rügen.

Cellepora galeata Hag.; Bronn, 1848, p. 254.

Cellepora galeata Hag.; Bronn, 1849, p. 132; Kreide.

Cellepora galeata, v. H.; Geinitz, 1849–50, pp. 248–9; Kreide; Rügen.

Non *Cellepora galeata*, Hag.; Ubaghs, 1879, p. 217; Sénonien; Limbourg; =*Murinopsia* [*Semiescharipora*] *galeata* (Beissel).

Non *Cellepora galeata*, Hag.; Mourlon, 1881, p. 116; Sénonien; Limbourg; =*Murinopsia* [*Semiescharipora*] *galeata* (Beissel).

Cellepora galeata, Hag.; Brydone, 1910, p. 483.

Tricephalopora galeata (Geinitz); Lang, 1916, pp. 86, 88; *B. mucronata*-zone; Rügen.

Diagnosis.—[*Tricephalopora*] in which there is a pair of apertural aviculœcia, but no median fenestra in the proximal apertural shield; the intraterminal front-wall is not reduced; the apertures are sub-circular; the aviculœcia are blunt; and the orthœcia are about twice as long as wide.

Description.— The intraterminal front-wall consists of seven or eight costæ; and there is a wide median band of fusion.

Distribution.—Senonian, Campanian, zone of *B. mucronata.* Rügen.

Type-specimen.—That figured by Geinitz, 1846, pl. xxiii *b*, fig. 34, is hereby selected.

Remarks.—Though in his description of this species, Geinitz gives seven or eight as the number of the costæ, his figure shows at least twelve. It is very doubtful whether this species can be regarded as a *Tricephalopora*.

Specimens.—None in the Collection.

7. Tricephalopora somptingensis, Lang.

Tricephalopora somptingensis, sp. n.; Lang, 1916, pp. 86, 88; *A. quadratus*-zone; Sompting, N.E. of Worthing, Sussex.

Diagnosis.—*Tricephalopora* in which there is normally a pair of blunt apertural aviculœcia leaning against the apertural ring, and not carried up on to its rim; there is no median fenestra in the apertural shield; the intraterminal front-wall is not reduced; the apertures are not markedly transversely elongate; and the orthœcia are not twice as long as wide.

Description.—Asty erect, unilaminar; œcia dimorphic. Orthœcia about ·67 mm. long and about ·37 mm. wide, broadly elliptical; extraterminal front-wall hidden beneath interœcial secondary tissue which is well developed and contains irregularly-shaped median lacunæ; intraterminal front-wall rather flat owing to the great width of the flat median area of fusion, and consisting of about ten rather stout costæ, which are somewhat widely spaced, have no lateral fusions, bear each a pelmatidium towards their distal ends, and are joined medianly in a broad area of fusion; this area involves nearly half the total length of each costa, and across it the outlines of the costæ may be traced in so far as they are not hidden by secondary tissue, which tends to spread proximally from the neighbourhood of the apertural bar, and to over-run the median area of fusion; apertural bar with a broad median process, which fuses with the proximal pair of apertural spines to form the proximal shield of a secondary aperture; secondary aperture subcircular, tending to be wider transversely, surrounded by a complete ring of secondary tissue. Aviculœcia small, short, with blunt apertures, slightly laterally constricted, and divided by a transverse bar into a very much larger rostrum and a smaller proximal portion; sporadically distributed, but generally a pair placed, one on each side, proximally and laterally to the aperture of each orthœcium, and directed towards the centre of the aperture; otherwise variously directed and some, at least, more-or-less proximally directed.

Distribution.—Senonian, Campanian, zone of *A. quadratus*, subzone of *A. quadratus*. Pit 7 of Gaster, in Upton Lane (or Lambley's Lane), N.W. of Sompting Church, N.E. of Worthing, Sussex.

Type-specimen.—D. 23113. Collected and presented by T. H. Withers, Esq., F.G.S., 1914.

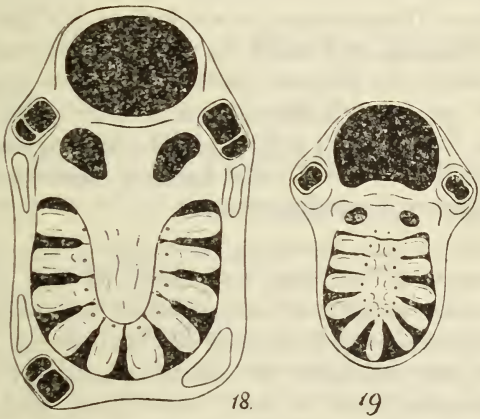


Fig. 18.—*Tricephalopora somptingensis*. Diagram of an orthœcium and three aviculœcia, from above. × about 75 diameters.

Fig. 19.—*Tricephalopora longuessensis*. Diagram of an orthœcium and two aviculœcia, from above. × about 75 diameters.

Remarks.—*T. somptingensis* is more primitive than the subsequently-described species, because the apertural pair of aviculœcia has not become firmly established, being somewhat irregular in position and sometimes incomplete—that is, with one of the pair absent; moreover, these aviculœcia lie against the apertural ring and are not carried up on to its rim as in the following species of *Tricephalopora*. The intraterminal front-wall is, however, well consolidated, and in this respect *T. somptingensis* is by no means primitive.

Figures.—Text-fig. 18. Orthœcium and three aviculœcia.

Plate I, fig. 6. Two orthœcia of the type-specimen, the aperture of a third orthœcium, and about seven aviculœcia. × about 27 diameters.

SPECIMENS.—Type-specimen. Distribution and collection as above.

8. Tricephalopora longuessensis, Lang.

Tricephalopora languessensis [sic], sp. n.; Lang, 1916, pp. 87, 88: Campanian; Languesse [sic], France.

Tricephalopora languessensis Lang; Lang, 1919 [3], p. 106, fig. 19 *c*; Campanian; Languesse, France.

DIAGNOSIS.—*Tricephalopora* in which there is a pair of blunt apertural aviculœcia, well raised on the apertural ring, and no median fenestra in the proximal apertural shield; the intraterminal front-wall is not reduced; the aperture is more or less circular; the orthœcia are not twice as long as wide, but are oval-elliptical in shape; the median area of costal fusion is narrow, and there is little or no interœcial secondary tissue.

DESCRIPTION.—Asty incrusting, unilaminar; œcia dimorphic. Orthœcia about ·45 mm. long and about ·27 mm. wide, oval-elliptical; extraterminal front-wall appearing as a narrow lateral and proximal arched strip from which the intraterminal front-wall springs, and not obliterated by interœcial secondary tissue, of which there is very little or none; intraterminal front-wall well arched, consisting of about eleven thin, rather widely-spaced costæ with no lateral fusions, each bearing towards its distal end a single pelmatidium, and firmly united in the middle line in a wide band of fusion; apertural bar, presumably, with a broad median process which fuses with the proximal pair of apertural spines to form the proximal shield of the secondary aperture, but this character cannot be clearly seen in the type-specimen; secondary apertural ring complete, formed laterally by tissue round the apertural aviculœcia, and distally by a rim of secondary tissue; secondary aperture subcircular. Aviculœcia small, blunt, typically a pair raised high on the apertural ring, one at each lateral-proximal corner, and directed obliquely, distally, and towards the mid-line of the orthœcium to which they pertain.

DISTRIBUTION.—Senonian, Campanian. Longuesse, Seine-et-Oise, France.

TYPE-SPECIMEN.—In Mr. F. Canu's collection, Versailles.

REMARKS.—*Tricephalopora longuessensis* (originally written, by error, *T. languessensis*) in its small size and other characters appears to resemble [*T.*] *capitata*, but is distinguished from that species by its more oval shape and by the greater amount of secondary tissue. If [*T.*] *capitata* is a *Tricephalopora*—a point which is not yet certain—it is probable that *T. longuessensis* is closely allied to it.

FIGURES.—Text-fig. 19. Diagram of an orthœcium and its two apertural aviculœcia.

SPECIMENS.—Only a photograph of the type-specimen.

9. [Tricephalopora] capitata (Canu).

Membraniporella capitata, nov. sp.; Canu, 1911, pp. 251, 286, pl. vi, figs. 1–3; Rocanéen; Río Negro, Argentine.

Tricephalopora capitata (Canu); Lang, 1916, pp. 86, 87; Rocanéan; Rio Negro.

DIAGNOSIS.—*Traicephlopora* in which there is a pair of blunt apertural aviculœcia, well raised on the apertural ring, and no median fenestra in the proximal apertural shield; the intraterminal front-wall is not reduced; the apertures are more-or-less circular; the orthœcia are not twice as long as wide, but elliptical; the median area of fusion is narrow, and there is a fair amount of interœcial secondary tissue.

DESCRIPTION.—Asty incrusting, unilaminar; œcia dimorphic. Orthœcia about ·46 mm. long and about ·21 mm. wide, elliptical; extraterminal front-wall hidden beneath secondary tissue, which, though well developed, has large median lacunæ; intraterminal front-wall consisting of about ten thin costæ with no lateral fusions, firmly united in a narrow median band of fusion; apertures very large, sub-circular, surrounded by a high, complete, secondary apertural ring, which bears on its rim, laterally and somewhat proximally, a pair of small, blunt apertural aviculœcia.

DISTRIBUTION.—Rocanean [= Senonian, Emscherian]. Río Negro, Argentine, S. America.

TYPE-SPECIMEN.—That figured by Canu, 1911, pl. vi, fig. 1, is hereby selected.

Remarks.—Thanks to the excellent figures and full description given by Canu, many of the characters of this species can be satisfactorily determined. Since, however, the presence of pelmatidia cannot be certified, the species can only be included provisionally in the genus *Tricephalopora*. If a *Tricephalopora*, the most striking character is its small size, in which it approaches the primitive *T. prænuncia*; but the apertural aviculœcia, carried on the complete apertural ring, remove it far from that species in complexity. Canu states that there are ten costæ; but his figures give about twelve. Its affinities seem to be with *T. longuessensis*.

Specimens.—None in the Collection.

10. [Tricephalopora] brevis (d'Orbigny).

Semiescharipora brevis, d'Orb., 1851; d'Orbigny, 1852, pl. 718, figs. 21–24, 1853, p. 485, 1854, p. 1098; Sénonien; Sainte-Colombe (Manche).
Semiescharipora brevis, D'Orb.; Vine, 1885, pp. 116, 156.
? Non *Cribrilina* (*Semiescharipora*) *brevis*, d'Orb.; Vine, 1893, pp. 323, 336; zones of *Marsupites* and *M. coranguinum*; Highfield, Salisbury.
Cribrilina (*Cribrilina*) *brevis* d'Orb.; Canu, 1900 [2], p. 449; Senonien; ? = *C. crepidula* (Marss.).
? Non *Cribrilina brevis*, d'Orb.; Jukes-Browne, 1904, p. 490; zone of *M. coranguinum*; Salisbury.
Tricephalopora brevis (d'Orbigny); Lang, 1916, pp. 86, 87; Senonian; Sainte Colombe, France.

Diagnosis.—[*Tricephalopora*] in which there is a pair of blunt apertural aviculœcia, well raised on the apertural ring, and no median fenestra in the proximal apertural shield; the intraterminal front-wall is not reduced; the aperture is more-or-less circular; the orthœcia are not twice as long as wide; the median area of costal fusion is wide, and there is little or no interœcial secondary tissue.

Description.—Asty incrusting, unilaminar; intraterminal front-wall consisting of about seventeen costæ.

Distribution.—Senonian. Sainte Colombe, Charente, France.

Type-specimen.—That figured by d'Orbigny, 1852, pl. 718, fig. 22, is hereby selected.

Remarks.—Canu, who has examined d'Orbigny's types, considers that this species may be identical with [*T.*] *crepidula*.

But the latter species has the orthœcia far more widely spaced than [*T.*] *brevis*, and, probably, the interœcial valleys are filled with secondary tissue, which is scanty or absent in [*T.*] *brevis*. On the other hand, it is quite possible that [*T.*] *brevis* gave rise to [*T.*] *crepidula*, and arose in its turn from *T. longuessensis*. *T. longuessensis*, however, has far fewer costæ; and, in the evolution of *Tricephalopora* generally, the sequence is from more to fewer costæ.

SPECIMENS.—None in the Collection.

11. [Tricephalopora] crepidula (von Hagenow).

Cellepora crepidula nob.; von Hagenow, 1839, p. 275, pl. iv, fig, 10, *a*, *b*, *c*; Kreide; Rügen.

Cellepora crepidula n.; von Hagenow, 1840, p. 639; Kreide; Rügen.

Escharina (*Cellepora*) *crepidula* v. Hag.; Römer, 1840, p. 14; Obere Kreide; Rügen.

Cellepora crepidula v. Hg.; Boll, 1846, p. 207; oberer weisse Kreide; Rügen.

Cellepora crepidula v. Hag.; Geinitz, 1846, p. 612; oberer Kreide; Rügen and ("ahnliche Formen mit 9–10 Kerben") Maastricht.

Cellepora crepidula Hag.; Bronn, 1848, p. 254.

Escharina crepidula Roe.; Bronn, 1848, p. 472.

Escharina crepidula Roe.; Bronn, 1849, p. 131; Kreide.

Cellepora crepidula v. H.; Geinitz, 1849–50, pp. 248–9; Kreide; Rügen.

Cellepora crepidula v. H.; Hagenow in Geinitz, 1849–50, pp. 248–9; Kreide; Carlshamn and Balsberg.

Escharina crepidula V. Hag.; d'Orbigny, 1850, p. 262; Sénonien; Bohême and Rügen.

Cellepora crepidula Hag.; Schlüter, 1870, p. 940; Trümmerkalke with *Belemnitella subventricosa*; Balsberg, Carlshamn and Rügen.

Cellepora crepidula (Hag.); de Morgan, 1882, p. 39; Balsberg (fide Schlüter).

Cribrilina crepidula v. Hagenow sp.; Marsson, 1887, pp. 97, 109, pl. x, fig. 9; weisse Schreibkreide; Rügen.

Cellepora crepidula Hag.; Lundgren, 1888, p. 10; beds with *Actinocamax mammillatus*; Kristianstad district.

Cellepora crepidula v. Hag.; Hennig, 1892, p. 3; Cretaceous; Balsberg.

Cribillina crepidula Hag.; Deecke, 1895, p. 80; Senon; Rügen.

Cribrilina crepidula (Hag. Marss.); Canu, 1900 [2], pp. 445, 449; (peut-être *Semiescharipora brevis* d'Orbigny).

Cribrilina crepidula Hag.; Deecke, 1902, p. 113; Kreide with *Belemnitella mucronata*; Grimme bei Löcknitz.

Membraniporella crepidula Hag.; Levinsen, 1909, p. 83.

Tricephalopora crepidula (von Hagenow); Lang, 1916, pp. 87, 88; *B. mucronata*-zone; Rügen.

DIAGNOSIS.—[*Tricephalopora*] in which there is a pair of blunt apertural aviculœcia, well raised on the apertural ring, and no median fenestra in the proximal apertural shield; the intraterminal front-wall is not reduced; the aperture is more-or-less circular; the orthœcia are not twice as long as wide; the median area of costal fusion is wide, and there is much interœcial secondary tissue (or the orthœcia are very widely spaced); and the aviculœcia are monomorphic.

DESCRIPTION.—Asty incrusting or sometimes erect, unilaminar. Orthœcia about ·68 mm. long and about ·46 mm. wide; intraterminal front-wall consisting of about sixteen costæ.

DISTRIBUTION.—Senonian, Campanian, zone of *B. mucronata*. Rügen. Possibly also S. Sweden (high in *A. quadratus*-zone), but probably not Maastricht or Bohemia.

TYPE-SPECIMEN.—That figured by von Hagenow, 1839, pl. iv, fig. 10 *c*, is hereby selected.

REMARKS.—See under [*Tricephalopora*] *brevis*.

SPECIMENS.—None in the Collection.

12. [Tricephalopora] bedhamptonensis (Brydone).

Membraniporella Bedhamptonensis, sp. nov.; Brydone, 1918, pp. 2, 4, pl. i, figs. 3–5; zone of *B. mucronata*, Hants and I. of Wight.

DIAGNOSIS.—[*Tricephalopora*] with an apertural pair of blunt distally-directed aviculœcia well raised on the circular secondary apertural rim, but not meeting to form a median fenestra; intraterminal front-wall not greatly reduced, though the extraterminal front-wall is larger than is usual in *Tricephalopora*; orthœcia not twice as long as broad; the median area of fusion of the intraterminal front-wall is wide; sporadic aviculœcia markedly dimorphic, the larger approximating in size to the orthœcia.

DISTRIBUTION.—Senonian, Campanian, zone of *B. mucronata*; Bedhampton, Hants, and I. of Wight.

TYPE-SPECIMEN.—That figured by Brydone, 1918, pl. i, figs. 3, 4, is hereby selected.

REMARKS.—The dimorphic aviculœcia combined with the differentiation of an apertural pair distinguish [*Tricephalopora*] *bedhamptonensis* from other species of *Tricephalopora*, and render probable its independent derivation from a form resembling *T. ansata*.

SPECIMENS.—None in the Collection.

13. Tricephalopora pustulosa (Brydone).

Membraniporella pustulosa, nov.; Brydone, 1910, p. 483, pl. xxxvi, fig. 9; zone of *M. coranguinum* [the figured specimen comes from Gravesend]; Gravesend.

? Non *Membraniporella pustulosa*, nov.; Brydone, 1910, p. 483; zones above that of *M. coranguinum* up to and including that of *B. mucronata*.

Membraniporella pustulosa, Bryd.; Brydone, 1916, p. 100.

Tricephalopora pustulosa (Brydone); Lang, 1916, pp. 87, 88; *M. coranguinum*-zone; Gravesend.

DIAGNOSIS.—*Tricephalopora* with a pair of comparatively small, rather blunt, proximally-directed apertural aviculœcia, and no median fenestra in the proximal apertural shield; the intraterminal front-wall is not reduced, nor much obscured by secondary tissue, and the aperture is subcircular.

DESCRIPTION.—Asty incrusting, unilaminar; œcia dimorphic. Orthœcia about ·75 mm. long and about ·35 mm. wide, elliptical; extraterminal front-wall hidden beneath interœcial secondary tissue, which is abundant and contains narrow median lacunæ; intraterminal front-wall consisting of about fourteen rather widely-spaced costæ without lateral fusions and firmly united in a wide band of fusion; proximal shield of secondary aperture presumably formed as in *T. saltdeanensis*; secondary apertural ring complete; secondary aperture sub-circular. An occasional sporadic aviculœcium placed in the interœcial secondary tissue, and an apertural pair to each aperture, placed laterally and directed obliquely, proximally, and towards the middle line of the orthœcium that it encompasses; the aviculœcia are small—their total length being hardly as great as the diameter of an orthœcial aperture,—and in this respect *T. pustulosa* differs from the following species, *T. saltdeanensis*.

DISTRIBUTION.—Senonian, Santonian, zone of *M. coranguinum*. Gravesend, Kent.

TYPE-SPECIMEN.—That figured by Brydone, 1910, pl. xxxvi, fig. 9, is hereby selected.

REMARKS.—To judge from Brydone's figure and description, *Tricephalopora pustulosa* so nearly resembles *T. saltdeanensis* that, although the pelmatidia are neither mentioned as present nor apparent in the figure, it may be considered as certain that the species is a *Tricephalopora*. Moreover, it is possible that Brydone originally included *T. saltdeanensis* in his species *T. pustulosa*, for he says that the latter ranges from the *M. coranguinum*-zone to that of *B. mucronata* (though later he described *T. saltdeanensis* as *Cribrilina transita*). Now his figured specimen, here selected as the type-specimen, came from Gravesend, and, therefore, from the *M. coranguinum*-zone. Therefore *T. pustulosa* has the characters of this specimen, which differs from *T. saltdeanensis* in having smaller aviculœcia. *T. saltdeanensis*, then, which occurs in the *E. depressa*-subzone of the *A. quadratus*-zone, is a further development of *T. pustulosa*. A further point of interest is Brydone's statement that his species *T. pustulosa* ranges into the *B. mucronata*-zone. Only three Cribrimorph forms have been found common to the zones of *A. quadratus* and *B. mucronata* (see Vol. III, pp. xci–ii); it is, therefore, exceedingly probable that the form of *T. pustulosa* recorded by Brydone from the *B. mucronata*-zone is a third species, perhaps [*T.*] *coronata* (von Hagenow).

The lineage of *T. pustulosa* and *T. saltdeanensis* probably is an independent off-shoot of *Tricephalopora* from a form near *T. ansata*, as suggested in the phylogenetic diagram of the species of *Tricephalopora* (p. 54).

SPECIMENS.—None in the Collection.

14. Tricephalopora saltdeanensis, Lang.

Tricephalopora saltdeanensis, sp. n.; Lang, 1916, pp. 87, 88; *A. quadratus*-zone, *E. depressa* sub-zone; E. of Brighton, Sussex.

? *Membraniporella pustulosa*, nov.; Brydone, 1910, p. 483; zone of *A. quadratus*.

? Non *Membraniporella pustulosa*, nov.; Brydone, 1910, p. 483; zone of *B. mucronata*.

Non *Membraniporella pustulosa*, nov.; Brydone, 1910, p. 483, pl. xxxvi, fig. 9; zone of *M. coranguinum*; Gravesend.

Cribrilina transita, sp. nov.; Brydone, 1917, p. 492, pl. xxxii, fig. 1; *Marsupites*-zone, *Uintacrinus* band; Hants and Sussex.

Cribrilina transiens; Brydone, 1917, p. 496.

Diagnosis.—*Tricephalopora* with a pair of comparatively large, pointed, and proximally-directed apertural aviculœcia, and no median fenestra in the proximal apertural shield; the intraterminal front-wall is not reduced; the aperture is sub-circular.

Description.—Asty incrusting, unilaminar; œcia dimorphic. Orthœcia about ·8 mm. long and about ·35 mm. wide, elliptical, blunter distally; extraterminal front-wall entirely hidden beneath interœcial secondary tissue, which is abundant and contains many long median lacunæ; intraterminal front-wall rather flat, consisting of about fifteen thin, somewhat widely spaced costæ, with no lateral fusions, each bearing a single pelmatidium distally, and firmly united medianly in a wide band of fusion, across which the outlines of the individual costæ can be more-or-less clearly traced; on the median band of fusion there are irregularities often taking the form of granular projections, which possibly may represent the up-turned ends of individual costæ, though they do not appear to be hollow; the primary costal ends are represented by the pelmatidia, and should these granular projections prove to be of a similar nature they would be secondary pelmatidia, which are generally absent from the Tricephaloporinæ; apertural bar with a wide median projection, which fuses with the proximal pair of apertural spines and forms the proximal shield of a secondary aperture; the apertural ring of the secondary aperture is complete, and formed distally by a ring of secondary tissue, and laterally by the distal ends of the two apertural aviculœcia; secondary aperture sub-circular. An occasional sporadic aviculœcium, proximally directed, is placed in the interœcial secondary tissue, and there is an apertural pair to each orthœcial aperture, placed laterally and directed obliquely, proximally, and towards the middle line of the orthœcium to which it pertains; aviculœcia large (their total length equals or exceeds the diameter of the secondary aperture, including the apertural rim), sub-triangular, acutely pointed, with the aperture divided by a transverse bar into a larger sub-triangular rostrum and a smaller proximal portion.

Distribution.—Senonian, Campanian, zone of *Marsupites*, *Uintacrinus* band, and zone of *A. quadratus*, subzone of *E. scutata* var. *depressa*; Hants and Sussex.

TYPE-SPECIMEN.—**28915.** Cliffs between the last groyne east of Rottingdean Gap, and Saltdean, Sussex. Collected by C. T. A. Gaster, Esq., and presented by him, 1916.

REMARKS.—*Tricephalopora saltdeanensis* may have been derived from *T. pustulosa* by an increase in size of the aviculœcia. Its relations with this species have been discussed under the remarks on *T. pustulosa*.

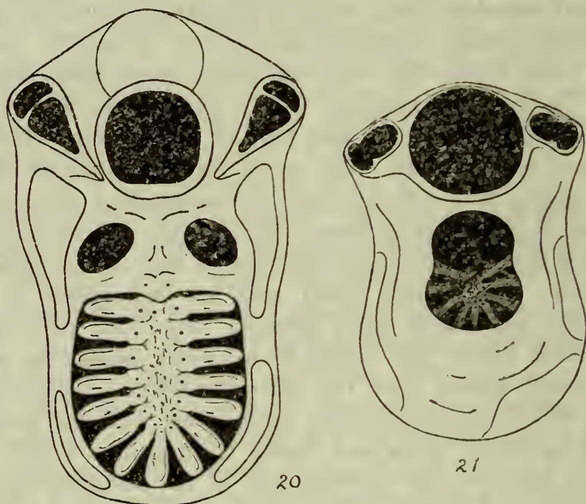


Fig. 20.—*Tricephalopora saltdeanensis.* Diagram of an orthœcium with ovicell and two aviculœcia, from above, × about 75 diameters.
Fig. 21.—*Tricephalopora prolifera.* Diagram of an orthœcium and two aviculœcia, from above. × about 75 diameters.

FIGURES.—Text-fig. 20. Orthœcium and two aviculœcia.

Plate I, fig. 7. Part of the type-specimen, showing three complete orthœcia with ovicells, parts of several others, and a pair of aviculœcia at each orthœcial aperture. × about 27 diameters.

SPECIMENS.—The type-specimen. Distribution and collection as above.

15. [Tricephalopora] coronata (von Hagenow).

Eschara coronata, Hag.; von Hagenow, 1851, pp. 64, 108, pl. vii, figs. 7, 8; Maastrichter Kreidebildung; Maastricht.

Cellepora coronata v. Hag.; von Hagenow in Geinitz, 1846, p. 613; Rügen.

Eschara coronata; d'Orbigny, 1854, p. 435.

Non=*Eschara filograna* nobis; Goldfuss, 1826, p. 25, pl. viii, fig. 17; as considered by d'Orbigny, 1853, p. 435.

Eschara coronata, Hag.; Binkhorst van den Binkhorst, 1859, p. 87; Craie chloritée, Craie tuffeau; Ciply.

Escharifora coronata (Hag.); Ubaghs, 1879, p. 218; Maastrichtien supérieur; Limbourg.

Escharifora coronata (Hag.); Mourlon, 1881, pp. 95, 116; Ciply and Limbourg.

Eschara coronata, H.; Vine, 1885, p. 163; Maestricht Beds.

Beisselina coronata Hagenow, 1851; Canu, 1920, p. 197, pl. v, figs. 14–16; Maastrichtien; Saint-Gaudens.

Diagnosis.—[*Tricephalopora*] with a pair of aviculœcia placed towards the distal end of the aperture, short, slightly pointed, and proximally directed; no median fenestra in the apertural shield; intraterminal front-wall not much reduced, but considerably obscured by secondary tissue; apertures more-or-less circular.

Distribution.—Senonian, Maastrichtian. Maastricht, Limburg, Holland; Ciply, S. of Mons, Belgium; North of Sainte-Gaudens, Haute-Garonne, France.

Type-specimen.—That figured by von Hagenow, 1851, pl. vii, fig. 7 *c*, is hereby selected.

Remarks.—It is only on the evidence afforded by Canu's figures (1920, pl. v, figs. 14–16) that *Eschara coronata*, von Hagenow, is included in *Tricephalopora*. Even there, the structure of the intraterminal front-wall is not shown; but the invading secondary tissue and the distribution of the apertural aviculœcia render its place in *Tricephalopora* very probable. The proximally-directed and distally-placed aviculœcia seem to ally [*T.*] *coronata* with *T. pustulosa* and *T. saltdeanensis*.

Specimens.—None in the Collection.

16. [Tricephalopora] pinguis (von Hagenow).

Cellepora (*Escharoïdes*) *pinguis*, Hag.; von Hagenow, 1851, pp. 88, 107, pl. x, fig. 15; Maastrichter Kreidebildung; Maastricht.

Multescharipora pinguis (de Hagenow); d'Orbigny, 1853, p. 496; Maëstrich. [Genotype of *Multescharipora*.]

Multescharipora pinguis (Hagenow); Pictet, 1857, p. 112; Craie blanche.

Multescharipora pinguis, d'Orb. (*Cellepora pinguis*, Hag.); Ubaghs, 1879, p. 217; Maastrichtien; Limbourg.

Multescharipora pinguis, d'Orb. (*Cellepora pinguis*, Hag.); Mourlon, 1881, p. 116; Maastrichtien; Limbourg.
Cellepora (*Escharoides*) *pinguis*, H.; Vine, 1885, p. 164; Maestricht Beds.
Lagodiopsis (*Cellepora*) *pinguis* v. Hagenow; Marsson, 1887, p. 99.
Cellepora pinguis, Hag.; Brydone, 1906, p. 297.
Tricephalopora pinguis (von Hagenow); Lang, 1916, pp. 87, 88; Maastrichter-Kalk; Maastricht.
Cellepora pinguis von Hagenow; Lang, 1917, p. 171.

Diagnosis.—[*Tricephalopora*] with a pair of apertural aviculœcia that, apparently, do not fuse above the apertural bar to form a median fenestra; the extraterminal front-wall, however, is greatly developed at the expense of the intraterminal front-wall, which is reduced to a mere vestige with three or four costæ.

Distribution.—Senonian, Maastrichtien. Maastricht.

Type-specimen.—That figured by von Hagenow, 1851, pl. x, fig. 15 *b*, is hereby selected.

Remarks.—As mentioned on p. 53, [*Tricephalopora*] *pinguis* is very doubtfully included here, since the diagnostic characters of the sub-family are absent from von Hagenow's description and figure. The general resemblance is to the *T. triceps* group, but there appears to be no median fenestra in the proximal shield. [*T.*] *pinguis* is a genosyntype of *Multescharipora*, of which genus *M. insignis* is the genolectotype (see Vol. III, p. lxii). [*T.*] *pinguis* is also mentioned by Marsson as a second species of his genus *Lagodiopsis*, here considered as congeneric with *Murinopsia*, but the genotype of *Lagodiopsis* is clearly *Multescharipora francqana*, d'Orbigny.

Specimens.—None in the Collection.

17. [Tricephalopora] prolifera (Gabb & Horn).

Reptescharellina prolifera, n. s.; Gabb & Horn, 1862, p. 146, pl. xx, fig. 28; Cretaceous; near Mullica Hill, New Jersey.
Escharellina prolifera, Gabb & Horn; Meek, 1864, p. 3; Cretaceous; N.J.
Reptocelleporaria [*Reptescharellina*] *prolifera* (Gabb & H.); Vine, 1885, p. 168; Cretaceous; Mallica Hill.
Reptescharellina prolifera Gabb & Horn; Vine, 1891, p. 381; Cretaceous; N. America; non = *Cellepora marginopora* Reuss, a Tertiary form, as there stated.

Reptescharenilla [sic] *prolifera* n. sp., Gabb & Horn; Nickles & Bassler, 1900, p. 156; Cretaceous; Mullica Hill, New Jersey.

Reptescharellina prolifera G. & H.; Johnson, 1905, p. 5; Cretaceous.

Reptescharellina prolifera Gabb & Horn; Weller, 1907, pp. 167, 346, pl. xxv, fig. 2 [a copy of Gabb & Horn, 1862, pl. xx, fig. 28]; Vincentown Limesand; near Mullica Hill, New Jersey, and N. bank of Rancocas Creek, N.W. of Vincentown, New Jersey.

Hoplocheilina prolifera (Gabb & Horn); Canu, 1911, pp. 261, 283; Danien; New Jersey.

Tricephalopora prolifera (Gabb & Horn); Lang, 1916, pp. 87, 89; Danian; New Jersey.

Diagnosis.—[*Tricephalopora*] with a pair of blunt apertural aviculœcia, which fuse over the apertural bar and form a median fenestra; this fenestra migrates proximally, so as ultimately to lie over the distal end of the intraterminal front-wall.

Description.—Asty incrusting, unilaminar; œcia dimorphic. Orthœcia about ·6 mm. long and about ·45 mm. wide, oval; extraterminal front-wall well developed laterally and proximally, tumid, with a rough and punctate surface, and bearing a few ridges or flanges of interœcial secondary tissue; this secondary tissue does not fill the interœcial valleys, but forms an incrustation over the proximal and lateral parts of the extraterminal front-wall; intraterminal front-wall almost entirely covered by an incrustation of secondary tissue possibly formed (to judge from comparison with *Tricephalopora cerberus*) by the proximally extended proximal shield of the secondary aperture; well arched and composed of thin, rather widely-spaced costæ which have no lateral fusions, bearing a single pelmatidium towards the distal end, and firmly united medianly in a narrow band of fusion, in which, however, the outlines of the composing costæ can be more-or-less clearly traced; apertural bar (to judge from comparison with other species of *Tricephalopora*) phylogenetically a wide median process that fuses with the proximal pair of apertural spines to form the base of the proximal shield; this is either then displaced proximally over the top of the intraterminal front-wall, and thus loses all trace of its origin and of the lateral fenestræ by its general mergence in a tertiary front-wall formed by the proximal extension of the proximal shield of the secondary aperture; or the median fenestra, of which the base of the proximal shield forms the lower boundary, coalesces with a proximal fenestra formed by the encroachment of secondary tissue over the intraterminal front-wall; the middle part of the proximal shield is occupied by a large fenestra, through which the intraterminal front-wall can be seen; the upper part of the proximal shield of the secondary aperture is formed by two processes of tissue extending towards one another from the neighbourhood of each apertural aviculœcium and fusing in the middle line, thus completing the large median fenestra; the apertural ring is complete, being formed laterally by the distal ends of the apertural aviculœcia, and distally by a rim of secondary tissue. Aviculœcia, a pair placed one on each side of the aperture, raised high on the apertural ring and directed obliquely, distally, or sometimes slightly proximally towards the mid-line of the orthœcium to which it is attached, also slightly upwards; rather large, rather blunt, and divided into a larger rostrum and a smaller proximal portion.

Distribution.—Danian. New Jersey, U.S.A.

Type-specimen.—That figured by Gabb & Horn, 1862, pl. xx, fig. 28, is hereby selected.

Remarks.—It is with great hesitation that I have placed *Reptescharellina prolifera*, Gabb & Horn, in the genus *Tricephalopora*, since no sign of the median fenestra is visible in the figure of this species. Specimen **D. 19206**, however, shows such a general resemblance to the figure, and the fenestra in some orthœcia is so inconspicuous, that it is assumed that this specimen, from the Vincentown Limesand, is of the species that Gabb & Horn figured as *Reptescharellina prolifera*. Thus interpreted, the species is allied to *Tricephalopora cerberus*, which in turn, apparently, has been derived through *T. triceps* from [*T.*] *castrum*. But [*T.*] *prolifera* has blunt aviculœcia, while in the other two species the aviculœcia are sharp. And, since the general evolution of the aviculœcia in this sub-family is from blunt to sharp, [*T.*] *prolifera* must have been derived from some form more primitive than [*T.*] *castrum*. Otherwise its aviculœcia are catagenetically blunt, but this would be, apparently, unique in the Tricephaloporinæ.

Figures.—Text-fig. 21. Orthœcium and two aviculœcia.

LIST OF SPECIMENS.

D. 19206. A small fragmentary asty incrusting *Coscinopleura digitata* (Morton). Danian, Vincentown Limesand. Near Blackwoods Town, New Jersey, U.S.A. In exchange with United States National Museum. 1899.

18. [Tricephalopora] castrum (Brydone).

Membraniporella castrum, nov.; Brydone, 1909, pp. 398, 400, pl. xxii, figs. 4, 5; Trimmingham.

Membraniporella castrum; Brydone, 1910, p. 483.

Membraniporella castrum, Bryd.; Brydone, 1916, p. 100.

Tricephalopora castrum (Brydone); Lang, 1916, pp. 87, 88; *B. mucronata*-zone; Trimingham.

Membraniporella castrum, Bryd.; Brydone, 1917, pp. 147, 494, 496, pl. xxxii, fig. 7; Trimingham.

Membraniporella castrum, Bryd.; Brydone, 1918, p. 2.

Diagnosis.—*Tricephalopora* with a pair of pointed, distally-directed apertural aviculœcia well raised on the apertural ring; a median fenestra present in the proximal apertural shield, and not shifted proximally so as to lie over the intraterminal front-wall; the intraterminal front-wall is not reduced, nor is the extraterminal front-wall expanded.

Description.—Asty incrusting, [unilaminar]; œcia dimorphic. Orthœcia about ·58 mm. long and about ·33 mm. wide, elliptical; extraterminal front-wall hidden beneath secondary tissue, which is abundant; intraterminal front-wall consisting of about 15 costæ, with no lateral fusions, and firmly united in a broad median area of fusion; secondary apertural ring complete; proximal shield with a fenestra; secondary aperture sub-circular. Aviculœcia, apertural pairs and occasional sporadic, interœcially-placed aviculœcia; they are pointed and the apertural pair is directed towards the centre of the orthœcial aperture it accompanies.

Distribution.—Senonian, Campanian, zone of *B. mucronata*. Trimingham, Norfolk.

Type-specimen.—That figured by Brydone, 1909, pl. xxii, fig. 4, is hereby selected.

Remarks.—Though the excellent figure (1917, pl. xxxii, fig. 7) and full description given by Brydone of this species enable many characters to be determined and render it almost certain that this species is a Tricephaloporine, and probably a *Tricephalopora*, yet it is not possible from the figure to observe whether or not pelmatidia are present, and, since they are not mentioned in the description, some doubt still remains as to the affinities of this form. If it is a *Trieephalopora*, *T. ansata* may well have been its ancestor.

SPECIMENS.—None in the Collection.

19. Tricephalopora triceps (Marsson).

Cribrilina triceps n. sp.; Marsson, 1887, pp. 98, 109, pl. x, fig. 12, "incrustirend"; Weisse Schreibkreide; Rügen.

Non *Cribrilina triceps* n. sp.; Marsson, 1887, p. 98, "frei"; Weisse Schreibekreide; Rügen.

Cribillina [sic] *triceps* Marss.; Deecke, 1895, p. 80; Senonian; Rügen.

Tricephalopora triceps (Marsson); Lang, 1916, pp. 87, 88; *B. mucronata*-zone; Rügen.

Cribrilina triceps Marsson; Lang, 1917, p. 171.

DIAGNOSIS.—*Tricephalopora* with a pair of comparatively small, pointed apertural aviculœcia meeting over the apertural bar and thus forming a median fenestra in the proximal apertural shield; the proximal shield is not so proximally shifted that the median fenestra lies over the intraterminal front-wall; asty incrusting; buttresses of secondary tissue on the sides of the apertural aviculœcia not more than three in number, and not strongly developed.

DESCRIPTION.—Asty incrusting, unilaminar; œcia dimorphic. Orthœcia about ·75 mm. long and about ·4 mm. wide; elongate-elliptical; extraterminal front-wall well arched and occupying a considerable area laterally and proximally; interœcial secondary tissue represented only by buttresses and ridges separated by spacious lacunæ, at the base of which the extraterminal front-wall is seen; intraterminal front-wall well arched, consisting of twelve thin, rather widely-spaced costæ, which have no lateral fusions, each bearing a single pelmatidium distally, and firmly united medianly in a band of fusion, which is more or less covered with a tongue of secondary tissue projecting from the neighbourhood of the apertural bar; apertural bar with a median process fused (to judge from allied forms) with the proximal pair of apertural spines to form the lower part of the proximal shield of a secondary aperture; the higher part of this shield is formed by the distal ends of the pair of apertural aviculœcia: thus the proximal shield has three fenestræ, namely, a lower, smaller pair, being the spaces enclosed by the apertural bar, its median process, and the proximal pair of apertural spines ; and a larger median fenestra whose lower edge is formed by the top of the median process of the apertural bar, and whose sides and top are formed by the apertural aviculœcia ; the apertural ring is complete, and the distal shield is formed of a rim of secondary tissue : secondary aperture subcircular. Aviculœcia, a pair situated proximally with regard to the secondary aperture, carried high up on the apertural ring ; each aviculœcium of the pair is directed obliquely, slightly distally, and towards its fellow, and, fusing with it on the proximal side of the rim of the secondary aperture, leaves a space beneath the fusion ; this space forms the large median foramen in the proximal shield ; aviculœcia rather large, pointed, the aperture with a transverse bar dividing it into a long pointed sub-triangular rostrum and a small semicircular proximal portion ; three buttresses of secondary tissue lie against the sides of each of the apertural aviculœcia, but they are comparatively feebly developed.

Distribution.—Senonian, Campanian, zone of *B. mucronata.* Rügen.

Type-specimen.—That figured by Marsson, 1887, pl. x, fig. 12, is hereby selected.

Remarks.—*Tricephalopora triceps* is a form from which arose several lineages. It may have been derived from [*T.*] *castrum* by an enlargement of the extraterminal front-wall and a correlative shrinking of the intraterminal front-wall. In *T. triceps* there are three buttress-like ridges of secondary tissue on the sides of each of the apertural aviculœcia, but they are not high or conspicuous. There are similar buttresses in the erect, unilaminar form, *T. tripla.* But in *T. tripartita,* which is erect and bilaminar, these buttresses are higher, and, at least those nearest to the lateral fenestra on each side of the proximal apertural shield, sometimes perforated, so as to resemble flying buttresses, and connected by a depression at these perforations to the lateral fenestræ. In *T. sherborni* the buttresses are still higher, often four in number, and more perforated than in *T. tripartita.*

In his definition of *T. triceps,* Marsson includes both incrusting and erect forms. His species is here restricted to those with an incrusting habit.

LIST OF SPECIMENS.

D. 15359. A small fragment of an asty. Senonian, Campanian, zone of *B. mucronata*; Rügen. Agnes Laur collection. 1909.

20. Tricephalopora tripla, new species.

Cribrilina triceps n. sp.; Marsson, 1887, p. 98, "frei"; Weisse Schreibekreide; Rügen.

Non *Cribrilina triceps* n. sp.; Marsson, 1887, pp. 98, 109, pl. x, fig. 12, "incrustirend"; Weisse Schreibekreide; Rügen.

Diagnosis.—*Tricephalopora* with a pair of comparatively small, pointed apertural aviculœcia meeting over the apertural bar and thus forming a median fenestra in the proximal apertural shield; the proximal shield is not so proximally shifted that the median fenestra lies over the intraterminal front-wall; asty erect, unilaminar; buttresses of secondary tissue on the sides of the apertural aviculœcia not more than three in number, and not strongly developed.

Description.—Asty erect, unilaminar; œcia dimorphic. Orthœcia about ·8 mm. long and about ·5 mm. wide, elliptical; extraterminal front-wall well arched and occupying a considerable area laterally and proximally, hardly at all obscured by interœcial secondary tissue, which, when present, is in the form of buttresses and narrow ridges separated by wide lacunæ, the bases of which are formed by the extraterminal front-wall; intraterminal front-wall well arched and consisting of about fourteen thin, rather widely-spaced costæ, which have no lateral fusions, bear distally each a single pelmatidium, and are firmly united medianly in a wide band of fusion, more-or-less hidden by a tongue of secondary tissue, which spreads proximally from the neighbourhood of the apertural bar; apertural bar with a wide median process which (judging from other species) fuses with the proximal apertural spines to form the lower part of the proximal shield of the secondary aperture; the higher part of this shield is formed by the distal ends of the apertural pair of aviculœcia, which fuse over the apertural bar, forming a large median fenestra; thus the proximal shield has three fenestræ, the larger median one just mentioned and a smaller right and left pair bounded by the apertural bar, its median process, and a secondarily thickened proximal apertural spine; the distal shield is formed by a rim of secondary tissue, and proximal and distal shields are joined by the apertural aviculœcia, thus forming a complete apertural ring to the sub-circular secondary aperture. Aviculœcia, a pair placed laterally and somewhat proximally with regard to the secondary aperture, carried high on the apertural ring, each aviculœcium of the pair directed obliquely, somewhat distally, and towards its fellow, and fusing with its fellow at their distal ends, thus forming the large median fenestra in the proximal shield of the secondary aperture; aviculœcia rather large and pointed, with apertures (to judge from allied species) divided by a transverse bar into a longer, pointed, sub-triangular rostrum, and a smaller sub-semicircular proximal portion; two or three buttresses of secondary tissue run down from the aviculœcia and enclose a large lateral lacuna on the extreme right and left of each orthœcium; this lacuna, sometimes, if not invariably, communicates with the neighbouring fenestra under the buttress of secondary tissue separating it from that fenestra—namely, the lower fenestra in the proximal shield next to it; it is also probable that, at least in ephebic œcia, the lower fenestræ are blocked by secondary tissue from communication with the aperture, though they persist as pits.

Distribution.—Senonian, Campanian, zone of *B. mucronata*. Rügen.

Type-specimen.—**D. 15086**. Agnes Laur collection.

Remarks.—*Tricephalopora tripla* differs from *T. triceps* in its erect, unilaminar habit; it appears, however, often to have only two aviculœcian buttresses, and the one nearest the middle line of the orthœcium is sometimes perforate as in *T. tripartita*.

Specimens.—Type-specimen. Distribution and collection as above.

21. **Tricephalopora tripartita**, new species.

Diagnosis.—*Tricephalopora* with a pair of comparatively small, pointed, apertural aviculœcia meeting over the apertural bar and thus forming a median fenestra in the proximal apertural shield; the proximal shield is not so proximally shifted that the median fenestra lies over the intraterminal front-wall; asty erect, bilaminar; buttresses of secondary tissue on the sides of the apertural aviculœcia not more than three in number, but well developed and, at least those nearest the middle line of the orthœcium, often perforated.

Description.—Asty erect, bilaminar; œcia dimorphic. Orthœcia about ·87 mm. long and about ·4 mm. wide, elongate-elliptical; extraterminal front-wall very well developed laterally and proximally, well arched and visible as forming the bottoms of very large lacunæ between the sparse ridges and buttresses, which are all that represent the interœcial secondary tissue; intraterminal front-wall well arched and consisting of about fifteen thin, rather widely-spaced costæ, which have no lateral fusions, bear each a single pelmatidium towards the distal end, and are united medianly in a broad area of fusion, across which the outlines of the costæ can sometimes be indistinctly traced, but which is more often covered with secondary tissue extending proximally from the neighbourhood of the apertural bar; apertural bar, as in the neighbouring species, with a broad median process which, to judge by comparison with more primitive species, e. g. *T. ansata*, fuses with the proximal pair of apertural spines to form the lower part of the proximal shield of a secondary aperture, thus enclosing a small pair of fenestræ, which, however, are probably blocked, at least in ephebœcia, by a growth of secondary tissue, from communicating with the aperture; the lateral fenestræ are, however, often continued laterally and somewhat proximally by a slot-like perforation beneath a buttress of secondary tissue running down the proximal-lateral parts of the apertural aviculœcium towards the termen; this slot communicates with a lacuna in the interœcial secondary tissue lying laterally to the apertural bar; the upper part of the proximal shield is formed by the distal ends of the pair of apertural aviculœcia, which fuse over a large median fenestra in the proximal shield of the secondary aperture; the distal shield is formed by a rim of secondary tissue, and the two shields are joined by the distal parts of the apertural aviculœcia; thus the ring is completed round the sub-circular secondary aperture. Aviculœcia, a pair lying proximally and somewhat laterally to the aperture, carried high on the apertural ring; each aviculœcium of the pair is directed obliquely, somewhat distally, and towards its fellow, and the two are fused at their distal ends so that a median foramen is formed beneath them; they are rather large, pointed, with the aperture divided by a transverse bar into a long, sub-triangular, pointed rostrum and a sub-semicircular proximal portion; three well-developed buttresses on each aviculœcium, that nearest the middle line often perforated as described above, and connected by a slot-like furrow with the lateral fenestra of that side.

Distribution.—Senonian, Campanian, zone of *B. mucronata*. Rügen.

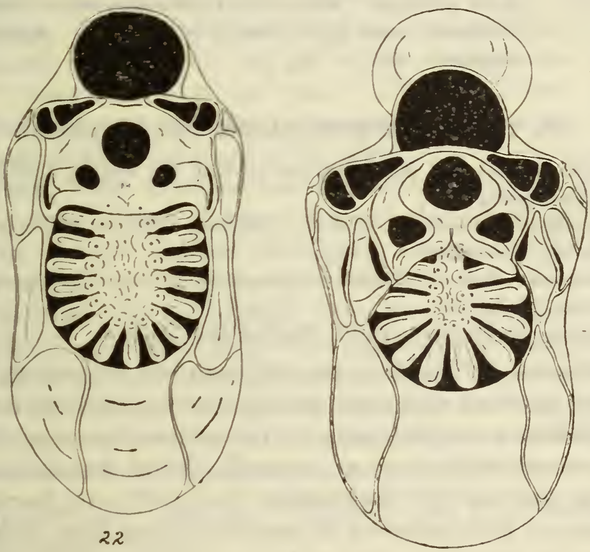

22 23

Fig. 22.—*Tricephalopora tripartita*. Diagram of an orthœcium and two aviculœcia, from above. × about 75 diameters.

Fig. 23.—*Tricephalopora sherborni*. Diagram of an orthœcium with an ovicell, and two aviculœcia, from above. × about 75 diameters.

Type-specimen.—D. 15062.

Remarks.—*Tricephalopora tripartita*, besides being erect and bilaminar, differs from *T. triplex* and *T. tripla* in the aviculœcian buttresses, which are higher, and that nearest the middle line more generally perforate, than in *T. tripla*. From *T. sherborni* it differs in the smaller size of the aviculœcia, in having three and never four aviculœcian buttresses, and in these being more seldom perforate than in *T. sherborni.*

Figures.—Text-fig. 22. Orthœcium and two aviculœcia.

Plate I, fig. 8. Part of the type-specimen, showing three orthœcia with their accompanying aviculœcia, and parts of three others. × about 27 diameters.

LIST OF SPECIMENS.

D. 15062. D. 15064. D. 15066. D. 15084. D. 15346. D. 15348. D. 15394. D. 15396. D. 16672. D. 16678–9. D. 29032. Type-specimen and eleven paratypes. More or less fragmentary astics. Senonian, Campanian, zone of *B. mucronata.* Rügen. Agnes Laur collection. 1909.

22. Tricephalopora sherborni (Brydone).

Cribrilina Sherborni, sp. nov.; Brydone, 1906, p. 296, text-fig. 7 on p. 296; Trimmingham.

Membraniporella Sherborni, mihi sp.; Brydone, 1913, pp. 437–8, pl. xiv, fig. 10; Trimingham.

Tricephalopora sherborni (Brydone); Lang, 1916, pp. 87, 88; *B. mucronata*-zone; Trimingham.

Membraniporella Sherborni, Bryd.; Brydone, 1918, pp. 3, 4.

Diagnosis.—*Tricephalopora* with a pair of comparatively large, pointed, apertural aviculœcia meeting over the apertural bar and thus forming a median fenestra in the proximal apertural shield; the proximal shield is not so proximally shifted that the median fenestra lies over the intraterminal front-wall; asty incrusting, unilaminar; high buttresses of secondary tissue, three or four in number, lie against the sides of the apertural aviculœcia and are often perforate, so as to look like flying buttresses.

Description.—Asty incrusting, unilaminar; œcia dimorphic. Orthœcia about ·82 mm. long and ·45 mm. wide, elongate-elliptical; extraterminal front-wall large and inflated laterally and proximally, covered with buttresses or ridges of interœcial secondary tissue, and forming the floors of spacious lacunæ between these; intraterminal front-wall well arched, nearly circular in outline, and consisting of about eleven thin, rather widely-spaced costæ, which have no lateral fusions, bear each a single pelmatidium towards the distal end, and are united medianly in a narrow band or broad line of fusion, on which the outlines of the constituent costæ can be more-or-less clearly traced; apertural bar thickened laterally with secondary tissue, so that it tends to overgrow the proximal ends of the neighbouring costæ; with a broad median process which (judging from comparison with allied forms) fuses with the proximal pair of apertural spines to form the lower part of the proximal shield of the secondary aperture; thus two lateral fenestræ are formed, whose connection with the aperture, however, in ephebic stages, may be closed by secondary tissue, leaving only deep pits; the pits are often connected with the neighbouring lacunæ formed by buttresses or flanges running down the proximal sides of the apertural aviculœcia, so that the 'buttresses' are converted into 'flying buttresses,' or, as Brydone has put it, the aviculœcia are "set on legs"; neighbouring lacunæ round the proximal ends of the aviculœcia may also be thus connected; the upper part of the proximal shield is composed of the distal ends of the apertural aviculœcia, which meet and fuse over the apertural bar so as to form a large median fenestra; the secondary aperture is subcircular, with the proximal side slightly flattened or indented by the distal ends of the apertural aviculœcia; distally and laterally the apertural ring is completed by a rim of secondary tissue. Aviculœcia, a pair borne high on the lateral-proximal and proximal portions of the apertural ring; each is directed somewhat distally and towards the other, is large and pointed, and has the aperture divided by a transverse bar into a distal, elongate, sub-triangular, pointed rostrum and a proximal sub-semicircular portion.

Distribution.—Senonian, Campanian, zone of *B. mucronata.* Trimingham, Norfolk.

Type-specimen.—That figured by Brydone, 1906, text-fig. 7 on p. 296, is hereby selected.

Remarks.—*Tricephalopora sherborni* is a development of *T. triceps* with larger aviculœcia, three or four aviculœcian buttresses, instead of three only, and these high and often perforate, thus becoming flying buttresses. The perforation is not, as in *T. tripla*, entirely or almost entirely confined to the buttress nearest the median line of the orthœcium, but may affect any or all of them. It is curious that this form, so obviously in advance of the Rügen forms *T. triceps*, *T. tripla*, and *T. tripartita*, as shown by the size of the aviculœcia and by the character of their buttresses, should occur at Trimingham, where the fauna, as a whole, is a little less advanced than that of Rügen.

Figures.—Text-fig. 23. An orthœcium with ovicell and two aviculœcia.

LIST OF SPECIMENS.

D. 8002. Metatype specimen. A large fragment incrusting an echinoid. Senonian, Campanian, zone of *B. mucronata*, highest chalk exposed. Trimingham, Norfolk. Collected and presented by R. M. Brydone, Esq., F.G.S., 1907.

D. 15580. Fragments of a large asty, incrusting an echinoid. Senonian, zone of *B. mucronata*. Trimingham, Norfolk. A. C. Savin collection. 1910.

23. Tricephalopora cerberus, Lang.

Tricephalopora cerberus, sp. n.; Lang, 1916, pp. 87, 89; Danian; Faxe, Denmark.

Tricephalopora cerberus Lang; Lang, 1919 [3], p. 106, fig. 19, *d*; Danian; Faxe, Denmark.

Diagnosis.—*Tricephalopora* with a pair of pointed apertural aviculœcia, and a median fenestra situated over the intraterminal front-wall; deep interœcial valleys are present, more-or-less filled with secondary tissue, so that the tertiary front-wall is not complete.

Description.—Asty incrusting, multilaminar; œcia dimorphic. (*a*) *Ephebœcia*.—Orthœcia about ·7 mm. long and about ·4 mm. wide, elliptical; extraterminal front-wall well developed laterally and proximally, but covered peripherally with interœcial secondary tissue, which has long median lacunæ, and, towards the termen, tending to be merged with the proximal extension of the proximal shield; intraterminal front-wall visible only through the great fenestra of the proximal shield, well-arched, consisting of about twelve or fourteen thin, rather widely-spaced costæ, each of which bears a single pelmatidium towards its distal end, has no lateral fusions, and unites medianly with the rest in a broad band of fusion, on which the limits of the constituent costæ are more-or-less traceable; apertural bar carried proximally with the proximal extension of the proximal shield that over-rides the intraterminal front-wall;

the apertural bar has a wide median process, which (phylogenetically) fuses with the proximal pair of apertural spines to form the lower part of the proximal shield of the secondary aperture; there are, however, no fenestræ (as in more primitive species) to mark this fusion, though traces of them can be seen in neanastic stages; tissue in the neighbourhood of the apertural aviculœcia fuses over the apertural bar and forms a large median fenestra in the middle part of the proximal shield, which moves proximally so as finally to lie over the proximal end of the intraterminal front-wall; the proximal shield thus forms a tertiary front-wall, covering the original intraterminal front-wall (secondary front-wall), which, however, may be seen through the large median fenestra; the upper part of the proximal shield has two small lateral fenestræ, one lying on each side of the median line; their origin is not apparent, as the original lateral fenestræ, presumably, were shifted proximally with the median fenestra and at the same time became filled up; moreover, there is no sign of them in the neanastic stages; but they may correspond to the slot-like passages under the aviculœcian buttresses in *T. tripartita* and *T. sherborni*; the apertural ring is complete, being formed laterally by the distal ends of the apertural aviculœcia, and distally by a rim of secondary tissue forming a distal shield; the secondary aperture is a rather pointed oval with its long axis transverse. Aviculœcia, a pair lying laterally to the aperture, borne high on the apertural ring, each aviculœcium of the pair directed obliquely, distally, and towards the mid-line of the orthœcium to which it pertains, rather large, pointed, and with the aperture divided by a transverse bar into a distal, pointed, triangular rostrum and a proximal sub-semicircular portion.

(*b*) *Neanœcia.*—Orthœcia about ·55 mm. long and about ·27 mm. wide, elliptical; extraterminal front-wall fairly well developed laterally and proximally, and well exposed, since there is little or no interœcial secondary tissue; intraterminal front-wall well arched, consisting of twelve or thirteen thin, rather widely-spaced costæ, which have no lateral fusions, bear each a single pelmatidium towards the distal end, and are firmly united medianly in a broad band of fusion, across which, however, the outlines of the component costæ can generally be traced; apertural bar (to judge from more primitive allied species) with a broad median process that fuses with the proximal pair of apertural spines to form the lowest part of the proximal shield of the secondary aperture; indications of this origin, however, have vanished, since the fenestræ so formed have been filled in with secondary tissue; traces, however, of these fenestræ are sometimes visible as slight pits; but the whole of this part of the proximal shield is slightly shifted proximally, though not so much as to over-ride more than, at most, the first pair of costæ of the intraterminal front-wall; there is a large median fenestra formed by tissue in the neighbourhood of the pair of lateral apertural aviculœcia over-arching the apertural bar and fusing over that structure; the upper part of the proximal shield is the apertural rim formed by this fusion; the apertural ring is completed laterally by the distal ends of the apertural aviculœcia and distally by a rim of secondary tissue; secondary aperture a rather pointed oval, with its long axis transverse. Aviculœcia as in the ephebœcia, but comparatively smaller and more proximally placed.

Distribution.—Danian. Faxe, Sjælland, Denmark.

Type-specimen.—D. 28205.

Remarks.—It is the neanastic stages of *Tricephalopora cerberus* that give the clue to the nature of its median foramen and, presumably, of that of *T. prolifera*, *T. obducta* and its derivatives, and of the genus *Haplocephalopora*. In the neanastic stages of *T. cerberus* we see the foramen in the same position and, presumably, formed as in *T. triceps* and its allies, then gradually shifting proximally, and, finally, in the ephebastic stages, situated over the intraterminal front-wall. The lateral fenestræ in the ephebastic proximal shield are not apparent in the neanastic stages, and their origin is, therefore, doubtful. Can they present a case of arrested development, and be the original fenestræ of the proximal shield, whose appearance has been delayed until after the proximal shifting of the median fenestra has come about?

Figures.—Text-fig. 24. An ephebœcium and two aviculœcia. Text-fig. 25. A neanœcium and two aviculœcia.

Plate I, fig. 9. Part of the type-specimen, showing four complete orthœcia with their apertural aviculœcia and portions of two others. × about 27 diameters.

LIST OF SPECIMENS.

D. 28205. D. 28199–D. 28204. D. 28206–8. Type-specimen and nine paratypes. Fragmentary asties. Danian. Faxe, Sjælland, Denmark. S. J. Pindborg. 1914.

D. 19430. Paratype. A worn young asty incrusting a tooth of *Lamna appendiculata*, Agassiz. Danian. Faxe, Sjælland. J. W. Davis collection. 1895.

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Fig. 24.—*Tricephalopora cerberus.* Diagram of an ephebœcium and two aviculœcia, from above. × about 75 diameters.

Fig. 25.—*Tricephalopora cerberus.* Diagram of a neanœcium and two aviculœcia, from above. × about 75 diameters.

24. Tricephalopora obducta (Lang).

Phractopora obducta, sp. n.; Lang, 1916, p. 89; *B. mucronata*-zone; Rügen.
Membraniporella pyramidalis, sp. nov.; Brydone, 1917, pp. 147–8, pl. ix figs. 10–12; zone of *B. mucronata*; Trimingham, Norfolk.

Diagnosis.—*Tricephalopora* with a pair of pointed apertural aviculœcia and a median fenestra situated over the intraterminal front-wall; interœcial valleys filled with secondary tissue, so that there is a complete tertiary front-wall; asty incrusting, unilaminar.

Description.—Asty incrusting, unilaminar; œcia dimorphic. Orthœcia about ·75 mm. long and about ·5 mm. wide, oval; extraterminal front-wall entirely concealed by interœcial secondary tissue, which overlaps the intraterminal front-wall and fuses with the proximal extension of secondary tissue from the neighbourhood of the proximal shield of the secondary aperture to form a tertiary front-wall; this tertiary front-wall in its proximal portion is perforated by a large sub-circular foramen, through which the intraterminal front-wall (secondary front-wall) should be seen; in the type-specimen, however, this is obscure, and the nature of the intraterminal front-wall is thus conjectural; probably, however, it is formed as in the genus *Tricephalopora*, and consists of thin, rather widely-spaced costæ, with no lateral fusions, each bearing a single pelmatidium towards its distal end, and firmly united medianly in a band of fusion; secondary apertural ring complete, formed proximally and distally by rims of secondary tissue and laterally by the distal ends of apertural aviculœcia; secondary aperture sub-circular. Aviculœcia, a pair placed laterally and somewhat proximally with regard to each orthœcial aperture, borne high on the apertural ring and directed towards the centre of the aperture; large, rather abruptly pointed; aperture divided by a transverse bar into a sub-triangular rostrum and a proximal more-or-less semicircular portion.

Distribution.—Senonian, Campanian, zone of *B. mucronata.* Rügen and Trimingham.

Type-specimen.—D. 15395.

Remarks.—*Tricephalopora obducta* was probably derived from a form like *T. triceps* by the proximal migration of the median fenestra, and by the complete infilling of the interœcial valleys with secondary tissue, which fuses with the proximally shifted proximal shield to form a complete lamina peristomica, or tertiary front-wall. The nature of the median foramen distinguishes it and *T. obtecta* from the genus *Phractoporella*, with the species of which they were originally grouped. In these the fenestra or fenestræ, generally a lateral pair, in the tertiary front-wall are formed by the fusion of a proximally-extending tongue of secondary tissue with the interœcial secondary tissue. *T. obducta* is the incrusting form of *T. obtecta*.

Figures.—Text-fig. 26. Orthœcium and two aviculœcia.

Plate I, fig. 10. Part of the type-specimen showing five complete orthœcia, each with its pair of apertural aviculœcia and two other apertures with their apertural aviculœcia. × about 27 diameters.

LIST OF SPECIMENS.

D. 15395. D. 16664. Type-specimen and paratype. Senonian, Campanian, zone of *B. mucronata.* Rügen. Agnes Laur collection. 1909.

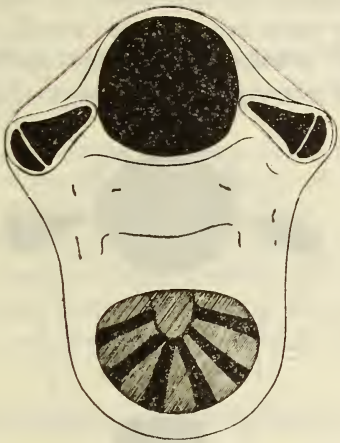


Fig. 26.—*Tricephalopora obducta.* Diagram of an orthœcium and two aviculœcia, from above. × about 75 diameters. The intraterminal front-wall, seen through the large, proximally-placed fenestra, is conjectural.

25. Tricephalopora obtecta (Lang).

Phractopora obtecta, sp. n.; Lang, 1916, p. 89; *B. mucronata*-zone; Rügen.

Diagnosis.—*Tricephalopora* with a pair of pointed apertural aviculœcia, and a median fenestra situated over the intraterminal front-wall; interœcial valleys entirely filled with secondary tissue, so that there is a complete tertiary front-wall; asty erect, unilaminar.

Description.—Asty erect, unilaminar; œcia dimorphic. Orthœcia about ·6 mm. long and about ·4 mm. wide, oval; extraterminal front-wall hidden by interœcial secondary tissue, which fuses with the proximal extension of secondary tissue in the neighbourhood of the proximal shield of the secondary aperture to form a tertiary front-wall; this in its proximal end has a small fenestra above the proximal end of the intraterminal front-wall (secondary front-wall), which, on the evidence of a broken-down lamina peristomica in the type-specimen, consists of thin costæ rather widely placed, without lateral fusions, presumably each with a pelmatidium towards its distal end, and firmly united in median band of fusion; apertural ring complete, having proximal and distal shields forming rims of secondary tissue, and completed laterally by the distal ends of the apertural aviculœcia; secondary aperture sub-circular. Aviculœcia, a pair laterally and often somewhat proximally placed,

Fig. 27.—*Tricephalopora obtecta.* Diagram of an orthœcium and two aviculœcia, from above. × about 75 diameters.

borne high on the apertural ring and directed towards the centre of the aperture; large, rather abruptly pointed, with the aperture divided by a transverse bar into a pointed triangular rostrum and a proximal more-or-less semicircular portion.

Distribution.—Senonian, Campanian, zone of *B. mucronata.* Rügen.

Type-specimen.—**D. 15019.** Agnes Laur collection. 1909.

Remarks.—*Tricephalopora obtecta* has been derived from *T. obducta,* being an erect unilaminar form; while *T. gastropora* is an erect cylindrical form, derived, presumably, from *T. obtecta.* For further remarks see under *T. obducta.*

FIGURES.—Text-fig. 27. Orthœcium and two aviculœcia.

Plate I, fig. 11. Part of the type-specimen, showing four complete orthœcia, each with its accompanying pair of aviculœcia, and portions of the proximal part, including the fenestra, of another orthœcium. × about 27 diameters.

SPECIMENS.—The type-specimen. Distribution and collection as above.

26. Tricephalopora gastropora (Marsson).

Porina gastropora n. sp.; Marsson, 1887, pp. 86, 108, pl. viii, fig. 11; Weisse Schreibkreide; Rügen.

Porina gastropora Marss.; Deecke, 1895, p. 79; Senon.; Rügen.

Phractopora gastropora (Marsson); Lang, 1916, pp. 89, 90; *B. mucronata*-zone; Rügen.

DIAGNOSIS.—*Tricephalopora* with a pair of pointed apertural aviculœcia, and a median fenestra situated over the intraterminal front-wall; interœcial valleys entirely filled with secondary tissue, so that there is a complete tertiary front-wall; asty erect, cylindrical.

DISTRIBUTION.—Senonian, Campanian, zone of *B. mucronata*. Rügen.

TYPE-SPECIMEN.—That figured by Marsson, 1887, pl. viii, fig. 11, is hereby selected.

REMARKS.—See under *Tricephalopora obtecta*.

SPECIMENS.—None in the Collection.

27. Tricephalopora scobina (Leymerie).

Adeone scobina; Leymerie, 1851, pp. 191–2, 201, pl. ix, fig. 6 *a–d*; Bois de Barade, Gensac, and its neighbourhood; Monléon; but not Gres vert supérieur, Le Mans, as recorded by Leymerie.

Beisselina scobina Leymerie, 1851; Canu, 1920, pp. 198–9, 211, pl. vi, figs. 7–11; Maastrichtian; Haute-Garonne.

DIAGNOSIS.—*Tricephalopora* with a single, more-or-less pointed apertural aviculœcium, or occasionally with two such aviculœcia, and with a tertiary front-wall, complete except for a median fenestra lying over the proximal end of the orthœcium.

Distribution.—Senonian, Maastrichtian; Bois de Barade, Gensac, and its neighbourhood; Monléon; Saint Marcet; Saint Gaudens; all in Haute-Garonne. Royan, Charente-Inférieure.

Type-specimen.—In l'Ecole des Mines, Paris; figured by Canu, 1920, pl. vi, fig. 11; see Canu, 1920, p. 211.

Remarks.—Canu's discovery of Leymerie's type-specimen, described in 1851, has made it possible to claim for the species a close relationship with *Tricephalopora obducta* and *T. obtecta*, and probably with Marsson's *Porina gastropora*. Canu's photograph of Leymerie's type (fig. 11) shows the complete tertiary front-wall with a large median fenestra at the proximal end of the orthœcium, and but one aviculœcium to each aperture. His photograph (fig. 10) of a specimen from Saint Gaudens shows some apertures with two aviculœcia—the normal number for *Tricephalopora obducta*, *T. obtecta*, and *T. gastropora*. It is possible, then, that *T. scobina* is directly derived from this group, by the suppression of one aviculœcium of the apertural pair.

Specimens.—None in the Collection.

II. HAPLOCEPHALOPORA, Lang, 1916.

Haplocephalopora, gen. nov.; Lang, 1916, pp. 86, 89.

Diagnosis.—Tricephaloporinæ in which the aviculœcia are a small apertural pair carried up on the greatly prolonged apertural ring; this is so produced that the secondary aperture is tubular; a fenestra, presumably formed as in *Tricephalopora*, is situated above the intraterminal front-wall.

Genotype.—*Haplocephalopora uniceps*, Lang.

Distribution.—Danian.

Remarks.—*Haplocephalopora* is a derivative of *Tricephalopora* and probably descended from *T. cerberus*. If the lacunæ of that species were filled with secondary tissue, the aviculœcia smaller and carried up on an immensely prolonged apertural ring, a form resembling *Haplocephalopora* would result. The general trend of the aviculœcia in the Tricephaloporinæ is to increase in size. The aviculœcia of *Haplocephalopora*, therefore, are catagenetic in this respect.

1. Haplocephalopora uniceps, Lang.

Haplocephalopora uniceps, sp. n.; Lang. 1916. p. 89; Danian; Faxe.

Diagnosis.—As for the genus.

Description.—Asty erect, cylindrical; œcia dimorphic. Orthœcia about ·9 mm. long and about ·55 mm. wide, flask-shaped, owing to the prolongation of the secondary aperture; extraterminal front-wall apparently rather extensive and inflated, but covered by rough secondary tissue, with occasional ridges or flanges, and with no lacunæ; intraterminal front-wall visible only through the fenestra in the tertiary front-wall, otherwise covered by that structure;

Fig. 28.—*Haplocephalopora uniceps*. Diagram of an orthœcium and its two apertural aviculœcia, from above. × about 75 diameters.

consisting of thin, rather wide-spaced costæ, apparently of the Tricephaloporine type—that is, with no lateral fusions and each with a pelmatidium towards its distal end; the costæ are firmly united medianly in a narrow band of fusion, and this band is more-or-less covered with secondary tissue, which rises pillar-wise at the distal end of the fenestra, and unites the median band of fusion of the (secondary) intraterminal front-wall with the tertiary front-wall;

the fenestra in the tertiary front-wall is presumably formed like that of the advanced species of *Tricephalopora*, such as *T. cerberus*, but no trace of its history is shown in the ephebic structure; the secondary apertural ring is greatly prolonged, so that the secondary aperture has a tubular nature and carries on its sides a pair of small aviculœcia; secondary aperture sub-circular, tending to be transversely wider. Aviculœcia, a pair of small, somewhat pointed apertural aviculœcia on each side of the aperture, borne high on the apertural ring, and directed obliquely, distally, and towards the mid-line of the aperture to which they pertain.

Distribution.—Danian. Faxe, Sjælland, Denmark.

Type-specimen,—**D. 28214**. S. J. Pindborg. 1914.

Remarks.—See under the genus.

Figures. Text-fig. 28.—Orthœcium and two apertural aviculœcia.

Plate II, fig. 1. Part of the type-specimen, showing four orthœcia, each with a pair of apertural aviculœcia. × about 27 diameters.

Specimens.—The type-specimens. Distribution and collection as above.

III. PHRACTOPORELLA, Lang, 1917.

[*Eschara* [partim]; von Hagenow, 1851, pp. 67, 108.]
[*Porina* [partim]; d'Orbigny, 1853, p. 435.]
[*Eschara* [partim]; Binkhorst van den Binkhorst, 1859, pp. 58, 87.]
[*Eschara* [partim]; Ubaghs, 1879, p. 218.]
[*Escharifora* [partim]; Ubaghs, 1879, p. 218.]
[*Escharifora* [partim]; Mourlon, 1881, p. 95.]
[*Eschara* [partim]; Vine, 1885, p. 163.]
[*Eschara* [partim]; Pergens, 1894, expl. to pl. xi, fig. 1 *b*.]
[*Beisselina* [partim]; *Eschara* [partim]; Canu, 1913, p. 141.]
Phractopora [partim] gen. nov.; Lang, 1916, pp. 86, 89.
Non *Phractopora*; Hall, 1883, p. 154.
Tricephalopora [partim]; Lang, 1916, pp. 87, 88.
Phractopora [partim]; Lang, 1917, p. 171.
Phractoporella, n. gen.; Lang, 1917, p. 172.
Membraniporella [partim]; Brydone, 1917, pp. 146, 148, 494, 496,

Membraniporella [partim]; Brydone, 1918, p. 2.
Phractoporella; Lang, 1919 [3], p. 105.
[*Beisselina* [partim]; *Eschara* [partim]; Canu, 1920, pp. 198, 211.]

DIAGNOSIS.—Tricephaloporinæ in which the aviculœcia consist of an apertural pair placed laterally and somewhat proximally with regard to the aperture; a tertiary front-wall is always more or less developed, and formed mainly by a tongue of secondary tissue which projects from the neighbourhood of the apertural bar, covering the median area of fusion of the (secondary) intraterminal front-wall and fusing with it.

GENOTYPE.—*Phractopora constrata*, Lang.

DISTRIBUTION.—Senonian, zone of *A. quadratus*, subzone of *E. scutata* var. *depressa*; zone of *B. mucronata*; and Maastrichtian. N.W. Europe.

REMARKS.—*Phractoporella* was probably derived from a *Tricephalopora* which had not yet acquired a fenestra in the proximal shield of the secondary aperture. It differs from *Tricephalopora* in the origin of its tertiary front-wall. This is formed mostly by a tongue of secondary tissue, which, creeping proximally from the neighbourhood of the apertural bar, covers and finally fuses with the median area of fusion of the intraterminal front-wall; but it is partly formed by the interœcial secondary tissue, which, having filled up the interœcial valleys, overflows the intraterminal front-wall and, meeting the encroaching tongue of secondary tissue just described, fuses with it, while leaving one or more fenestræ, generally a pair, one on each side of the middle line. In *P. subcastrum* and *P. trifaux* the tertiary front-wall is imperfect, and represented mainly by the proximally-creeping tongue of secondary tissue; in *P. operta* the tertiary front-wall is nearly complete, and the aviculœcia, as in *P. trifaux*, are blunt. In *P. constrata*, the tertiary front-wall is as complete as in *P. operta* and the aviculœcia are pointed. The last two species are rather smaller than *P. trifaux*. They all, except *P. subcastrum*, occur at Rügen, and generally constitute the single lineage *Phractoporella subcastrum–P. trifaux–P. operta–P. constrata*, though in the development of secondary interœcial tissue *P. subcastrum* appears to be more advanced than *P. trifaux*. [*P.*] *boryana* is probably a close ally of *P. constrata*.

Key to the Species of *Phractoporella*.

A. Aviculœcia blunt.
- I. Tertiary front-wall more imperfect and mainly represented by a median tongue of secondary tissue.
  - *a*. Orthœcia larger, about ·8 mm. long; interœcial secondary tissue with well-marked lacunæ (fig. 29) .... 1. *P. trifaux*.
  - *b*. Orthœcia smaller, about ·6 mm. long; interœcial secondary tissue apparently without lacunæ ... 2. *P. subcastrum*.
- II. Tertiary front-wall less imperfect; orthœcia smaller, about ·67 mm. long; interœcial secondary tissue with poorly developed lacunæ (fig. 30) .. 3. *P. operta*.

B. Aviculœcia pointed; orthœcia smaller, ·45–·6 mm. long; tertiary front-wall less imperfect; interœcial secondary tissue without well-marked lacunæ.
- I. Orthœcia about ·6 mm. long; unilaminar, incrusting (fig. 31) .... 4. *P. constrata*.
- II. Orthœcia about ·45–·5 mm. long, erect, cylindrical. 5. [*P.*] *boryana*.

1. **Phractoporella trifaux** (Lang).

Tricephalopora trifaux, sp. n.; Lang, 1916, pp. 87–88; *B. mucronata*-zone; Rügen.

Diagnosis.—*Phractoporella* with blunt aviculœcia; with a very imperfect tertiary front-wall; with large orthœcia (about ·8 mm. long); and with lacunæ in the interœcial secondary tissue.

Description.—Asty incrusting, unilaminar; œcia dimorphic. Orthœcia about ·8 mm. long and about ·45 mm. wide; broadly elliptical or oval; extraterminal front-wall hidden beneath interœcial secondary tissue, which has median lacunæ, but is very well developed and tends to overlap the intraterminal front-wall; intraterminal front-wall arched laterally, flat above, consisting of about fifteen rather stout costæ with no lateral fusions, each bearing a single pelmatidium at about the middle of its length, and in some cases what appears to be a secondary pelmatidium at its distal end; the costæ are firmly united medianly in a very wide area of fusion, which occupies nearly the distal half of each costa and covers the intraterminal front-wall with a flat, solid roof, across which the outlines of the constituent costæ can be traced in neanic œcia; in these, the sudden change of slope causes the costa to appear bent; in ephebic stages, secondary tissue spreads proximally from the neighbourhood of the apertural bar in a tongue-shaped process, covering the whole of the median area of fusion of the intraterminal front-wall, and thus obliterating the details of the constituent costæ; apertural bar probably with a wide median process, which fuses with the proximal pair of apertural spines to form the proximal rim of the secondary aperture; the depressions made by these structures are visible only in neanic stages; in ephebic stages they are obliterated beneath secondary tissue, which invades the whole neighbourhood of the apertural bar, and spreads proximally as a tongue-shaped mass over the middle part of the intraterminal front-wall; the distal shield is composed of a rim of secondary tissue, and the apertural ring is completed by the distal

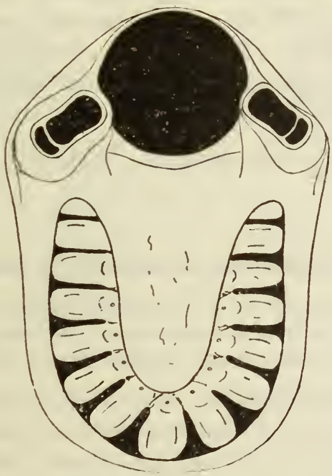


Fig. 29.—*Phractoporella trifaux.* Diagram of an orthœcium and two aviculœcia, from above. × about 75 diameters.

ends of the two apertural aviculœcia; secondary aperture subcircular. Aviculœcia, a pair raised high on the apertural ring, laterally and proximally placed, one on each side of every orthœcial aperture, rather large, with blunt, short apertures divided by a transverse bar into a larger rostrum and a smaller proximal portion; directed towards the centre of the orthœcial aperture that they accompany.

Distribution.—Senonian, Campanian, zone of *B. mucronata.* Rügen.

Type-specimen.—**D. 15417.** Agnes Laur collection. 1909.

Remarks.—*Phractoporella trifaux* and *P. subcastrum* connect the genera *Tricephalopora* and *Phractoporella*. In its neanic stages *P. trifaux* might be put under the former genus, near to, if not identical with, [*Tricephalopora*] *crepidula*. But the presence of the median tongue of secondary tissue points to the beginning of a tertiary front-wall, of the kind found in *Phractoporella operta* and *P. constrata* and unknown in *Tricephalopora*. *Phractoporella trifaux* has probably been derived from a primitive form like *P. subcastrum*, but with less interœcial secondary tissue.

Figures.—Text-fig. 29. Orthœcium with two aviculœcia.

Plate II, fig. 2. Part of the type-specimen, showing four complete orthœcia, each with its pair of apertural aviculœcia, and the apertures of two others. Three ovicells are shown, one in front of each of the three apertures in the lower left-hand part of the figure. × about 27 diameters.

Specimens.—The type-specimen. Distribution and collection as above.

2. Phractoporella subcastrum (Brydone).

Membraniporella subcastrum, sp. nov.; Brydone, 1917, pp. 494, 496, pl. xxxii, fig. 6; Senonian, subzone of *E. scutatus* var. *depressa*; Sussex.
Membraniporella subcastrum, Bryd.; Brydone, 1918, p. 2.

Diagnosis.—*Phractoporella* with blunt aviculœcia; an imperfect tertiary front-wall; of small orthœcial size (about ·6 mm. long); and with no lacunæ in the interœcial secondary tissue.

Distribution.—Senonian, Campanian, zone of *A. quadratus*, subzone of *E. scutata*, var. *depressa*. Rottingdean, E. of Brighton, Sussex.

Type-specimen.—That figured by Brydone, 1917, pl. xxxii, fig. 6, is hereby selected.

Remarks.—This species, if a *Phractoporella*, is the only known form occurring below the *B. mucronata*-zone. In keeping with this, it is more primitive than *P. trifaux*, the simplest of the other species, except in the greater development of its interœcial secondary tissue; it probably, therefore, represents a side branch from the base of the main lineage represented by *P. trifaux*, *P. operta*, and *P. constrata*.

SPECIMENS.—None in the Collection.

3. Phractoporella operta (Lang).

Phractopora operta, sp. n.; Lang, 1916, p. 89; *B. mucronata*-zone: Rügen.
Membraniporella manonia, sp. nov.; Brydone, 1917, pp. 146, 148, pl. ix. figs. 4–7; zone of *B. mucronata*; Hants and I. of Wight.

DIAGNOSIS.—*Phractoporella* with blunt aviculœcia; with a nearly perfect tertiary front-wall; and with interœcial secondary tissue that has poorly-developed lacunæ.

DESCRIPTION.—Asty incrusting, unilaminar; œcia dimorphic. Orthœcia about ·67 mm. long and ·42 mm. wide, oval-elliptical; extraterminal front-wall entirely hidden by interœcial secondary tissue, which is very strongly developed and over-arches the intraterminal front-wall, fusing with the broad tongue-like proximal extension of the secondary tissue in the neighbourhood of the proximal apertural shield; fenestræ are, however, left, through which the intraterminal front-wall may be seen; there may be a single horseshoe-shaped fenestra, or a pair of lateral slots, or a proximal semi-lunar median fenestra and a pair of lateral oval fenestræ, and modifications of these arrangements may occur; the intraterminal front-wall, visible in neanic stages, is rather low, and consists of about thirteen thin, well-spaced costæ with no lateral fusions, each bearing a single pelmatidium towards its distal end, and united medianly in a broad band of fusion, which is fused to, and covered by, the proximal extension of secondary tissue from the neighbourhood of the proximal shield of the secondary aperture; secondary apertural ring complete, formed proximally and distally by rims of secondary tissue, and laterally by the distal ends of the apertural aviculœcia; secondary aperture subcircular. Aviculœcia, a pair situated laterally and somewhat proximally with regard to each orthœcial aperture, raised high on the apertural ring, and directed towards the centre of the orthœcial aperture it accompanies; occasionally a third aviculœcium is present on the distal side of the aperture, either medianly or laterally placed, and directed towards the centre of the orthœcial aperture; rather small, blunt, with the aperture divided by a transverse bar into a large rostrum and a smaller proximal portion.

Distribution.—Senonian, Campanian, zone of *B. mucronata*. Rügen, Hants, and I. of Wight.

Type-specimen.—**D. 17997.**

Remarks.—*Phractoporella operta* in its neanic stages resembles the ephebic stages of *P. trifaux*; but the interœcial secondary tissue is always better developed. In its ephebic stages the tertiary front-wall, complete except for one or more fenestræ, distinguishes it from that species. It is distinguished from *P. constrata* by the blunt aviculœcia.

Fig. 30.—*Phractoporella operta*. Diagram of an orthœcium and its pair of apertural aviculœcia, from above. × about 75 diameters.

Fig. 31.—*Phractoporella constrata*. Diagram of an orthœcium and its pair of apertural aviculœcia, from above. × about 75 diameters.

Figures.—Text-fig. 30. Orthœcium and two aviculœcia.

Plate II, fig. 3. Part of the type-specimen, showing four complete orthœcia. × about 27 diameters.

LIST OF SPECIMENS.

D. 17997. Type-specimen. A fragmentary, incrusting asty. Senonian, Campanian, zone of *B. mucronata*. Rügen. Agnes Laur collection. 1906.

D. 15074. A fragment of an asty, apparently partially free, but probably it originally incrusted an object that has since become detached, or, perhaps, was incapable of fossilization. Same horizon, locality, and collection as the last. 1909.

4. Phractoporella constrata (Lang).

Phractopora constrata, sp. n.; Lang, 1916, p. 89; *B. mucronata*-zone; Rügen.
Phractopora constrata Lang, 1917, p. 171.
Phractoporella constrata (Lang); Lang, 1917, p. 172.
Membraniporella transligata, sp. nov.; Brydone, 1917, pp. 146, 148, pl. ix, figs. 8, 9; zone of *B. mucronata*; Norfolk.

Diagnosis.—*Phractoporella* with pointed aviculœcia; with a nearly perfect tertiary front-wall; and with interœcial secondary tissue that has no well-marked lacunæ.

Description.—Asty incrusting, unilaminar (or perhaps sometimes multilaminar); œcia dimorphic. Orthœcia about ·6 mm. long and ·37 mm. wide, oval; extraterminal front-wall entirely hidden beneath interœcial secondary tissue, which overlaps the intraterminal front-wall and fuses with the secondary tissue covering the median band of fusion of the intraterminal front-wall, thus forming a tertiary front-wall, or lamina peristomica, but leaving fenestræ through which the intraterminal front-wall is more-or-less visible; these fenestræ are generally a slot-like or oval pair, one on each side of the middle line, but they vary somewhat in shape and number, and often there is but a single horseshoe-shaped fenestra; intraterminal front-wall, as may be seen in neanic stages, rather flat, and consisting of ten or twelve thin, rather widely-spaced costæ which have no lateral fusions, bear each a single pelmatidium towards its distal end, and are firmly united medianly in a narrow band; proximal shield of secondary aperture produced proximally as a rather narrow tongue of tissue, which is joined beneath with the median band of fusion of the intraterminal front-wall, and fuses with the extensions of the interœcial secondary tissue, except at certain points, where the fenestræ, already described, are formed; a pair of pits, one on each side of the median line, are more-or-less visible on the proximal shield (see fig. 31); the secondary apertural ring is completed distally by a rim of secondary tissue forming a distal shield, and laterally by the distal ends of the apertural aviculœcia; secondary aperture a somewhat pointed oval with its long axis transverse and its proximal side somewhat flatter than its distal side; its outline is often impinged upon by the distal ends of the apertural aviculœcia. Aviculœcia, a pair placed laterally and somewhat proximally with regard to each orthœcial aperture, raised high on the apertural ring, and each directed towards the middle line of the orthœcial aperture it accompanies; large, pointed, with the aperture divided by a transverse bar into a pointed, subtriangular rostrum and a proximal more-or-less semicircular portion.

Distribution.—Senonian, Campanian, zone of *B. mucronata*. Rügen and Norfolk.

Type-specimen.—D. 15322.

Remarks.—*Phractoporella constrata* is possibly descended from *P. operta*, but is smaller and has the aviculœcia rather sharply pointed instead of blunt.

Figures.—Text-fig. 31. Orthœcium and two aviculœcia.

Plate II, fig. 4. Part of the type-specimen, showing five complete orthœcia, each with its pair of apertural aviculœcia. × about 27 diameters.

LIST OF SPECIMENS.

D. 15332. D. 14233. D. 14247. D. 15433. D. 17998. D. 18119. Type-specimen and five paratypes. Fragmentary asties—the last possibly is multilaminar. Senonian, Campanian, zone of *B. mucronata*. Rügen. Agnes Laur collection. 1906, 1909.

5. [Phractoporella] boryana (von Hagenow).

Eschara Boryana, Hag.; von Hagenow, 1851, pp. 67, 108, pl. viii, fig. 3, *a–d*; Maastrichter Kreidebildung; Maastricht.

Porina Boryana (de Hagenow); d'Orbigny, 1853, p. 435.

Non=*Eschara filograna* nobis; Goldfuss, 1826, p. 25, pl. viii, fig. 17, as stated by d'Orbigny, 1853, p. 435.

Eschara Boryana, v. Hag.; Binkhorst van den Binkhorst, 1859, p. 58, Marne de Kunraad; p. 87, Craie tuffeau, craie chloritée, Ciply.

Escharifora Boryana, Bosq., 1858 (*Eschara Boryana*, Hag. 1851); Ubaghs, 1879, p. 218; Maastrichtien; Limbourg.

Escharifora (*Eschara*) *Boryana*, Hag.; Mourlon, 1881, p. 95; tuffeau maestrichtien; Ciply.

Eschara Boryana, H.; Vine, 1885, p. 163; Maestricht Beds.

Eschara Boryana, Hag.; Pergens, 1894, pl. xi, fig. 1 *b*; no reference in the text, but a note in the explanation of the plate, saying it had been figured by accident.

Beisselina [*Eschara*] *Boryana* (von Hagenow); Canu, 1913, p. 141, text-fig. 6, on p. 141; Maëstrichtien de Maëstricht.

Beisselina [*Eschara*] *Boryana* (Hagenow); Canu, 1920, pp. 198, 211, pl. vi, figs. 1–6; Maestrichtien; Latoue, St. Gaudens (métairie de Terme), Gensac, Saint-Marcet; all in the neighbourhood of St. Gaudens, Haute-Garonne, France.

Diagnosis.—[*Phractoporella*] with pointed aviculœcia; with a complete tertiary front-wall; with well-marked median lacunæ in the interœcial secondary tissue; with orthœcia from ·45–·5 mm. long; and with an erect, cylindrical asty.

Distribution.—Senonian, Maastrichtian. Maastricht and Kunraad in the Maastricht district, Limbourg, Holland; Ciply, Belgium; and St. Gaudens, St. Marcet, Gensac, and Latoue, in the St. Gaudens district, Haute-Garonne, France.

Type-specimen.—That figured by von Hagenow, 1851, pl. viii, fig. 3 *c*, is hereby selected.

Remarks.—In placing *Eschara boryana*, von Hagenow, provisionally in the genus *Phractoporella*, I am following Canu's interpretation of this species as figured by him in the photographs on pl. vi of his paper in the Bull. Soc. Géol. France for 1920. Of these, fig. 6 is the most clear, and shows the sharp aviculœcia, generally in pairs, at the secondary apertures, proximal to which are paired foramina in the tertiary front-wall.

IV. POLYCEPHALOPORA, Lang, 1916.

[*Escharina* [partim]; Römer, 1840, p. 14.]
[*Cellepora* [partim]; Geinitz, 1846, p. 613.]
[*Cellepora* [partim]; Bronn, 1848, pp. 254, 471.]
[*Escharina* [partim]; Bronn, 1848, pp. 254, 471.]
[*Escharina* [partim]; Bronn, 1849, p. 131.]
[*Cellepora* [partim]; Geinitz, 1849–1850, pp. 248–9.]
[*Escharina* [partim]; d'Orbigny, 1850, p. 262.]
[*Cellepora* (*Escharina*) [partim]; von Hagenow, 1851, p. 89.]
[*Escharipora* [partim]; d'Orbigny, 1852, pp. 224, 233, 1854, p. 1097.]
[*Multescharipora* [partim]; d'Orbigny, 1853, p. 496, 1854, p. 1098.]

[*Reptescharipora* [partim] ; d'Orbigny, 1853, p. 490.]
[*Semiescharipora* [partim] ; d'Orbigny, 1853, p. 484, 1854, p. 1098.]
[*Multescharipora* [partim] ; Pictet, 1857, p. 112.]
[*Reptescharipora* [partim] ; Pictet, 1857, p. 112.]
[*Lepralia* [partim] ; Ubaghs, 1879, p. 221.]
[*Lepralia* [partim] ; Mourlon, 1881, p. 119.]
[*Cellepora* (*Escharina*) [partim] ; Vine, 1885, p. 164.]
[*Cribrilina* [partim] ; Marsson, 1887, pp. 98, 109.]
[*Escharipora* ; Pergens, 1893, pp. 202, 216.]
[*Cellepora* (*Escharina*) ; Peron, 1893, p. 356.]
[*Cribillina* [sic] [partim] ; Deecke, 1895, p. 80.]
[*Cribrilina* (*Cribrilina*) ; Canu, 1900 [2], p. 450.]
[*Cribrilina* (*Decurtaria*) ; Canu, 1900 [2], p. 451.]
[*Semiescharipora* [partim] ; Canu, 1900 [2], pp. 450–1.]
[*Cribrilina* ; Canu, 1902, p. 13.]
[*Escharipora* partim] ; Lang, 1916, p. 409.]
Polycephalopora, gen. nov. ; Lang, 1916, pp. 86, 90–1.
Membraniporella [partim] ; Brydone, 1918, pp. 1, 3, 4.
Polycephalopora ; Lang, 1919 [3], p. 106.

Diagnosis.—Tricephaloporinæ with three, four, or five apertural aviculœcia ; with comparatively small orthœcia ; and with a tertiary front-wall incomplete or absent.

Genotype.—*Polycephalopora hydra*, Lang.

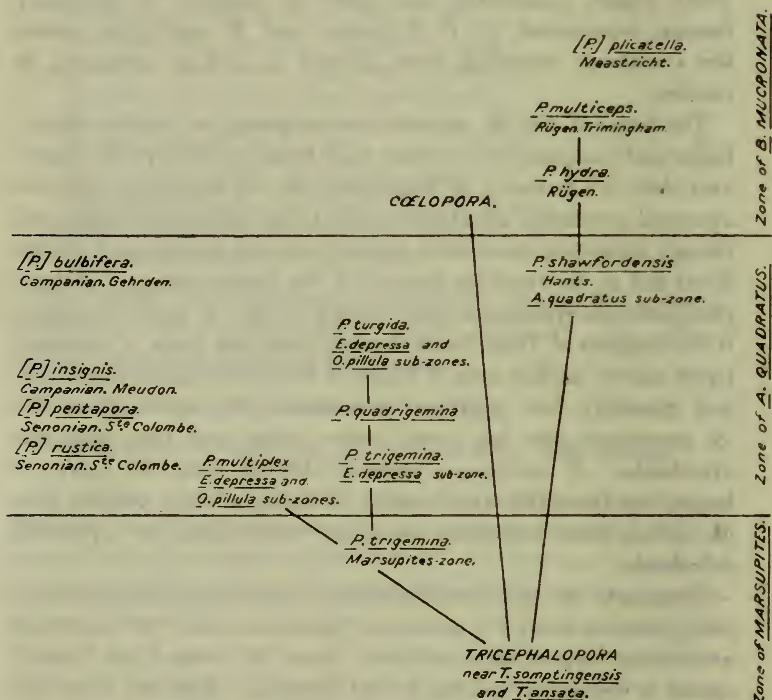
Distribution.—Senonian, *Marsupites*-zone ; and Aturian.

Remarks.—As in *Tricephalopora*, several species, which may or may not be *Polycephalopora*, are too vaguely described and too poorly figured for certain identification. If these are ignored for the present, the species of *Polycephalopora* fall into two groups, one occurring in the *A. quadratus*-zone and the other mainly in the zone of *B. mucronata*. The former group arose from *Tricephalopora trigemina*, an incrusting form with about eighteen costæ and three apertural aviculœcia, which are small and blunt. *P. multiplex* is an incrusting, multilaminar derivative with sometimes three, but generally four, somewhat elongate and rather pointed aviculœcia, and with fewer costæ than *P. trigemina*. *P. quadrigemina* is an incrusting form with four apertural aviculœcia, somewhat longer and larger than those of *P. trigemina*, but blunt and tending to be laterally constricted. It has fewer costæ (about 14) and more interœcial secondary tissue than *P. trigemina*, from which it appears to be derived. *P. quadrigemina* probably gave rise to *P. turgida*, also an incrusting form, with about twelve costæ, with five blunt, laterally constricted apertural aviculœcia. and a tongue of secondary tissue covering the median area of fusion of the intraterminal front-wall in ephebic œcia. The main lineage of this group, therefore, is seen to evolve along the following lines:—(1) the costæ become fewer; (2) the secondary tissue increases; (3) the apertural aviculœcia become larger, comparatively longer, constricted, and more in number. A secondary lineage, represented by *P. trigemina* and *P. multiplex*, shows the aviculœcia becoming more pointed as well as increasing in number.

The forms of the *B. mucronata*-zone-group are, on the whole, larger and comparatively shorter than those just described; moreover there is a tendency to dimorphism of the aviculœcia, and the apertural aviculœcia are always short, blunt, and rather large, and, though somewhat constricted laterally, do not develop such a wide distal end as do the later species of the former group. *Polycephalopora shawfordensis*, from the top of the *A. quadratus*-zone, is the simplest of these forms, having about ten costæ, a comparatively narrow median area of fusion of the intraterminal front-wall, and generally four apertural aviculœcia. *P. hydra* from the *B. mucronata*-zone has about twelve costæ and four apertural aviculœcia. *P. multiceps*, probably derived from *P. hydra*, is larger, has about the same number of costæ, a wider median area of fusion, more interœcial secondary tissue, and five apertural aviculœcia.

Turning to the more doubtful species, we find that [*Polycephalopora*] *rustica* and [*P.*] *pentapora* have four and five apertural aviculœcia, respectively, and each about 18 costæ; the former species is unilaminar and the lateral bilaminar; both are from the Senonian of Ste. Colombe; neither closely resembles the other species of *Polycephalopora*, and it is quite likely that both belong to another genus. [*P.*] *insignis*, from the Campanian of Meudon, is said by Canu to be identical with [*P.*] *rustica*; but the figures of these two forms bear no close resemblance. [*P.*] *insignis*, having four apertural aviculœcia and a multilaminar asty, may be allied to *P. multiplex*, but very probably is not a *Polycephalopora*. [*P.*] *bulbifera*, from the Campanian of Gehrden, apparently has five apertural aviculœcia; but little more can be made out of its affinities from an inspection of Römer's figure. There remains [*P.*] *plicatella* from Maastricht with four apertural aviculœcia. This form occurs higher than any other known *Polycephalopora*, and if belonging to this genus, may be placed near *P. hydra*.

The possible relationships of the different species of *Polycephalopora* may be summed up in the following table :—



Key to the Species of *Polycephalopora*.

A. Generally three (occasionally two or four) apertural aviculœcia; unilaminar; orthœcia about ·68 mm. long; costæ about 18; aviculœcia blunt (fig. 32) 1. *P. trigemina*.

B. Generally four, but often three aviculœcia; multilaminar; orthœcia about ·75 mm. long; costæ about 15; aviculœcia somewhat pointed (fig. 33). 2. *P. multiplex*.

C. Generally four apertural aviculœcia.
- I. Orthœcia comparatively long, about twice as long as wide.
  - a. Incrusting, unilaminar.
    - 1. Aviculœcia short, nearly circular ... ... 11. [*P.*] *plicatella.*
    - 2. Aviculœcia elongate (fig. 34) ... ... 3. *P. quadrigemina.*
  - b. [Incrusting], multilaminar.
    - 1. Costæ more than 20; [aviculœcia blunt] ... 6. [*P.*] *insignis.*
    - 2. Costæ about 15; aviculœcia somewhat pointed ... ... [2. *P. multiplex.*]
- II. Orthœcia comparatively short, about $1\frac{1}{2}$ times as long as wide.
  - a. Costæ about 18; less interœcial secondary tissue ... ... 5. [*P.*] *rustica.*
  - b. Costæ about 13; more interœcial secondary tissue (fig. 37) ... ... 10. *P. hydra.*
  - c. Costæ about 10 or less; more interœcial secondary tissue; aviculœcia markedly dimorphic ... ... 9. *P. shawfordensis.*

D. Often five apertural aviculœcia.
- I. Fifth apertural aviculœcium on the distal edge of the secondary aperture.
  - a. Costæ about 16; erect, bilaminar ... ... 8. [*P.*] *pentapora.*
  - b. Costæ about 12; [incrusting], unilaminar ... ... 7. [*P.*] *bulbifera.*
- II. Fifth apertural aviculœcium on the proximal edge of the secondary aperture.
  - a. Smaller, about ·60 mm. long; costæ about 12; secondary tissue over the intraterminal front-wall well developed (fig. 35) ... ... 4. *P. turgida.*
  - b. Larger, about ·85 mm. long; costæ about 13; secondary tissue over the intraterminal front-wall normally not so well developed; aviculœcia markedly dimorphic (fig. 38) ... ... 12. *P. multiceps.*

1. Polycephalopora trigemina, Lang.

Polycephalopora trigemina, sp. n.; Lang, 1916, p. 90; *A. quadratus*-zone, *E. depressus*-subzone; E. of Brighton, Sussex.

Diagnosis.—*Polycephalopora* about ·68 mm. long, having about 18 costæ and 3 blunt apertural aviculœcia.

Description.—Asty incrusting, unilaminar; œcia dimorphic. Orthœcia about ·68 mm. long and ·35 mm. broad; elliptical and somewhat parallel-sided; extraterminal front-wall hidden by interœcial secondary tissue with large median lacunæ; intraterminal front-wall slightly arched, consisting of about eighteen closely-set, thin costæ, with no lateral fusions, each bearing a single pelmatidium towards its distal end, and firmly united in a fairly wide median band of fusion, which occupies about the distal third of each costa; the outlines of each costa are clearly marked within the median area of fusion; apertural bar thicker than the normal costæ, and raised along its distal edge to form, in conjunction with two laterally-placed aviculœcia, the proximal shield of the secondary aperture; the distal shield of the secondary aperture is formed of a rim of secondary tissue connected laterally, either on the right- or left-hand side, with a single lateral aviculœcium; secondary aperture sub-circular, somewhat flattened, indented medianly by the apertural bar on its proximal edge, and somewhat indented on its sides by the proximal-lateral aviculœcia. Aviculœcia, rather small, with blunt apertures divided by a constriction into a larger rostrum and a smaller proximal part; they occur in two positions, namely, in the interœcial tissue and around the aperture; the interœcial aviculœcia are sporadic, occasional, and directed distally and obliquely towards the mid-line of one of the orthœcia between which they lie; the apertural aviculœcia are three to each aperture (though occasionally only two, or as many as four), a proximal pair in the proximal-lateral corners, and an unpaired one in either the right or the left distal corner, all directed towards the centre of the orthœcial aperture they accompany.

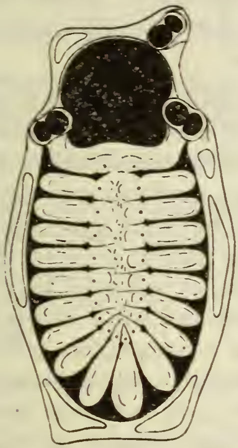
Distribution.—Senonian, zone of *Marsupites*, and zone of *A. quadratus*, sub-zone of *E. scutata* var. *depressa*. E. of Brighton, Sussex.

Type-specimen.—**D. 29003.**

Remarks.—*P. trigemina* is undoubtedly the most primitive species of those found in the English *A. quadratus*-zone. It was derived from a primitive *Tricephalopora* by the addition of a distal apertural aviculœcium. This is indicated in specimen **D. 29851,** whose neanastic stages often show but two apertural aviculœcia.

Figures.—Text-fig. 32. Orthœcium with three apertural aviculœcia.

Plate II, fig. 5. Part of the type-specimen, showing three complete orthœcia and the aperture of a fourth, each with its three apertural aviculœcia; also two sporadic aviculœcia. × about 27 diameters.



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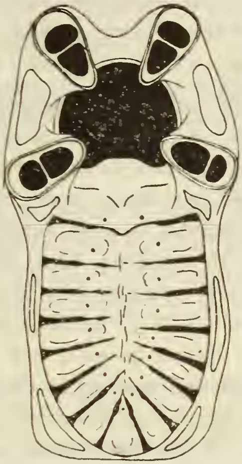

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Fig. 32.—*Polycephalopora trigemina.* Diagram of an orthœcium and three apertural aviculœcia, from above. × about 75 diameters.

Fig. 33. *Polycephalopora multiplex.* Diagram of an orthœcium and four apertural aviculœcia, from above. × about 75 diameters.

LIST OF SPECIMENS.

D. 29003. The type-specimen. A small fragmentary asty incrusting an echinoid. Senonian, Campanian, zone of *A. quadratus*, sub-zone of *E. scutata* var. *depressa*; cliffs between the last groyne E. of Rottingdean Gap and Saltdean, E. of Brighton, Sussex. Collected by C. T. A. Gaster, Esq., and presented by him, 1916.

D. 29002. Paratype specimen. A small fragmentary asty incrusting an echinoid; from the same horizon and locality as **D. 29003**; collected by C. T. A. Gaster, Esq., and presented by him, 1916.

D. 28914. Paratype specimen. A small fragmentary asty incrusting an echinoid. Senonian, Santonian, zone of *Marsupites*; Brighton cliffs, Sussex. Collected by C. T. A. Gaster, Esq., and presented by him, 1916.

D. 29851. An asty showing neanastic stages, in which many œcia have only two apertural aviculœcia. Senonian, zone of *Marsupites*; cliffs E. of Brighton, Sussex. Collected by C. T. A. Gaster, Esq., and presented by him, 1919.

2. Polycephalopora multiplex, Lang.

Polycephalopora multiplex, sp. n.; Lang, 1916, pp. 90, 91; *A. quadratus*-zone, *E. depressa*-subzone; N.E. of Worthing, Sussex.

Diagnosis.—Multilaminar *Polycephalopora* having orthœcia about twice as long as wide, with about 15 costæ, and 3 or 4 somewhat pointed apertural aviculœcia.

Description.—Asty incrusting, multilaminar; œcia dimorphic. Orthœcia about ·75 mm. long and ·37 mm. broad, elliptical with somewhat parallel sides; extraterminal front-wall hidden beneath interœcial secondary tissue, which has occasional, generally somewhat triangular, lacunæ; intraterminal front-wall somewhat arched, though, if anything, sunk below the general level of the asty owing to the considerable development of secondary tissue; consisting of about 15 costæ, rather stout and rather closely placed, with no lateral fusions, each bearing a pelmatidium towards its distal end, and meeting in the broad median area of fusion, which occupies nearly the distal half of each costa, and across which the outlines of the fused costæ can be clearly traced; apertural bar about twice as wide as the normal costæ, with its upper surface sloping obliquely distally, so as to form a proximal shield, which is completed by the lateral-proximal aviculœcia; distal shield formed by secondary tissue filling up the space between the lateral-distal aviculœcia; primary aperture sub-semicircular; secondary aperture sub-circular, with a flattened proximal side, and indented by the distal ends of the aviculœcia. Aviculœcia a varying number, generally four apertural, and an occasional sporadic aviculœcium in the interœcial tissue; a pair of apertural aviculœcia always present in the lateral-proximal corners of each orthœcial aperture, directed towards the centre of the aperture, and generally a second pair similarly placed in the lateral-distal corners, though nearer the middle line than the proximal pair and, consequently, nearer each other, similarly directed towards the centre of the aperture; occasionally, especially in neanastic stages, only one distal apertural aviculœcium is present, and is then placed medianly, directed as before; when an ovicell is present on an orthœcium with three apertural aviculœcia, the third aviculœcium is either placed medianly and distally to the ovicell or tucked in laterally between the ovicell and a lateral-proximal pair; rarely both distal apertural aviculœcia are absent—for instance, one orthœcium of the type-specimen has only the proximal-lateral pair of apertural aviculœcia; the aviculœcia are rather large, somewhat pointed, and divided by a transverse bar into a larger rostrum and a smaller proximal portion. Ovicells endozoœcial, but often prominent and sometimes approaching hyperstomial ovicells in appearance.

Distribution.—Senonian, Campanian, zone of *A. quadratus*, subzones of *O. pillula* and *E. scutata* var. *depressa*. Sussex.

Type-specimen.—D. 28944.

Remarks.—In its somewhat sharp aviculœcia *Polycephalopora multiplex* is more advanced than *P. quadrigemina* and *P. turgida*, the other species derived from *P. trigemina*. It is larger than *P. trigemina*, has fewer costæ as well as larger and more pointed aviculœcia.

Figures.—Text-fig. 33. Orthœcium with four apertural aviculœcia.

Plate II, fig. 6. Part of the type-specimen, showing four complete orthœcia, two with four apertural aviculœcia, and two with three. The proximal end of a fourth orthœcium, and the aperture of a fifth with three apertural aviculœcia, are also shown. × about 27 diameters.

LIST OF SPECIMENS.

D. 28295–6. Paratypes. Senonian, Campanian, zone of *A. quadratus*, subzone of *O. pillula*. About 1 mile East of Telscombe Staircase, W. of Newhaven, Sussex. Collected by C. T. A. Gaster, Esq., and presented by him, 1915.

D. 28916. Paratype. Portions of a single asty showing ovicells, and, near the periphery in one portion, two very large, apparently sporadic, aviculœcia. Senonian, Campanian, zone of *A. quadratus*, subzone of *E. scutata* var. *depressa*. Pit No. 2 of Gaster, by the reservoir, near Hill Barn, N. of North Lancing, E. of Worthing, Sussex. Collected by C. T. A. Gaster, Esq., and presented by him, 1916.

D. 28944. Type-specimen. Central portion of an asty, showing a few ovicells. Senonian, Campanian, zone of *A. quadratus*, subzone of *E. scutata* var. *depressa*. Pit 3 of Gaster, E. of Boundstone Lane and S. of Lancing Ring, N.E. of Worthing, Sussex. Collected by C. T. A. Gaster, Esq., and presented by him, 1916.

D. 28945. Paratype specimen. Portions of a single asty showing ontogenetic stages on the periphery. From the same horizon and locality as **D. 28944.** Collected by C. T. A. Gaster, Esq., and presented by him, 1916.

3. Polycephalopora quadrigemina, new species.

Diagnosis. — Incrusting, unilaminar *Polycephalopora*, with orthœcia nearly twice as long as wide, and 4 blunt, elongate apertural aviculœcia.

Description.—Asty incrusting, unilaminar; œcia dimorphic. Orthœcia about ·61 mm. long and about ·33 mm. wide; elliptical, somewhat blunter distally; extraterminal front-wall of small extent and hidden beneath interœcial secondary tissue, which is well developed and has but occasional, small, triangular, median lacunæ; intraterminal front-wall sunk beneath the level of the interœcial secondary tissue, rather flat, consisting of about fourteen somewhat stout and rather closely-placed costæ with no lateral fusions, each bearing a single pelmatidium towards its distal end, and meeting in a broad median area of fusion, which occupies nearly the distal half of each costa, and across which the outlines of the fused costæ can be clearly traced; apertural bar produced vertically to form, in conjunction with the proximal pair of apertural aviculœcia, a proximal shield; this shield has a pair of lateral pits, probably representing an ancestral fusion of its median process with the proximal pair of apertural spines; it also has a proximally-directed median process, covering, and fusing with, the distal part of the median area of fusion of the intraterminal front-wall; the distal shield is formed of the distal pair of apertural aviculœcia, and the apertural ring is complete; aperture sub-circular with a tendency for the outline to be indented by the distal ends of the apertural aviculœcia, especially the proximal pair. Aviculœcia, a distal and a proximal apertural pair to each aperture, rather small, directed towards the centre of the aperture they surround, elongate, but with blunt apertures divided by a transverse bar into a shorter proximal portion and a longer rostrum.

Distribution.—Senonian, Campanian, zone of *A. quadratus* Saltdean, E. of Brighton, Sussex.

Type-specimen.—D. 28297. Collected by C. T. A. Gaster, Esq., and presented by him, 1915.

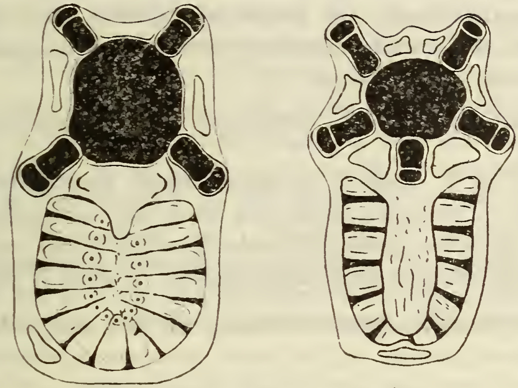

Fig. 34.—*Polycephalopora quadrigemina*. Diagram of an orthœcium and four apertural aviculœcia, from above. × about 75 diameters.

Fig. 35.—*Polycephalopora turgida*. Diagram of an ephebic ephebœcium and its five apertural aviculœcia, from above. × about 75 diameters.

Fig. 36.—*Polycephalopora turgida*. Diagram of a neanic ephebœcium with two apertural aviculœcia, from above. × about 75 diameters. Note the greatly swollen apertural bar and the absence of the median and distal-lateral apertural aviculœcia; the paucity of interœcial secondary tissue, allowing the extraterminal front-wall to appear; the arched intraterminal front-wall; and the narrow median area of fusion, not hidden, as in the ephebic stage, beneath secondary tissue.

Remarks. — *Polycephalopora quadrigemina* probably was derived from *P. trigemina* by a reduction in the size of the orthœcium, a reduction in the number of the costæ, an increase in size, comparative length, and number of apertural aviculœcia, and an increase of interœcial secondary tissue. *P. quadrigemina*, in turn, gave rise to *P. turgida*.

Figures.—Text-fig. 34. Orthœcium with four apertural aviculœcia.

Plate II, fig. 7. Part of the type-specimen showing two complete orthœcia, the proximal end of a third, and the aperture of a fourth; also various apertural aviculœcia, which in this part of the specimen are somewhat irregularly arranged. × about 27 diameters.

Specimens.—The type-specimen. Collection and distribution as above.

4. Polycephalopora turgida, Lang.

Polycephalopora turgida, sp. n.; Lang, 1916, pp. 90, 91; *A. quadratus*-zone, *O. pillula*-subzone; E. of Brighton, Sussex.

Polycephalopora turgida Lang; Lang, 1919[3], p. 106, fig. 19, *a*, *b*; Senonian, *A. quadratus*-zone, *O. pillula*-subzone; E. of Brighton, Sussex.

Diagnosis.—*Polycephalopora* of rather small size (about ·6 mm. long), having about 12 costæ, with the median area of fusion of the intraterminal front-wall fairly well covered with secondary tissue, and with 5 apertural aviculœcia, one of these being placed in the middle of the proximal edge of the aperture.

Description.—Asty incrusting, unilaminar; œcia dimorphic.

(a) *Ephebœcia, ephebic stages.* Orthœcia about ·6 mm. long and about ·35 mm. wide, elliptical with irregular distal ends; extraterminal front-wall entirely hidden by interœcial secondary tissue, which has few irregularly-shaped, but usually more-or-less triangular or quadrilateral, median lacunæ; intraterminal front-wall formed (1) of about 12 thin costæ, rather widely spaced, with no lateral fusions, each bearing a pelmatidium towards its distal end (hidden by secondary tissue) and fused in the median line; this (secondary) intraterminal front-wall is, however, largely obscured by (2) a partial tertiary intraterminal front-wall, formed partly by the overlapping of the interœcial secondary tissue and partly by a tongue of secondary tissue, which proceeds in a proximal direction from the proximal, median, apertural aviculœcium and covers the median area of fusion of the costæ; apertural bar entirely obliterated by the median apertural aviculœcium and by secondary tissue, which often has median lacunæ, and fills the spaces between the proximal-lateral and median apertural aviculœcia; this tissue and corresponding tissue distal to it, with the apertural aviculœcia, form the proximal and distal shields of the secondary aperture, which is generally circular in outline, but indented by the distal ends of the aviculœcia, especially the proximal pair. Aviculœcia, five apertural and an occasional sporadic interœcial aviculœcium; the apertural five are arranged one at each proximal-lateral and distal-lateral corner, and one, smaller than the other four, medianly and proximally; all are directed towards the centre of the aperture, are somewhat elongate (the median one is shorter than the rest), have blunt ends, and apertures slightly constricted laterally and divided by a thin bar into a longer rostrum and a shorter proximal portion.

(b) *Ephebœcia, neanic stages.* Orthœcia of same length and breadth as in ephebic stages, broadly elliptical; extraterminal front-wall visible laterally and proximally, well arched, forming a narrow border to the œcium, and covered to a certain extent with secondary tissue; intraterminal front-wall well arched and formed by about twelve thin, rather widely-spaced costæ with no lateral fusions, each bearing a pelmatidium towards its distal end and firmly fused medianly with the other costæ in a narrow median band; apertural bar very thick and swollen, and appearing as if inflated, divided by a median furrow, and each half somewhat produced in a proximal direction over the median line of fusion as a knob-shaped protuberance; aperture large, sub-circular with a flattened proximal side and, apparently, four apertural spines. Aviculœcia, a pair in the proximal-lateral corners of the aperture, directed towards the centre of the aperture, blunt, rather short, with aperture slightly constricted laterally and with a thin bar dividing the rostrum from the proximal portion.

Distribution.—Senonian, Campanian, zone of *A. quadratus*, subzones of *O. pillula* and *E. scutata* var. *depressa*; Sussex.

Type-specimen.—D. 29000.

Remarks.—*Polycephalopora turgida* is the most advanced term in the lineage *P. trigemina–P. quadrigemina–P. turgida*, having the smallest orthœcia, the fewest costæ, the most secondary tissue, the largest apertural aviculœcia compared with the size of the aperture, and the greatest number of these aviculœcia.

Figures.—Text-fig. 35. An ephebic ephebœcium and five apertural aviculœcia.

Text-fig. 36. A neanic ephebœcium and two apertural aviculœcia.

Plate II, fig. 8. Part of the type-specimen, showing three complete orthœcia and attendant apertural aviculœcia, as well as parts of other orthœcia and other aviculœcia. × about 27 diameters.

LIST OF SPECIMENS.

D. 29000. Type-specimen. Portion of an asty incrusting an echinoid, showing neanic ephebœcia at the periphery. Senonian, zone of *A. quadratus*, subzone of *O. pillula*. East Hill, Rottingdean, E. of Brighton, Sussex. Collected by C. T. A. Gaster, Esq., and presented by him, 1916.

D. 29001. Paratype. An asty, incrusting an echinoid, and showing on the periphery neanic, and possibly brephic, ephebœcia. Senonian, zone of *A. quadratus*, subzone of *E. scutata* var. *depressa*. Cliffs between the last groyne east of Rottingdean Gap and Saltdean, E. of Brighton, Sussex. Collected by C. T. A. Gaster, Esq., and presented by him, 1916.

5. [Polycephalopora] rustica (d'Orbigny).

Semiescharipora rustica d'Orb., 1851; d'Orbigny, 1852, pl. 718, figs. 13–16, 1853, p. 484, 1854, p. 1098; Sénonien; Sainte-Colombe (Manche).

Semiescharipora rustica d'Orb.; Canu, 1900 [2], p. 450; non=*Multescharipora insignis* d'Orb., as there stated.

Polycephalopora rustica (d'Orbigny); Lang, 1916, p. 90; Senonian; Sainte-Colombe, France.

Diagnosis.—[*Polycephalopora*] with comparatively short orthœcia, about 18 costæ, a small amount of interœcial secondary tissue, and 4 apertural aviculœcia.

Description.—Asty erect, unilaminar.

Distribution.—Senonian. Sainte-Colombe, Charente, France.

Type-specimen.—That figured by d'Orbigny, 1852, pl. 718, fig. 14, is hereby selected.

Remarks.—Canu makes *Semiescharipora rustica*, d'Orbigny, a synonym of *Multescharipora insignis*, d'Orbigny; but, except for the possession of four apertural aviculœcia, there is hardly a character in common between these two species as portrayed by d'Orbigny, and, without any explanation by Canu why he considers them identical, I feel bound to keep them separate. The inclusion of either species in *Polycephalopora* or, indeed, in the Tricephaloporinæ, is sanctioned solely by the general appearance of the figures. The diagnostic characters—*e. g.* the presence of pelmatidia—cannot be certainly determined from the figures and descriptions.

Specimens.—None in the Collection.

6. [Polycephalopora] insignis (d'Orbigny).

Multescharipora insignis, d'Orb., 1851; d'Orbigny, 1852, pl. 720, figs. 11–15, 1853, p. 496, 1854, p. 1098; Sénonien; Meudon près de Paris.
Multescharipora insignis, d'Orb.; Pictet, 1857, p. 112; craie blanche.
Cribrilina (*Cribrilina*) *insignis* (d'Orb.); Canu, 1900[2], p. 450; Sénonien.
Non=*Semiescharipora rustica* d'Orb.; as stated by Canu, 1900[2], p. 450.
Polycephalopora insignis (d'Orbigny); Lang, 1916, pp. 90, 91; Senonian [Campanian]; Meudon, France.

Diagnosis.—Incrusting, multilaminar [*Polycephalopora*] with comparatively long orthœcia, more than 20 costæ, and 4 [blunt] apertural aviculœcia.

Distribution.—Senonian, [Campanian, zone of *B. mucronata*]. Meudon, S.W. of Paris.

Type-specimen.—That figured by d'Orbigny, 1852, pl. 720, fig. 13, is hereby selected.

Remarks.—*Multescharipora insignis*, d'Orbigny, is tentatively placed here because Canu has identified the species with *Semiescharipora rustica*, d'Orbigny, which, in its turn, has a general resemblance to a *Polycephalopora*. But it was pointed out in the remarks on [*Polycephalopora*] *rustica* that, in spite of Canu's statement, there is hardly a character in common between the figures of these two species. The importance of the generic position of *Multescharipora insignis* lies in the fact that this species is the genolectotype of *Multescharipora* (see Vol. III, p. lxii). Therefore, if the species could be proved congeneric with *Polycephalopora hydra*, Lang, the name *Polycephalopora* would become a synonym of *Multescharipora*. It is not likely, however, that the characters of *M. insignis*, and therewith the characters of the genus *Multescharipora*, will ever be clearly established.

Specimens.—None in the Collection.

7. [Polycephalopora] bulbifera (F. A. Römer).

Escharina bulbifera N.; Römer, 1840, p. 14, pl. v, fig. 6; oberer Kreidemergel; bei Gehrden.

Cellepora bulbifera Röm.; Geinitz, 1846, p. 613; oberer Kreidemergel; Gehrden.

Cellepora bulbifera Hag.; Bronn, 1848, pp. 254, 471.

Escharina bulbifera Roe.; Bronn, 1848, pp. 254, 471.

Escharina bulbifera Roe.; Bronn, 1849, p. 131; Kreide.

Cellepora bulbifera (Röm.); Geinitz, 1849–50, pp. 248–9; oberer Quadermergel; Gehrden.

Escharina bulbifera, Rœmer; d'Orbigny, 1850, p. 262; Sénonien; Gehrden.

Reptescharipora bulbifera (Rœmer); d'Orbigny, 1853, p. 490; Sénonien; Gehrden.

Reptescharipora bulbifera (Roemer); Pictet, 1857, p. 112; craie blanche; Allemagne.

Polycephalopora bulbifera (Römer); Lang, 1916, pp. 90, 91; Ober kreidemergel [Campanian]; Gehrden, Hanover.

Diagnosis.—[Incrusting], unilaminar [*Polycephalopora*] with about 12 costæ and 5 apertural aviculœcia, one being placed in the middle of the distal rim of the aperture.

Distribution.—Senonian, Campanian, obere Kreidemergel. Gehrden, Hanover, Germany.

Type-specimen.—That figured by Römer, 1840, pl. v, fig. 6, is hereby selected.

Remarks.—Römer's figure and description are such that his *Escharina bulbifera* can only be placed here tentatively.

Specimens.—None in the Collection.

8. [Polycephalopora] pentapora (d'Orbigny).

Escharipora pentapora, d'Orb., 1851; d'Orbigny, 1851, pl. 685, figs. 5–8, 1852, p. 224, 1854, p. 1097; Sénonien, la craie à Thécidées; environs de Sainte-Colombe (Manche).

Non *E. incrassata*, d'Orb., 1851; d'Orbigny, 1851, pl. 685, figs. 1–4, 1852, p. 223, 1854, p. 1097; Sénonien; Meudon, près de Paris; as stated by Canu, 1900 [2], p. 451 [see *Rhacheopora incrassata* (d'Orbigny)].

Escharipora ovalis, d'Orb., 1851; d'Orbigny, 1852, p. 233, pl. 703, figs. 13–15, 1854, p. 1097; Sénonien; environs de Tours; *fide* Canu, 1900 [2], p. 451.

Non *Escharipora raripora*, d'Orb., 1851; d'Orbigny, 1852, p. 234, pl. 703, figs. 16–18, 1854, p. 1097; Sénonien; environs de Tours (Indre-et-Loire); as stated by Canu, 1900 [2], p. 451 [see *Graptopora raripora* (d'Orbigny)].

Escharipora regularis, d'Orb., 1851; d'Orbigny, 1851, pl. 685, figs. 9–12, 1852, p. 224, 1854, p. 1097; Sénonien; environs de Sainte-Colombe; *fide* Canu, 1900 [2], p. 451.

Non *Semiescharipora semicostata*, d'Orb., 1851; d'Orbigny, 1852, pl. 719, figs. 1–4, 1853, p. 486, 1854, p. 1098; Sénonien; environs de Tours (Indre-et-Loire); as stated by Canu, 1900 [2], p. 451 [see *Graptopora semicostata* (d'Orbigny)].

Escharipora regularis, d'Orbigny; Pergens, 1893, pp. 202, 216; Sénonien; Sainte-Paterne and Sainte-Colombe.

Cribrilina (*Decurtaria*) *pentapora* d'Orb.; Canu, 1900 [2], p. 451, Sénonien; there considered synonymous with *Escharipora raripora* d'Orbigny, *E. incrassata* d'Orbigny, *E. regularis* d'Orbigny, *E. ovalis* d'Orbigny, *Semiescharipora semicostata* d'Orbigny, and *Escharipora regularis* Pergens.

Polycephalopora pentapora (D'Orbigny); Lang, 1916, pp. 90, 91; Senonian; Sainte-Colombe, France.

Escharipora ovalis; Lang, 1916, p. 409; Senonian; Tours.

Escharipora regularis; Lang, 1916, p. 409; Senonian; Sainte-Colombe.

Diagnosis.—Erect, bilaminar [*Polycephalopora*] with about 16 costæ and 5 apertural aviculœcia, one of which is in the middle of the distal edge of the aperture.

Distribution.—Senonian. Sainte-Colombe and Tours, France.

Type-specimen.—That figured by d'Orbigny, 1851, pl. 685, fig. 6, is hereby selected.

Remarks.—As synonyms of *Escharipora pentapora*, d'Orbigny, Canu has included five more of d'Orbigny's species. He appears, however, to be doubtful about two of these, namely *Escharipora raripora* and *Semiescharipora semicostata*, both of which species I consider to be *Graptopora*. I have ventured also to refer

Escharipora incrassata to another genus—*Rhacheopora*, leaving *Escharipora ovalis* and *E. regularis* as synonyms of *E. pentapora*. Even so, to place these forms for the present under *Polycephalopora* does not imply that their generic characters are clearly understood. Their position here is purely tentative.

Specimens.—None in the Collection.

9. Polycephalopora shawfordensis (Brydone).

Membraniporella Shawfordensis, sp. nov.; Brydone, 1918, pp. 1, 4, pl. i, figs. 6, 7; *A. quadratus*-subzone; Hants.

Diagnosis.—*Polycephalopora* with comparatively short orthœcia; 10 or fewer costæ; a fair amount of secondary interœcial tissue, and generally 4 apertural aviculœcia; aviculœcia dimorphic.

Distribution.—Senonian, Campanian, zone of *A. quadratus*, subzone of *A. quadratus*. Shawford, S. of Winchester, Hants.

Type-specimen.—That described and figured by Brydone, 1918, p. 1, pl. i, figs. 6 & 7, being the only specimen that author possessed at the time.

Remarks.—*Polycephalopora shawfordensis* shows marked dimorphism of the aviculœcia. It is probably derived from a form more primitive than *P. trigemina* (from which the *A. quadratus*-zone species of *Polycephalopora* arose) and is the simplest known species of the lineage of which *P. hydra* and *P. multiceps* are more advanced terms.

Specimens.—None in the Collection.

10. Polycephalopora hydra, Lang.

Polycephalopora hydra, sp. n.; Lang, 1916, p. 90; *B. mucronata*-zone; Rügen.

Diagnosis.—*Polycephalopora* with comparatively short orthœcia, about 13 costæ, interœcial secondary tissue well developed, and 4 apertural aviculœcia.

Description.—Asty incrusting, unilaminar; œcia dimorphic. Orthœcia about ·6 mm. long and about ·4 mm. broad; elliptical, blunter distally; extraterminal front-wall hidden beneath secondary tissue, which has median, more-or-less triangular lacunæ;

intraterminal front-wall rather strongly arched, though, owing to the considerable development of interœcial secondary tissue, not standing out much from the general surface of the asty; consisting of twelve somewhat widely-spaced, rather thin costæ, with no lateral fusions, each bearing a pelmatidium towards its distal end, and firmly united in a wide median band of fusion occupying about the distal half of each costa and with the outlines of the fused costæ clearly marked across it; apertural bar wider than the normal costæ, and low, so that the proximal shield of the secondary aperture, if regarded as present, consists of the walls of a pair of aviculœcia, one in each of the proximal-lateral corners of the secondary aperture; the distal shield is present, and formed of a rim of secondary tissue prolonging the distal rim of the original aperture and connected with a pair of aviculœcia, one in each of the distal-lateral corners of the aperture; secondary aperture sub-circular, somewhat flattened proximally, and tending to have its outline indented by the aviculœcia surrounding it. Four rather large aviculœcia surround the aperture of each orthœcium, one being placed at each of the proximal-lateral and distal-lateral corners and directed towards the centre of the orthœcial aperture it accompanies; apertures with spines (not shown in fig. 37) on their distal rims, blunt, and divided by a bar into a larger rostrum and a smaller proximal part.

Distribution.—Senonian, Campanian, zone of *B. mucronata*. Rügen.

Type-specimen.—**D. 18001**. Agnes Laur collection. 1906.

Remarks.—*Polycephalopora hydra* was probably derived from *P. shawfordensis* in the zone below. It differs from that form mainly in the number of its costæ, and is in some respects the simplest of the species of *Polycephalopora* occurring in the *B. mucronata*-zone. It probably in turn gave rise to *P. multiceps*, which is larger, with a wider median area of fusion and five apertural aviculœcia. It is of interest that two of these three high-zonal forms exhibit dimorphism of the aviculœcia, and *P. multiceps* in this respect resembles the derived genus *Cœlopora*. Nevertheless, it is clear that *Cœlopora* was derived from a *Polycephalopora* more primitive than *P. multiceps*—for *Cœlopora cormoran*, the most primitive species, has but one or two apertural aviculœcia.

This dimorphism of the aviculœcia, then, is an example of a tendency in the primitive *Polycephalopora*, independently appearing in the derived forms of two different stocks.

FIGURES.—Text-fig. 37. Orthœcium and four apertural aviculœcia.

Pl. II, fig. 9. Part of the type-specimen showing three complete orthœcia, the proximal end of a fourth orthœcium, and eight aviculœcia. ×about 27 diameters.

SPECIMENS.—Type-specimen. Distribution and collection as above.

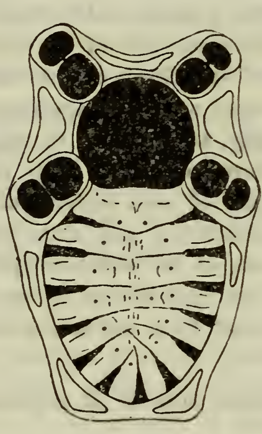

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Fig. 37.—*Polycephalopora hydra.* Diagram of an orthœcium and four apertural aviculœcia, from above. about 75 diameters. Apertural spines should be indicated along the distal edge of the aviculœcian apertures.

Fig. 38.—*Polycephalopora multiceps.* Diagram of an orthœcium and five apertural aviculœcia, from above. about 75 diameters.

11. [Polycephalopora] plicatella (von Hagenow).

Cellepora (Escharina) plicatella, Hag.; von Hagenow, 1851, p. 89, pl. x fig. 12; Maastrichter Kreide; Maastricht.

Repteschanipora plicatella (de Hagenow); d'Orbigny, 1853, p. 490; Sénonien; Maëstrich.

Reptescharipora plicatella (Hagen.); Pictet, 1857, p. 112; Maestricht.

Lepralia plicatella, Bosq. (Hag.); Ubaghs, 1879, p. 221; Maastrichtien supérieur; Limbourg.

Lepralia plicatella, Bosq. (Hag.); Mourlon, 1881, p. 119; Maastrichtien; Limbourg.

Cellepora (Escharina) plicatella, H.; Vine, 1885, p. 164; Maestricht Beds.

Cribrilina plicatella v. Hagenow sp.; Marsson, 1887, pp. 98, 109; Weisse Schreibkreide; Rügen.

Cellepora (Escharina) plicatella Haguenow [sic]; Peron, 1893, p. 356.

Cribillina [sic] *plicatella* Hag.; Deecke, 1895, p. 80; Senon.; Rügen.

Cribrilina plicatella Hag.; Canu, 1902, p. 13; Sénonien supérieur; Chavot.

Polycephalopora plicatella (von Hagenow); Lang, 1916, pp. 90, 91; Maastrichter-Kalk; Maastricht.

Diagnosis.—Incrusting, unilaminar [*Polycephalopora*], with comparatively long orthœcia (about twice as long as wide) and 4 short, nearly circular, apertural aviculœcia.

Distribution.—Senonian, Maastrichtian. Maastricht.

Type-specimen.—That figured by von Hagenow, 1851, pl. x, fig. 12, is hereby selected.

Remarks.—[*Polycephalopora*] *plicatella* occurs at a higher horizon than the other known species of *Polycephalopora*. It has but four short (not elongate as in *P. quadrigemina*), blunt, apertural aviculœcia, and thus resembles *P. hydra*, from which, however, it is distinguished by its longer orthœcia.

Specimens.—None in the Collection.

12. Polycephalopora multiceps, Lang.

Polycephalopora multiceps, sp. n.; Lang, 1916, pp. 90, 91; *B. mucronata*-zone; Rügen.

Membraniporella Trimensis, sp. nov.; Brydone, 1918, pp. 3, 4, pl. i, figs. 8–10; Trimingham Chalk.

Diagnosis.—*Polycephalopora* with large orthœcia (·85 mm. long), about 13 costæ, and often 5 apertural aviculœcia, of which one is in the middle of the proximal edge of the aperture.

Description.—Asty unilaminar, erect, or, possibly, incrusting, with the incrusted surface perished; œcia dimorphic. Orthœcia about ·85 mm. long and ·45 mm. wide; elliptical, blunter distally; extraterminal front-wall hidden by interœcial secondary tissue, which is well developed and has occasional lacunæ; intraterminal front-wall arched laterally, but flat on the wide median area of fusion, and not standing up from the general level of the asty, owing to the considerable development of secondary tissue; consisting of about thirteen rather widely-spaced, thin costæ with no lateral fusions, each bearing a single pelmatidium towards its distal end, and firmly united in a very wide median area of fusion, which occupies rather more than the distal half of each costa, and across which the outlines of each costa can be more-or-less clearly traced; apertural bar wide, forming, in conjunction with the proximal-lateral apertural aviculœcia, the proximal shield of a secondary aperture; the bar itself is often covered by a median proximal apertural aviculœcium; distal shield of secondary aperture similarly formed by the two distal-lateral apertural aviculœcia and the secondary tissue between these; secondary aperture sub-circular, somewhat flattened proximally, and tending to be bulged by the distal ends of the apertural aviculœcia. Aviculœcia, a proximal-lateral apertural pair always present and nearly always a similar distal-lateral pair; a fifth apertural aviculœcium is often present, medianly placed, and generally proximal, sometimes distal to the orthœcial aperture; all directed towards the centre of that aperture; they are rather large, but vary considerably in size, and are blunt, with their apertures divided by a bar into a larger rostrum and a smaller proximal portion; much larger, sporadically-distributed aviculœcia occasionally are present.

Distribution.—Senonian, Campanian, zone of *B. mucronata*. Rügen and Trimingham.

Type-specimen.—**D. 15370.**

Remarks.—*Polycephalopora multiceps* has been derived from *P. hydra* by increase of size, extension of median area of fusion, and increase in the number of apertural aviculœcia and in the amount and extent of secondary tissue. It is possible that Brydone's *Membraniporella trimensis* may be distinct, since the occasional, sporadic, large aviculœcia of that species appear to have more elongate rostra than those of *P. multiceps*.

Figures.—Text-fig. 38. Orthœcium and five apertural aviculœcia.

LIST OF SPECIMENS.

D. 15370. D. 16673. Type and paratype. The latter is certainly incrusting, but the type-specimen is apparently free; its lower surface, however, is very rough, and it is probable that it has become detached from what it incrusted, or that this has perished before the fossilization of the Polyzoan. Senonian, Campanian, zone of *B. mucronata*. Rügen. Agnes Laur collection. 1909.

V. CŒLOPORA, Lang, 1917.

Pustulopora; Leymerie, 1851, pp. 192, 201.
Siphoniotyphlus; Gregory, 1899, p. 279.
Antropora, gen. nov.; Lang, 1916, pp. 91, 92.
Non *Antropora*, gen. nov.; Norman, 1903, p. 87.
Antropora; Lang, 1917, p. 169.
Cœlopora, n. gen.; Lang, 1917, p. 169.
Beisselina [partim]; Canu, 1920, pp. 196, 199, 210–11.

Diagnosis.—Tricephaloporinæ of comparatively gigantic size (orthœcia about 1 mm. long), generally with markedly dimorphic aviculœcia; with 3, 4, or 5 apertural aviculœcia; and sometimes with a complete tertiary front-wall, or lamina peristomica; the apertural aviculœcia have buttress-like ridges of secondary tissue, which may, however, be obliterated by a tertiary front-wall.

Genotype.—*Antropora cavernosa*, Lang.

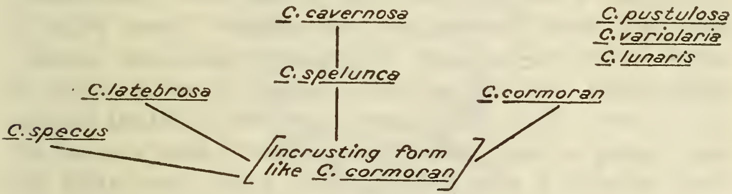
Distribution.—Senonian, Campanian, zone of *B. mucronata*; and Maastrichtian. Northern and Western Europe.

Remarks.—*Cœlopora* differs from *Polycephalopora* mainly in the comparatively gigantic size of the orthœcia, but, generally speaking, its aviculœcia are in a more primitive condition. The aviculœcia, however, are often markedly dimorphic, whereas, in *Polycephalopora*, only one lineage shows that character clearly. If derived from *Polycephalopora*, *Cœlopora* must have branched from the main lineage at a point very near its emergence from *Tricephalopora*—that is, at a time when there were seldom more than two apertural aviculœcia, still occasional sporadic aviculœcia, and when there was considerable variation in the relative sizes of the aviculœcia. The apertural aviculœcia of *Cœlopora* are never pointed, are but slightly elongate, and always, unless enveloped in secondary tissue, have buttress-like ridges running down their sides. In *Polycephalopora*, these buttress-like ridges are found more-or-less developed in *P. turgida* and probably in *P. hydra* and *P. multiceps*; they occur again in some advanced forms of *Tricephalopora*, e. g. *T. triceps*; but they are always present in *Cœlopora*, except in forms with a tertiary front-wall, in which, presumably, the ridges have been obliterated by secondary tissue.

In most of the species of *Cœlopora* spines may be seen in the aviculœcia along the distal edge of the aperture, and their visibility is probably owing to the large size of the aviculœcia. It is likely that spines are present generally in the aviculœcia of Tricephaloporinæ, at any rate in those species with blunt aviculœcia, but that owing to their small size and to the mineral condition of the specimens, they are seldom clearly visible. (They are certainly present, for instance, in the type-specimen of *Polycephalopora hydra*, though they had not been noticed when fig. 37, p. 124, was drawn.) Consequently their presence or absence has not been insisted on as diagnostic—in fact, not treated with more than passing notice. Even in the large-sized species of *Cœlopora* it is impossible to be certain of their number. This, however, appears to be six; and, on the assumption that aviculœcia are modified forms of orthœcia, and that (as has been suggested above, p. 1, and Vol. III, p. xliv) the original number of apertural spines in Pelmatoporidæ was six, the appearance of six apertural spines in the aviculœcia of *Cœlopora* is to be expected.

The several species of *Cœlopora* appear to be derived from a simple form like *C. cormoran*, but with an incrusting, unilaminar asty. The main lineage (represented by that form, *C. spelunca*, and *C. cavernosa*) shows an increase in the number of apertural aviculœcia, an increase in size, an increase in the amount of interœcial secondary tissue, and the attainment of a tertiary front-wall. *C. cormoran* is an erect bilaminar derivative of the first (hypothetical) term of the lineage. From this term also, *C. latebrosa* and *C. specus* seem to have arisen independently: the former species acquiring a multilaminar incrusting asty, a slightly larger orthœcium, and four apertural aviculœcia; and the latter, while retaining an incrusting unilaminar asty, acquiring a much larger orthœcium and four or five apertural aviculœcia. The relationships of the remaining species (*C. lunaris*, *C. variolaria*, and *C. pustulosa*) are more obscure.

The phylogeny suggested is represented in the following diagram. Whether or not it approximately represents the evolution in this genus, it will be seen that the several species are closely inter-related and generally advance along the following lines :—(1) The asty evolves in the usual manner, namely, from an incrusting to an erect habit, from a unilaminar to a bilaminar or multilaminar condition, and from an expanded to a cylindrical shape. (2) The size of the orthœcium increases. (3) The interœcial secondary tissue increases, and a tertiary front-wall is formed. (4) The apertural aviculœcia increase in number; though in *C. lunaris*, *C. variolaria*, and *C. pustulosa*, their condition is not evident—perhaps they become obliterated by the growth of secondary tissue, perhaps they represent a stock which has lost its smaller aviculœcia and retained the larger only, like the Castanoporines, which, starting with two kinds of aviculœcia in their primitive genera, lose one kind in *Rhiniopora* and the other in *Castanopora* :—



Key to the Species of *Cœlopora*.

I. Tertiary front-wall incomplete; asty various.

- A. Apertural aviculœcia typically 3, sometimes only 2.
  - 1. Apertural aviculœcia commonly 2; less interœcial secondary tissue; length of orthœcium about ·8 mm.; erect bilaminar asty (fig. 39) ... 1. *C. cormoran.*
  - 2. Apertural aviculœcia commonly 3; more interœcial secondary tissue; length of orthœcium about 1 mm.; erect, unilaminar asty (fig. 40)... 2. *C. spelunca.*
- B. Apertural aviculœcia typically 4; much interœcial secondary tissue; length of orthœcium about ·9 mm.; incrusting, multilaminar asty (fig. 41) ... 3. *C. latebrosa.*
- C. Apertural aviculœcia typically 4 or 5; much interœcial secondary tissue; length of orthœcium about 1 mm.; incrusting, unilaminar asty (fig. 42) 4. *C. specus.*

II. Tertiary front-wall complete, or nearly so; asty erect, bilaminar, or compressed-cylindrical.

A. Tertiary front-wall with shallow, mazy lacunæ; a U-shaped fenestra proximal to the very large aperture (fig. 43) .... 5. *C. cavernosa.*
B. Tertiary front-wall without mazy lacunæ.
1. A semi-lunar fenestra proximal to the comparatively small aperture. The large sporadic aviculœcia are pointed (fig. 44) .... 6. *C. lunaris.*
2. No semi-lunar fenestra proximal to the comparatively small aperture.
α. Large sporadic aviculœcia blunt .... 7. *C. variolaria.*
β. Large sporadic aviculœcia pointed .... 8. *C. pustulosa.*

1. Cœlopora cormoran *, new species.

Diagnosis.—*Cœlopora* with no tertiary front-wall; 2 or 3 apertural aviculœcia; a small amount of interœcial secondary tissue; an orthœcium about ·8 mm. long; and an erect bilaminar asty.

Description.—Asty erect, bilaminar; œcia dimorphic. Orthœcia about ·8 mm. long and about ·5 mm. wide; extraterminal front-wall hidden beneath interœcial secondary tissue, which is rather scanty and has large elongate or quadrangular lacunæ; intraterminal front-wall moderately arched, consisting of ten to twelve stout, rather widely-spaced costæ with no lateral fusions, each bearing a single pelmatidium towards its distal end and all firmly united by a wide median band of fusion, across which the outlines of the individual costæ can hardly be traced; apertural ring complete, the proximal shield having a pair of pits laterally, probably representing ancestral lateral fenestræ formed by the fusion of a median process of the apertural bar with the proximal pair of apertural spines; secondary aperture circular. Aviculœcia, a proximal apertural pair and occasionally an unpaired aviculœcium at one of the distal-lateral corners of each orthœcial aperture, all directed towards the centre of the aperture they surround; comparatively small, oval in shape, with blunt apertures, which are divided by a transverse bar into a smaller proximal portion and a longer rostrum; the edge of this part of the aperture is beset with about six spines; two or three buttresses of secondary tissue run down the proximal sides of each aviculœcium; an occasional aviculœcium of the same nature occurs in the interœcial tissue.

Distribution.—Senonian, zone of *B. mucronata.* Rügen.

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* Cormoran—the name of a giant.

Type-specimen.—**D. 15056.** Agnes Laur collection. 1909.

Remarks.—*Cœlopora cormoran*, except in regard to its asty, is the most primitive member of its genus, and probably arose from a stock of *Polycephalopora* very soon after that genus had diverged from *Tricephalopora*. It is more primitive than any other *Cœlopora* in having often only two apertural aviculœcia and comparatively little interœcial secondary tissue, and than most other species in the orthœcial length, which is less than 1 mm.

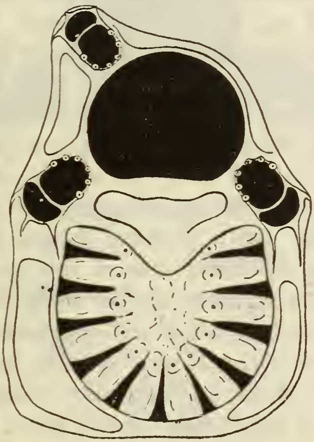

Fig. 39.—*Cœlopora cormoran*. Diagram of an orthœcium and three apertural aviculœcia, from above. × about 75 diameters.

Figures.—Text-fig. 39. Orthœcium and three apertural aviculœcia.

Plate II, fig. 10. Part of the type-specimen, showing two complete orthœcia, one with an ovicell, apertural aviculœcia, and parts of other orthœcia. × about 27 diameters.

Specimens.—The type-specimen. Distribution and collection as above.

2. Cœlopora spelunca (Lang).

Antropora spelunca, sp. n.; Lang, 1916, pp. 91, 92; *B. mucronata*-zone; Rügen.

Diagnosis.—*Cœlopora* with no tertiary front-wall; generally 3 apertural aviculœcia; a considerable amount of interœcial secondary tissue; an orthœcium about 1 mm. long; and an erect unilaminar asty.

Description.—Asty erect, unilaminar; œcia dimorphic. Orthœcia about 1 mm. long and ·6 mm. wide, elliptical, blunter distally; extraterminal front-wall hidden beneath interœcial secondary tissue, which is abundant, and has numerous median lacunæ generally sub-triangular in shape; intraterminal front-wall arched, but rather sunk owing to the considerable development of secondary tissue, consisting of about eleven thin, rather widely-spaced costæ with no lateral fusions, each bearing a single pelmatidium towards its distal end, and firmly fused medianly in a broad band of fusion; apertural bar very wide, and sloping steeply distally to form, in conjunction with the proximal apertural aviculœcia, the proximal shield of the secondary aperture; the distal shield is similarly formed of a rim of secondary tissue joining the distal apertural aviculœcia when two are present; secondary aperture sub-circular, with a proximal flattening, and more-or-less impinged upon by the distal ends of the apertural aviculœcia. Aviculœcia somewhat varied in number and position, but typically three apertural aviculœcia, one in each proximal-lateral corner, and one in a distal-lateral corner of each orthœcial aperture, all directed towards the centre of the aperture they accompany; aviculœcian apertures blunt, oval, and divided by a bar into a larger rostrum and a smaller proximal portion; the rostrum has a beaded distal edge; buttress-like ridges of secondary tissue run over the proximal parts of the aviculœcia.

Distribution.—Senonian, Campanian, zone of *B. mucronata*. Rügen.

Type-specimen.—**D. 14972.**

Remarks.—*Cœlopora spelunca* may have been derived from an incrusting unilaminar form otherwise resembling *C. cormoran*, by an increase of size of the orthœcium, in the amount of interœcial secondary tissue, and in the number of apertural aviculœcia.

Figures.—Text-fig. 40. Orthœcium and four apertural aviculœcia.

LIST OF SPECIMENS.

D. 14972. D. 14995. D. 15003. D. 15021. D. 15437. Type-specimen and four paratypes. Fragmentary asties. Senonian, Campanian, zone of *B. mucronata*. Rügen. Agnes Laur collection. 1909.

Fig. 40.—*Cœlopora spelunca.* Diagram of an orthœcium and four apertural aviculœcia, from above. × about 75 diameters.

3. Cœlopora latebrosa *, new species.

Diagnosis.—*Cœlopora* with no tertiary front-wall or, at most, an imperfect one; with typically 4 apertural aviculœcia; much interœcial secondary tissue; an orthœcium about ·9 mm. long; and an incrusting multilaminar asty.

Description.—Asty incrusting, multilaminar; œcia dimorphic. Orthœcia about ·9 mm. long and about ·47 mm. wide, elliptical, blunter and wider distally; extraterminal front-wall entirely hidden beneath interœcial secondary tissue, which is greatly developed and

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* *Latebrosus*—" full of hollows."

tends to overlap the intraterminal front-wall; it has but poorly-developed median lacunæ; intraterminal front-wall nearly covered in ephebic stages by the encroaching interœcial secondary tissue on the one hand, and, on the other hand, by a tongue of secondary tissue spreading proximally from the neighbourhood of the aperture, and covering the median area of fusion of the intraterminal front-wall; in neanic stages the intraterminal front-wall is seen to be fairly well arched and composed of about 10 thin costæ, rather widely spaced, with no lateral fusions, each bearing a single pelmatidium towards its distal end, and firmly fused in the median line in a broad area of fusion; secondary aperture, from circular to a somewhat pointed oval with its long axis transverse and its proximal side a little more flattened than its distal side, surrounded by a complete rim formed of secondary tissue connecting the apertural aviculœcia; the rim is highest proximally and distally—that is, is fundamentally formed by proximal and distal shields. Aviculœcia of three kinds:—(1) apertural; these are irregular in size and number, but typically four, never large, typically small, somewhat elongated, with blunt apertures, slightly constricted and divided by a transverse bar into a larger rostrum and a smaller proximal portion; they are directed towards the centre of the orthœcial aperture they accompany; (2) small occasional sporadic aviculœcia, situated in the interœcial secondary tissue and generally resembling the apertural aviculœcia; (3) large occasional sporadic aviculœcia; these vary in size and shape, some being as big or nearly as big as orthœcia and others not half as big, but always decidedly larger than the first two classes, sometimes of the same proportions as these, and sometimes comparatively twice as long; otherwise their characters resemble the first two classes; they are generally directed distally; all aviculœcia have buttress-like ridges on their sides.

Distribution.—Unknown.

Type-specimen.—D. 29078.

Remarks.—Considering that all the other known species of *Cœlopora* come from the *B. mucronata*-zone and all but one from Rügen, it is likely that the specimen on which this species is founded came, if not from Rügen, from some locality in the *B. mucronata*-zone. For the probable relationship of this form, see the phylogeny on p. 129.

Figures.—Text-fig. 41. Orthœcium with an ovicell and four apertural aviculœcia.

Plate II, fig. 11. Part of the type-specimen, showing a complete neanic ephebœcium, parts of other ephebœcia, the lowest of which bears an ovicell, apertural aviculœcia, and one of the large sporadic aviculœcia. × about 27 diameters.

LIST OF SPECIMENS.

D. 29078. D. 29071–7. D. 29079. Type-specimen and eight paratypes. Fragmentary asties. Locality and horizon unknown. Toulmin Smith collection. 1869.

Fig. 41.—*Cœlopora latebrosa.* Diagram of an orthœcium and four apertural aviculœcia, from above. × about 75 diameters.

4. Cœlopora specus (Lang).

Antropora specus, sp. n.; Lang, 1916, pp. 91, 92; *B. mucronata*-zone; Rügen.

Diagnosis.—*Cœlopora* with tertiary front-wall imperfect or absent; typically 4 or 5 apertural aviculœcia; much interœcia secondary tissue; an orthœcium about 1 mm. long; and an incrusting unilaminar asty.

DESCRIPTION.—Asty incrusting, unilaminar; œcia dimorphic. Orthœcia about 1 mm. long and ·66 mm. wide, elliptical, blunt distally; extraterminal front-wall hidden beneath secondary tissue, which is well developed and has few, if any, lacunæ; intraterminal front-wall arched, but, owing to the great development of secondary tissue, much sunk beneath the general level of the asty; consisting of about eight visible costæ, and probably two or three more distally, hidden beneath secondary tissue, with no lateral fusions, each bearing a single pelmatidium towards its distal end, and firmly united in a broad median area of fusion, which is largely covered with a tongue of secondary tissue spreading proximally from the median proximal apertural aviculœcium; this tongue of secondary tissue covers up the pelmatidia of all except the most proximal costæ; apertural bar hidden beneath secondary tissue, which forms, with the apertural aviculœcia, the proximal shield of the secondary aperture; very often it is also concealed by a median proximal apertural aviculœcium; distal shield of the secondary aperture similarly formed; secondary aperture sub-circular with a somewhat flattened proximal edge. Aviculœcia grouped round each orthœcial aperture, but possibly there is also an occasional sporadic aviculœcium in the interœcial secondary tissue; apertural aviculœcia are variable in number and position, but apparently are typically five—a proximal-lateral pair, a distal-lateral pair, and a median proximal one, all directed towards the centre of the orthœcial aperture they accompany; they are also unequally and irregularly raised—sometimes, for instance, one proximal-lateral aviculœcium rides high on the apertural rim, while its fellow is down at the general level of the asty; the distal ends of the proximal-lateral apertural aviculœcia do not reach the edge of the secondary aperture, and, consequently, do not impinge upon its outline; the distal pair, especially, tends to be asymmetrically placed; the aviculœcia also vary in size; the apertures are oblong, tending to be narrow distally, and divided by a bar into a larger rostrum and a smaller proximal portion; there are buttress-like ridges on the sides of the aviculœcia.

DISTRIBUTION.—Upper Senonian, Campanian, zone of *B. mucronata*. Rügen.

TYPE-SPECIMEN.—D. 15362.

REMARKS.—See under the genus *Cœlopora* and the phylogeny on p. 129.

FIGURES.—Text-fig. 42. Orthœcium and five apertural aviculœcia.

LIST OF SPECIMENS.

D. 15362. D. 14116. D. 15350. The type-specimen and two paratypes. Fragmentary asties. Senonian, Campanian, zone of *B. mucronata*. Rügen. Agnes Laur collection. 1906, 1909.

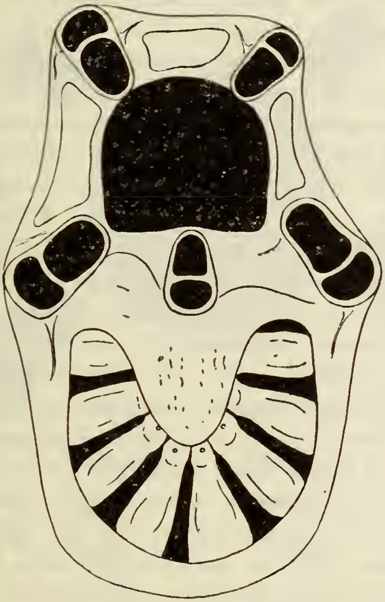


Fig. 42.—*Cœlopora specus.* Diagram of an orthœcium and five apertural aviculœcia, from above. × about 75 diameters.

5. Cœlopora cavernosa (Lang).

Antropora cavernosa, sp. n.; Lang, 1916, pp. 91, 92; *B. mucronata*-zone; Rügen.

Antropora cavernosa Lang; Lang, 1917, 169.

Cœlopora cavernosa (Lang); Lang, 1917, p. 169.

DIAGNOSIS.—*Cœlopora* with a nearly complete tertiary front-wall, or lamina peristomica. On this are shallow lacunæ of a mazy shape. A U-shaped fenestra is present over the intraterminal front-wall, through which this structure sometimes may be seen. The secondary apertures are very large.

Description.—Asty erect, solid, compressed-cylindrical; œcia dimorphic. Orthœcia very large, about 1·25 mm. long and about ·75 mm. wide, elliptical, blunter distally; extraterminal front-wall entirely hidden beneath interœcial secondary tissue, which is very strongly developed and has large irregularly shaped median lacunæ; intraterminal front-wall almost entirely concealed beneath secondary tissue, since the interœcial tissue encroaches laterally and tends to meet a wide tongue of secondary tissue, which, spreading proximally from the aperture, encroaches on the intraterminal front-wall in the median area; thus the circum-apertural secondary tissue, spreading generally on all sides, and particularly in a long tongue proximally, together with the greatly developed interœcial secondary tissue, covers the whole surface of the asty with a tertiary front-wall, which is pierced only by the apertures of the orthœcia and aviculœcia, and by a more-or-less developed U-shaped fenestra, through which the intraterminal front-wall is partly visible; the orthœcial boundaries are shown only by the mazy lacunæ of the secondary tissue; the intraterminal front-wall is well arched, and formed of about twelve thin, rather widely spaced costæ, with no lateral fusions, each bearing a pelmatidium towards its distal end, and firmly fused medianly; but its characters can be seen only in the neanic or earlier stages; secondary aperture circular, surrounded with a complete wide and high rim, so as to be nearly tubular, with the apertural aviculœcia buttressing its sides. Aviculœcia rather irregularly distributed and spaced, from two to four, apertural in position, one at each of the proximal-lateral and distal-lateral corners, and directed towards the centre of the secondary orthœcial aperture they surround; somewhat variable in size and shape, but generally with blunt apertures, somewhat constricted laterally and divided by a bar into a larger rostrum and a smaller proximal portion.

Distribution.—Senonian, Campanian, zone of *B. mucronata*. Rügen.

Type-specimen.—D. 15438.

REMARKS.—*Cœlopora cavernosa* may have been derived from *C. spelunca* by increase in size, and by the development of a complete tertiary front-wall and an erect compressed-cylindrical asty.

FIGURES.—Text-fig. 43. Orthœcium and four apertural aviculœcia, from above. × about 75 diameters.

Plate II, fig. 12. Part of the type-specimen, showing two complete orthœcia, portions of others, and several apertural aviculœcia. × about 27 diameters.

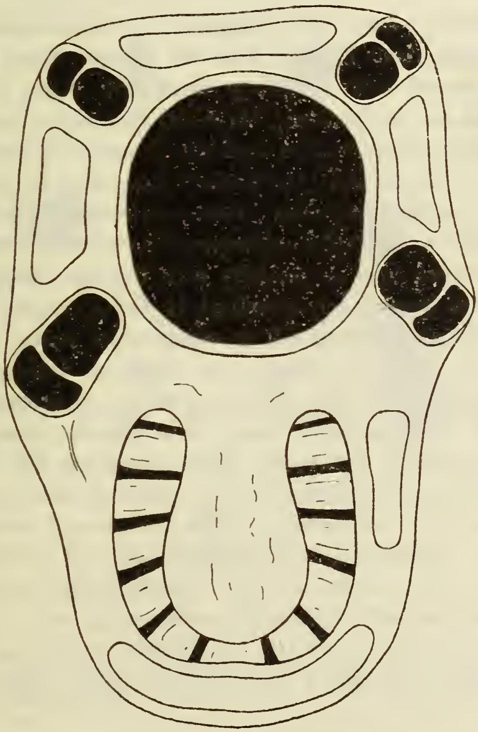


Fig. 43 —*Cœlopora cavernosa*. Diagram of an orthœcium and four apertural aviculœcia, from above. × about 75 diameters.

LIST OF SPECIMENS.

D. 15438. D. 15002. D. 16598. D. 18122. D. 18544. Type-specimen and four paratypes. Fragmentary asties. Senonian, Campanian, zone of *B. mucronata.* Rügen. Agnes Laur collection. 1906, 1909.

6. Cœlopora lunaris (Lang).

Antropora lunaris, sp. n.; Lang, 1916, pp. 91, 92; Campanian; Meudon.

Diagnosis.—*Cœlopora* with a complete tertiary front-wall, which has no mazy lacunæ. A semi-lunar fenestra, through which the intraterminal front-wall may be seen, is present immediately proximal to the aperture, which is comparatively smaller than those of *C. cavernosa.*

Description.—Asty erect, bilaminar; œcia dimorphic. Orthœcia very large, about 1·1 mm. long and ·65 mm. broad, elliptical; the whole covered with a tertiary front-wall, which, besides the aperture, has several openings; the distal openings are assumed to be the apertures of apertural aviculœcia, the proximal ones fenestræ in the tertiary front-wall; the tertiary front-wall is, presumably, formed by apertural secondary tissue coalescing with interœcial secondary tissue; the latter overarches the secondary intraterminal front-wall, which may be partially seen through the large semi-lunar fenestra immediately proximal to the aperture; it is clear that the secondary front-wall is composed of costæ, and these appear to be of the same nature as those of *Cœlopora*; as in *C. specus* and *C. cavernosa*, there is a tongue of secondary tissue covering the median area of fusion; this, however, does not form part of the tertiary front-wall, which overarches this tongue of tissue, and is continued distally to the semi-lunar fenestra as a very wide apertural rim; secondary aperture circular and surrounded by a thick rim. Aviculœcia: presumably about four apertural aviculœcia, short, rather small, with blunt apertures, and an occasional much larger sporadically distributed aviculœcium, with an elongated aperture, tending to be pointed, constricted laterally and divided by a transverse bar into a long rostrum and a short proximal portion.

Distribution.—Senonian, Campanian, zone of *B. mucronata.* Meudon, S.W. of Paris; and Dorset.

Type-specimen.—In Mr. Canu's collection, Versailles. A second specimen, from the zone of *B. mucronata* of Dorset, is in the collection of Dr. Rowe of Margate.

Remarks.—From *C. cavernosa* and the other species with a complete tertiary front-wall *Cœlopora lunaris* differs in having numerous small fenestræ proximal to the large semi-lunar fenestra. The intraterminal front-wall appears to be Tricephaloporine; and the tongue of secondary tissue covering its median area of fusion is like that of many members of this subfamily. The gigantic size of *C. lunaris*, and the apparent irregularity in the number, position, and size of its aviculœcia, suggest the genus *Cœlopora*, with which it may be placed provisionally.

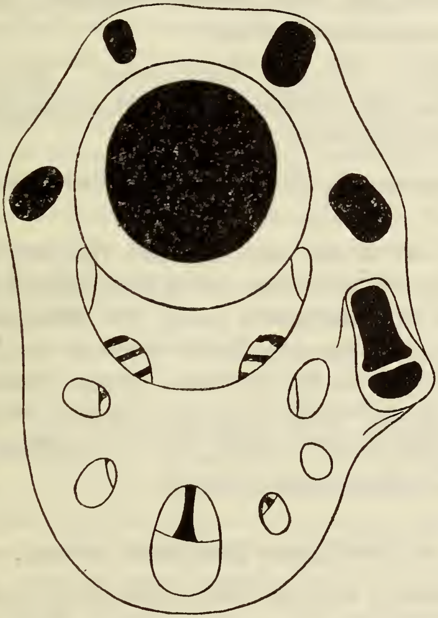


Fig. 44.—*Cœlopora lunaris*. Diagram of an orthœcium, four (presumed) apertural aviculœcia, and a large sporadic aviculœcium, from above. The proximal openings are interpreted as fenestræ in the tertiary front-wall. × about 75 diameters.

Figures.—Text-fig. 44. Orthœcium, four apertural aviculœcia and one sporadic aviculœcium.

Specimens.—Only a photograph of the type-specimen.

7. Cœlopora variolaria (Leymerie).

Pustulopora variolaria; Leymerie, 1851, pp. 192, 201, pl. ix, fig. 8, *a*, *b*, *c*; marnes à *Orbitolites*; Barade près de Gensac; Monléon.

Siphoniotyphlus variolaria (Leymerie); Gregory, 1899, p. 279; Maastrichtian; Bois de la Barade, near Gensac.

Beisselina variolaria Leymerie; Canu, 1920, pp. 199, 211, pl. vi, figs. 12–13; Maastrichtien: Gensac, Latoue, Saint-Gaudens.

Diagnosis.—*Cœlopora* with a complete tertiary front-wall without mazy lacunæ; with no semi-lunar fenestra proximal to the apertures; with large, blunt, sporadic aviculœcia; asty erect, bilaminar, or compressed-cylindrical.

Distribution.—Senonian, Maastrichtian. Bois de Barade, Gensac, Latoue, Saint-Gaudens, all in Haute-Garonne, France; Royan, Charente-Inférieure, France.

Type-specimen.—In l'École des Mines, Paris, see Canu, 1920, p. 186.

Remarks.—It is not surprising that Gregory, having only Leymerie's figure to guide him, should have included *Pustulipora variolaria* in *Siphoniotyphlus* among the Entalophorid Cyclostomes. Canu's photographic figures of this species, however, and his description of the type-specimen, clearly indicate a Cheilostome; and the general agreement with the more advanced species of *Cœlopora* make it nearly certain that it is congeneric with them.

Specimens.—None in the Collection.

8. Cœlopora pustulosa (Canu).

Beisselina pustulosa, n. sp.; Canu, 1920, pp. 196, 210, pl. iv, figs. 3, 4.

Diagnosis.—*Cœlopora* with a complete tertiary front-wall without mazy lacunæ; with no semi-lunar fenestra proximal to the apertures; with large, pointed, sporadic aviculœcia and many small, blunter, apertural aviculœcia; asty erect, bilaminar.

Type-specimen.—That figured by Canu, 1920, pl. iv. fig. 4, is hereby selected.

Distribution.—Senonian, Maestrichtian. Cazeneuve, Roquefort, Gensac, Saint-Gaudens, Saint-Marcet, all in Haute-Garonne, France; Royan, Charente-Inférieure, France.

REMARKS.—The particular relationships of Canu's *Beisselina pustulosa* are by no means clear, but the excellent photograph given by Canu renders it most probable that this species is a *Cœlopora*

SPECIMENS.—None in the Collection.

e. PNICTOPORINÆ, Lang, 1916.

Pnictoporinæ, subfam. nov.; Lang, 1916, pp. 83, 92.

DIAGNOSIS.—Pelmatoporidæ with very much reduced intraterminal front-walls and correspondingly enlarged extraterminal front-walls; the costæ are closely set, and have no lateral fusions, but apparently bear a normal pelmatidium distally (probably a secondary pelmatidium) and generally have a median longitudinal slot-like gash in their upper surface and proximal to the pelmatidium (probably representing the primary pelmatidium); a secondary aperture is formed by the bifurcation of (typically) six apertural spines and the fusing of their neighbouring branches to form hoop-like structures (fig. 45); secondary tissue enwraps the asty, often becoming bark-like and even corky in appearance.

DISTRIBUTION.—Senonian, Lower Santonian, zone of *M. coranguinum*; and Coniacian, zone of *M. cortestudinarium*.

REMARKS.—The extreme reduction of the intraterminal front-wall of the Pnictoporinæ, approached in the Pelmatoporidæ only in such forms as *Tricephalopora sherborni*, renders difficult the certain elucidation of its structure. In many specimens it is choked with secondary tissue; and in those in which it can be seen, little can be made out beyond the fact that it consists of costæ united in a median area of fusion. This is partly owing to bad preservation, and partly to the smallness of the structures involved. A few specimens, however, show more than this, and in some (e. g. **D. 24440**, a specimen of *Pnictopora suffocata*) it is possible to make out pelmatidia at the distal ends of certain costæ. Generally the costæ have also median longitudinal slots in their upper surfaces. Such slots are sometimes seen in other groups—in forms like *Decurtaria cornuta* (Beissel) possessing tertiary and secondary pelmata. It is, therefore, possible that the slots of *Pnictopora* are primary pelmatidia, and that the pelmatidia at the distal ends of the costæ are secondary. Since there are indications of secondary pelmatidia in *Tricephalopora saltdeanensis*, it is likely that the Pnictoporinæ are allied to the Tricephaloporinæ, and may have been derived from them by a great reduction of the intraterminal front-wall and a great development of a bark-like, investing secondary tissue. The Pnictoporinæ retain, however, the primitive character of six apertural spines (reduced to five in most cases by the fusion of the most distal pair), and, if derived from the Tricephaloporinæ, must have diverged very early from that stock. They have not the blunt sporadic aviculœcia of the primitive Tricephaloporines nor the large and still blunt, but definitely situated, aviculœcia of the more specialised species of that sub-family; but the aviculœcia are small, few, pointed, and definitely placed, resembling those of the Pelmatoporinæ rather than the aviculœcia of the Tricephaloporines. So their aviculœcia forbid us from deriving the Pnictoporinæ from any but a remote Tricephaloporine ancestor.

The secondary aperture of the Pnictoporinæ is peculiar (see fig. 45). The apertural bar takes no part in forming the proximal shield, but has merely a short median projection with a free distal end. High over this a hoop is formed by the fusion of the proximal halves of the bifurcating proximal pair of apertural spines. The distal forks similarly form hoops with the proximal forks of the bifurcating median pair of apertural spines, whose distal forks, in turn, form hoops with the bifurcations of the distal shield, which is formed by the coalescence of a distal pair of apertural spines. To put it in another way, the secondary aperture consists of a ring borne on five uprights—namely, a pair in the proximal-lateral corners of the aperture, a pair in the distal-lateral corners of the aperture, and a median distal one. The first pair are the proximal apertural spines; the second pair the median apertural spines; the single median distal upright is a distal shield, formed by the coalescence of the distal pair of apertural spines—shown by such a specimen as **D. 24489**, of *Pnictopora suffocata*, in which the two component spines are still separate. Now, suppose that each upright bifurcated and the neighbouring forks fused, this would produce a complete ring at the top of a secondary aperture.

One of the most remarkable features of the Pnictoporinæ is the nature of the secondary tissue and its great development. In its most primitive condition (*e. g.* as shown at one end of the type-specimen of *Pnictopora suffocata*, **D. 28525**), it consists of wavy, anastomosing, longitudinal ridges. A thin crust of secondary tissue then appears between the ridges, becomes thicker, and acquires a peculiar bark-like grain. The ridges become comparatively less prominent, and the secondary tissue tends to overrun the intraterminal front-walls and to swamp the apertures of the orthœcia and the aviculœcia. In *P. strangulata* the aviculœcia often hardly emerge from the choking investment of secondary tissue; while in *P. obstructa* they are seldom seen, and even the apertures of the orthœcia are sunk deep in the secondary tissue, which has become rugose and resembles corky bark.

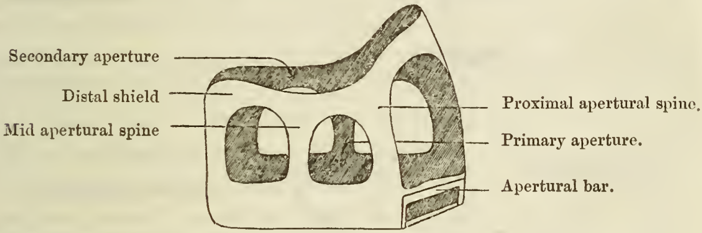


Fig. 45.—Diagram of the secondary aperture of *Pnictopora*. View from the side and partly from behind. Very much enlarged.

I. PNICTOPORA, Lang, 1916.

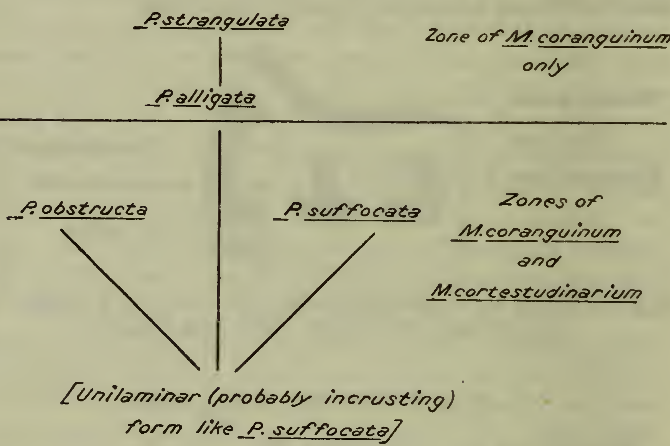
Pnictopora, gen. nov.; Lang, 1916, p. 92.
Pnictopora; Lang, 1919, p. 105.

Diagnosis.—As for the family.

Genotype.—*Pnictopora suffocata*, Lang.

Distribution.—As for the family.

Remarks.—Evolution within the genus *Pnictopora* is seen in the reduction of the number of aviculœcia and in the increase of investing secondary tissue. In *P. suffocata* there are frequently two aviculœcia situated distally with regard to a given orthœcium, and there is comparatively little secondary tissue. In *P. alligata* and in *P. strangulata* there is seldom, if ever, a pair of aviculœcia in connection with any one orthœcium, and there is always much secondary tissue of a barky consistency. In *P. obstructa* aviculœcia are rarely seen, but, when visible, consist of a pair to each orthœcium, and the secondary tissue has the appearance of an investment of corky bark. *P. suffocata* is thus the simplest form, leading, mainly by means of a reduction in the number of aviculœcia, to *P. strangulata*, and, mainly by a great increase of secondary tissue, to *P. obstructa*. But *P. alligata* is a unilaminar (probably incrusting) form of *P. strangulata*. It probably arose, then, from a unilaminar (probably incrusting) form of *P. suffocata*. The phylogeny, therefore, would be represented by the following scheme, and the stratigraphical evidence offers no contradiction to it:—



Key to the Species of *Pnictopora*.

A. Investment of secondary tissue, if well-developed, of a barky consistency, but not very rugose; aviculœcia singly or in pairs usually distal to the apertures of the orthœcia.

- I. Aviculœcia more numerous and less swamped by secondary tissue .... 1. *P. suffocata.*
- II. Aviculœcia less numerous and more swamped by secondary tissue.
  - *a.* Unilaminar, incrusting .... 2. *P. alligata.*
  - *b.* Erect, cylindrical (fig. 46) .... 3. *P. strangulata.*

B. Investment of secondary tissue very much developed and having the appearance of a rugose, corky bark; aviculœcia seldom visible, but, when present, in pairs proximal to the apertures of the orthœcia ... 4. *P. obstructa.*

1. Pnictopora suffocata, Lang.

Pnictopora suffocata, sp. n.; Lang, 1916, p. 92; *M. cortestudinarium*-zone; Luton, Kent.

Diagnosis.—*Pnictopora* in which the secondary tissue is comparatively poorly developed and the aviculœcia are comparatively numerous, often a pair distal to each orthœcial aperture.

Description.—Asty erect, cylindrical; œcia dimorphic. Orthœcia about ·66 mm. to ·8 mm. long, and ·3 to ·4 mm. wide, quadrilateral or very long-elliptical; extraterminal front-wall very well developed, arched and smooth where not covered with secondary tissue; intraterminal front-wall exceedingly small, and often obliterated by secondary tissue, consisting of some eight or ten closely-placed costæ with no lateral fusions, but generally with a longitudinal median slot, sometimes, if not always, with a distal pelmatidium, and united in a median line of fusion; apertural bar with a median projection; primary aperture rather longer than wide, sub-circular with a flattened proximal side; proximal shield of the secondary aperture formed of the proximal pair of apertural spines, which bifurcate and meet each other in their proximal forks, while their distal forks meet similar bifurcations of the median apertural spines, which in turn are joined by the distal forks of their bifurcations to the distal shield; distal shield formed by the coalescence of the distal pair of apertural spines. Aviculœcia, a single one, or a pair, distal to each aperture, more-or-less surrounded by secondary tissue, but not, as a rule, deeply buried in it; small, more-or-less distally directed, with a constricted aperture and a pointed, upwardly directed rostrum.

Distribution.—Senonian, Santonian, zone of *M. coranguinum*, and Coniacian, zone of *M. cortestudinarium*.

Type-specimen.—D. 28525.

Remarks.—See under the genus *Pnictopora*.

Figures.—Plate III, fig. 1. Part of the type-specimen, showing three complete orthœcia and eight aviculœcia. × about 27 diameters.

LIST OF SPECIMENS.

D. 24489. A specimen with barky secondary tissue with anastomosing ridges. The intraterminal front-walls are fairly well exposed. In one orthœcium the apertural spines of the distal pair have not fused to form a distal shield. Senonian, zone of *M. coranguinum*. Gillingham, N.E. of Chatham, Kent. Collected by W. Gamble, Esq. 1911.

D. 24492. A specimen with little secondary tissue besides the anastomosing ridges. The intraterminal front-walls are well exposed. From the same horizon, locality, and collection as **D. 24489.**

D. 21187. Paratype. A worn specimen with barky secondary tissue. Senonian, zone of *M. coranguinum*. Harefield, N. of Uxbridge, Middlesex. Collected by L. Treacher, Esq., F.G.S. 1911.

D. 21185. A worn specimen with comparatively little secondary tissue. Senonian, low in zone of *M. coranguinum*. Cookham Dean Common, N.W. of Maidenhead, Berks. Collected by L. Treacher, Esq., F.G.S. 1911.

D. 4368. D. 14976–7. Three paratypes. Senonian, low in the zone of *M. coranguinum* or the zone of *M. cortestudinarium*. Chatham, Kent. Collected by W. Gamble, Esq. 1898.

D. 21186. A paratype, with little secondary tissue, and with intraterminal front-walls clearly shown. Senonian, base of *M. coranguinum* zone, or top of *M. cortestudinarium* zone. Great Central Railway Cutting, Loudwater, S.E. of High Wycombe, Bucks. Collected by L. Treacher, Esq., F.G.S. 1911.

D. 8179. A worn paratype, with a fair amount of secondary tissue; but this does not obliterate the intraterminal front-walls, which are well exposed. Senonian, high in the zone of *M. cortestudinarium*. Luton, S.E. of Chatham, Kent. W. Gamble Coll. 1903.

D. 28523–4. Two paratypes, with much secondary tissue, which entirely obliterates the intraterminal front-walls. Same horizon, locality, and collection as **D. 8179.**

D. 24438–41. Four specimens. **D. 24438**, much worn, **D. 24439** and **D. 24441** with barky secondary tissue and intraterminal front-walls well preserved, and **D. 24440** with less secondary tissue and well-preserved intraterminal front-wall. One orthœcium of **D. 24440** clearly shows a costa with a distal pelmatidium. Same horizon, locality, and collection as **D. 8179.** 1911.

D. 28525. Type-specimen, with but little secondary tissue and the intraterminal front-walls well preserved. Senonian, zone of *M. cortestudinarium*. Luton, S.E. of Chatham, Kent. Collected by W. Gamble, Esq. 1906.

D. 8531. A rather worn paratype, Same horizon, locality, and collection as **D. 28525.**

D. 24921. A worn specimen with much secondary tissue. Senonian, zone of *M. cortestudinarium*. Luton Valley, S.E. of Chatham, Kent. Collected by W. Gamble, Esq. 1911.

D. 27047–8. Two paratypes, the former with little and the latter with a fair amount of secondary tissue. Senonian, zone of *M. cortestudinarium*. Lower Pit, Slines Oak, Worms's Heath, Warlingham, Surrey. F. Möckler Collection. 1912.

2. Pnictopora alligata, Lang.

Pnictopora alligata, sp. n.; Lang, 1916, p. 92; *M. coranguinum*-zone; Gillingham, Kent.

Diagnosis.—Unilaminar and, probably, incrusting *Pnictopora*, in which the secondary tissue is well developed and of a barky consistency, but not very rugose or corky; the aviculœcia are not so numerous as in *P. suffocata*, are usually placed distally with regard to the aperture of the orthœcium, are seldom if ever paired, and are generally much sunk in secondary tissue.

Description.—Asty incrusting, unilaminar; œcia dimorphic. Orthœcia about ·8 mm. long and about ·4 mm. wide, long-elliptical; extraterminal front-wall of great extent, but covered with secondary tissue; one orthœcium of the type-specimen, apparently in a neanic stage, has very little secondary tissue; intraterminal front-wall generally covered with secondary tissue, but, when visible, seen to consist of about eight or ten costæ, whose characters are obscure, but, presumably, similar to those of the costæ of *P. strangulata*; apertural bar with a short median projection; primary aperture more-or-less circular, but longer than wide, with a flattened proximal side, and somewhat narrower proximally than distally; secondary aperture formed as in the other species, namely by the bifurcation of five uprights formed by a proximal pair, a median pair, and a coalesced distal pair, of apertural spines, and a fusion of the neighbouring forks of these bifurcating uprights so as to form a complete secondary apertural ring. Aviculœcia, an occasional small aviculœcium generally placed distally to the orthœcial apertures, with pointed rostra, directed more or less distally.

Distribution.—Senonian, Santonian, zone of *M. coranguinum*. Gillingham, N.E. of Chatham, Kent.

Type-specimen.—D. 8283. W. Gamble collection. 1905.

Remarks.—*Pnictopora alligata* appears to differ from *P. strangulata* mainly in the form of the asty, which is unilaminar and probably incrusting. Probably it was derived from a unilaminar incrusting form otherwise resembling *P. suffocata*, and, in turn, gave rise to *P. strangulata*.

Figures.—Plate III, fig. 2. Part of the type-specimen, showing two complete orthœcia, the distal end of a third orthœcium, and two aviculœcia. × about 27 diameters.

Specimens.—The type-specimen. Distribution and collection as above.

3. Pnictopora strangulata, Lang.

Pnictopora strangulata, sp. n.; Lang, 1916, p. 92; *M. coranguinum*-zone; Span Hill, Oxon.

Diagnosis.—Erect cylindrical *Pnictopora* in which the secondary tissue is well developed and of a barky consistency, but not very rugose or corky; the aviculœcia are not so numerous as in *P. suffocata*, usually placed distally to the orthœcial apertures, seldom, if ever, paired, and generally very much sunk in secondary tissue.

Description.—Asty erect, cylindrical; œcia dimorphic. Orthœcia about ·8 mm. to 1 mm. long and about ·4 mm. wide, long-elliptical; extraterminal front-wall of great extent, but hidden beneath the investment of secondary tissue, which has a bark-like grain and anastomosing longitudinal ridges; intraterminal front-wall often also covered with secondary tissue, but, when visible, is seen to be very small, rather flat, and composed of about eight closely-placed costæ with no lateral fusions, but with a median longitudinal slot (probably the primary pelmatidium) and, presumably, a distal (secondary) pelmatidium, and united in a median line of fusion; apertural bar with a median distal projection; primary aperture sub-circular, rather longer than wide and somewhat flattened proximally; secondary aperture formed as in the other species, namely, of a distal horizontal rim carried on five uprights; the horizontal rim is formed of the bifurcations of the five uprights each fused with its neighbour; the five uprights are the proximal pair of apertural spines, the median pair of apertural spines, and the distal pair which have coalesced to form a distal shield. Aviculœcia much sunk in secondary tissue, usually, if not always, occurring singly and placed distally to the orthœcial apertures; small, with pointed apertures, generally distally directed.

Distribution.—Senonian, Santonian, zone of *M. coranguinum.*

Type-specimen.—D. 21180.

Fig. 46.—*Pnictopora strangulata.* Diagram of an orthœcium and aviculœcium, from above. × about 75 diameters.

Remarks.—See remarks under the genus *Pnictopora.*

Figures.—Text-fig. 46. Orthœcium and aviculœcium.

Plate III, fig. 3. The type-specimen, showing four complete orthœcia, the apertures (viewed sideways) of two other orthœcia, and four aviculœcia. × about 27 diameters.

LIST OF SPECIMENS.

D. 21180. Type-specimen. A specimen with a fair amount of bark-like secondary tissue, but a well-exposed intraterminal front-wall, and with well-preserved secondary apertures. Senonian, high in the zone of *M. coranguinum.* Span Hill, Oxon, N.W. of Sonning, Berks. Collected by L. Treacher, Esq., F.G.S. 1911.

D. 21177. A paratype, with much secondary tissue and well-preserved secondary apertures. Senonian, high in the zone of *M. coranguinum*. Chazy Farm, Oxon, W. of Caversham, Reading. Collected by L. Treacher, Esq., F.G.S. 1911.

D. 8326. D. 24490. Specimens with very high ridges of secondary tissue. D. 8326 is a paratype. Senonian, zone of *M. coranguinum*. Gillingham, N.E. of Chatham, Kent. Collected by W. Gamble, Esq. 1905, 1911.

D. 8064. D. 8065. D. 8337. D. 24491. Specimens with much secondary tissue with a bark-like grain. All except the last are paratypes. Same horizon, locality, and collection as the last. 1903, 1905, 1911.

D. 8063. A paratype with much secondary tissue, showing a bark-like grain, and with well-preserved secondary apertures. At one end of the specimen there appear to be perforations in the secondary tissue covering the extraterminal front-wall. Same horizon, locality, and collection as the last. 1903.

D. 8158. A paratype with much secondary tissue, which shows bark-like grain, with well-preserved secondary apertures, and well-exposed intraterminal front-walls. Same horizon, locality, and collection as the last. 1903.

D. 21178–9. Two worn paratypes. Senonian, zone of *M coranguinum*. Wooburn Green, S.W. of Beaconsfield, Bucks. Collected by L. Treacher, Esq., F.G.S. 1911.

D. 21181–2. Two worn paratypes. The former shows a well-preserved secondary aperture. Senonian, lower part of the zone of *M. coranguinum*. Bourne End, E. of Marlow, Bucks. Collected by L. Treacher, Esq., F.G.S. 1911.

4. Pnictopora obstructa, Lang.

Pnictopora obstructa, sp. n.; Lang, 1916, pp. 92, 93; *M. coranguinum*-zone: Wooburn Green, Bucks.

Diagnosis.—Erect, cylindrical *Pnictopora* in which the investment of secondary tissue is developed to such an extent that it presents a corky appearance and has a rugose surface, in which the apertures are deeply sunk. Aviculœcia are seldom seen, but may occur in pairs proximal to the apertures of the orthœcia.

Description.—Asty erect, cylindrical; œcia dimorphic. Orthœcia about 1 mm. long and about ·4 mm. wide, long-elliptical; extraterminal front-wall, presumably of great extent, but entirely covered up by secondary tissue; intraterminal front-wall likewise concealed, as a rule, but occasionally partially shown, when it is seen to consist of eight or ten costæ with no lateral fusions, but united in a median line of fusion; secondary aperture presumably formed as in the other species. Aviculœcia seldom seen, but one specimen (**D. 21184**) shows a pair, deeply sunk in the secondary tissue, lying in the proximal-lateral corners of each aperture, small, pointed and distally directed; secondary tissue, very thick, cork-like and rugose.

Distribution.—Senonian, Santonian, zone of *M. coranguinum*, and Coniacian, zone of *M. cortestudinarium.*

Type-specimen.—**D. 21183.**

Remarks.—When the aviculœcia are visible they appear to be comparatively numerous—that is, a pair to each orthœcium. This circumstance and the fact that *Pnictopora obstructa* occurs in the *M. cortestudinarium* as well as in the *M. coranguinum* zone render it probable that *Pnictopora obstructa* was independently derived from a form resembling *P. suffocata.*

Figures.—Plate III, fig. 4. Part of the type-specimen, showing six orthœcial apertures and an aviculœcium. Two of the apertures show a few apertural spines. The rest of the figure represents very rugose secondary tissue. × about 27 diameters.

LIST OF SPECIMENS.

D. 21183. Type-specimen. There is much rugose secondary tissue in which no aviculœcia or intraterminal front-walls are shown. Senonian, zone of *M. coranguinum.* Wooburn Green, S.W. of Beaconsfield, Bucks. Collected by L. Treacher, Esq., F.G.S. 1911.

D. 21184. Paratype. A specimen with rather less secondary tissue, with a pair of aviculœcia in the proximal-lateral corners of the aperture of each orthœcium, and with the intraterminal front-walls, at least partially, visible. Senonian, base of the zone of *M. coranguinum* or top of the zone of *M. cortestudinarium.* Great Central Railway Cutting, near Loudwater, S.E. of High Wycombe, Bucks. Collected by L. Treacher, Esq., F.G.S. 1911.

D. 8174. D. 28520–1–2. Four worn paratypes, with much secondary tissue. Senonian, zone of *M. cortestudinarium.* Luton, S.E. of Chatham, Kent. Collected by W. Gamble, Esq. 1903.

f. CASTANOPORINÆ, Lang, 1916.

Castanoporinæ, subfam. nov.; Lang, 1916, pp. 83, 93.

Diagnosis.—Pelmatoporidæ with primary, secondary, tertiary, and even higher orders of pelmatidia, and with lateral costal fusions corresponding in number and position to the pelmatidia.

Distribution.—Senonian, Santonian, zone of *Marsupites* to Danian; chiefly in the Senonian, Campanian, zone of *B. mucronata.*

Remarks.—The Castanoporinæ may be known at once from all other Pelmatoporidæ by having three or more pelmatidia on every costa, and intercostal fusions corresponding in number and position to the pelmatidia. In this respect they resemble, and in a general way form homœomorphic series with, the Pelmatoporinæ, the more advanced members of which have three or even more pelmata on every costa. Doubtless in both subfamilies the peculiar intraterminal front-wall built up by these costæ, recalling in the case of the Pelmatoporinæ the sole of a hob-nailed boot, and in the Castanoporinæ a nutmeg-grater, arose in the same manner. But, while in the Pelmatoporinæ the gradual stages from an intraterminal front-wall with a double median row of pelmata to one with six or more rows can be traced in different species, the simplest Castanoporinæ already have several rows of pelmatidia. The only comparable simpler forms are to be found in the Tricephaloporinæ, one of whose species (*Tricephalopora saltdeanensis*) has what may be the beginning of secondary pelmatidia; possibly in the Pnictoporinæ, which probably have secondary pelmatidia (see pp. 143–4); and in the Diacanthoporinæ, which have on each costa a proximal pelma and a distal pelmatidium. In none of these cases, however, are there lateral costal fusions; and, since the Pnictoporinæ contain none but highly specialised forms, probably derived from the Tricephaloporinæ, and the Diacanthoporinæ are a very small Danian group with no close resemblances to other Pelmatoporidæ, it is probable that the Castanoporinæ were derived from a primitive Tricephaloporine stock. Their development may have been brought about by the retreat of the primary pelmatidia, which drew with them their lateral connections with the neighbouring costæ, towards the proximal end of the costa on which they stand; by the formation of secondary pelmatidia at the distal ends of the costæ; and by the migration, in turn, of these secondary pelmatidia proximally, drawing with them their lateral fusions, and so on, until the intra-terminal front-wall has become a lattice-work with pelmatidia at the nodes. A similar process is diagrammatically shown in fig. 2 (p. 6), representing the development of the intraterminal front-wall in the Pelmatoporinæ. If pelmatidia be substituted for pelmata, the diagrams will equally well demonstrate the supposed development of the Castanoporine front-wall.

In their earlier forms the Castanoporinæ and Pelmatoporinæ are easily distinguished, but during development they tend to converge, since, without very careful scrutiny, the distinction between pelmata and pelmatidia is not always easy to maintain in some of the more advanced genera. Thus, *Phrynopora* might be confused with *Batrachopora*, and *Stichocados* with *Pachydera*. But in most cases the pelmatidium, unless much worn, is seen to be a far less conspicuous structure than the pelma. Moreover, in the Castanoporinæ the primary six apertural spines have not generally, as in the Pelmatoporinæ, become reduced to four, but vary somewhat irregularly from four to seven or more in the different species.

Evolution in the Castanoporinæ is shown in comparatively few characters. In contrast to the Tricephaloporinæ and the Pnictoporinæ, there is no remarkable development of interœcial secondary tissue. It is generally absent, or nearly so, but a fair amount is present in *Carydiopora*. Superfluous calcium carbonate is chiefly used in the elaboration of the intra-terminal front-wall and the secondary aperture, which in advanced genera may spread laterally and form a lamina peristomica. The size of the orthœcium, the number of costæ, the number of pelmatidia, and, correlated with the last, the number of lateral costal fusions all increase. The orthœcium tends to become more parallel-sided, but the Castanoporine orthœcium is generally well arched, with curved sides—in fact, has much the shape of a barrel bisected longitudinally.

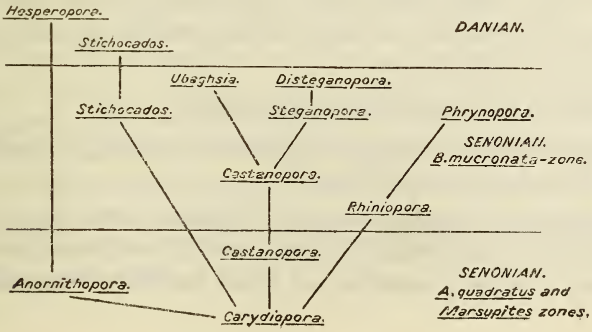
The best key, however, to the evolution of the Castanoporinæ is afforded by the aviculœcia. The primitive Tricephaloporinæ, which probably represent the nearest approach to the ancestors of the known Castanoporinæ, have numerous, sporadically distributed, indifferently directed, monomorphic, small, aviculœcia with blunt apertures; and these tend during evolution to become definitely placed, definitely directed, polymorphic, larger and with pointed apertures. The aviculœcia of the Castanoporinæ manifest the same tendencies and become less numerous during evolution. But these tendencies differ in relative importance and precedence. The most potent and first modification of the generalised Castanoporine aviculœcium is the producing of the rostrum to a sharp point; whereas in the Tricephaloporinæ blunt aviculœcia are characteristic and found even in advanced genera. The next important modification is dimorphism, and this is correlated with the orientation of the aviculœcium. Early in Castanoporine evolution two kinds of aviculœcium are found, namely, those with short rostra, irregularly, but more or less proximally, directed; and those with long rostra, generally, but not always, distally directed. The next most important modification is the tendency to lose the aviculœcia. But this at first affects the shorter, proximally-directed aviculœcia only. Lineages which have not yet developed dimorphic aviculœcia tend to lose their aviculœcia altogether and produce such forms as *Anornithopora.* Those in which both kinds of aviculœcia are present in the early terms give rise to forms like *Castanopora glandulosa* with elongate, distally-directed aviculœcia only, *Rhiniopora aspera* with shorter, proximally-directed aviculœcia only, and *R. scabra* with no or very few aviculœcia.

From the foregoing conclusions it is manifest that *Carydiopora*, with small orthœcia, comparatively few costæ, pelmatidia, and lateral costal fusions, and rather small aviculœcia, indefinitely placed, variously (though generally somewhat proximally) directed, monomorphic, and only moderately pointed, is the most primitive genus of the Castanoporinæ. And it is likely that *Anornithopora* arose directly from *Carydiopora* by the loss of the aviculœcia. *Hesperopora*, with a well-developed secondary aperture, is possibly a derivative of *Anornithopora*; and *Stichocados*, the remaining genus with small orthœcia, few costæ, and no or few aviculœcia, probably had an independent origin from *Carydiopora*, and tends to lose its aviculœcia, while retaining a primitively small number of costæ, and acquires a fenestrated secondary aperture. These three genera, *Anornithopora, Hesperopora*, and *Stichocados*, are small, and comparatively unimportant, developments of *Carydiopora*. The two main branches that diverged from *Carydiopora* are represented by the genera *Rhiniopora* and *Castanopora.* In both genera the early species possess both long and short aviculœcia, but in *Rhiniopora* they are all variously and on the whole proximally directed, while in *Castanopora* two of the longer aviculœcia, situated more-or-less symmetrically one on each side of each aperture, are distally directed. *Rhiniopora* soon loses the longer aviculœcia and gradually tends to lose the shorter ones as well, while *Castanopora* retains the distally-directed ones and likewise gradually loses the aviculœcia with shorter apertures.

Phrynopora has proximally-directed aviculœcia with short apertures, and the orthœcia have a secondary aperture. Manifestly it was derived from *Rhiniopora*.

Judging from d'Orbigny's figures, *Steganopora* and *Disteganopora* have, at the proximal-lateral corners of the aperture, a pair of aviculœcia, on which a lamina peristomica is supported. On the other hand, these paired structures may be the proximal apertural spines. On the assumption that they are aviculœcia, *Steganopora* was probably derived from *Castanopora*. The same difficulty of interpretation occurs with regard to *Ubaghsia*; and it is complicated by some of Jullien's figures (referred by him to *Steganopora*) of species other than the genotype, in which small, sporadically placed, variously orientated, shortly rostrate aviculœcia occur, besides the larger pair of supposed aviculœcia at the proximal-lateral corners of the aperture. These smaller aviculœcia do not appear in the figure of the genotype. Assuming that there are paired aviculœcia in *Ubaghsia*, and that the small sporadic aviculœcia of Jullien's figures correspond to the proximally-directed aviculœcia with short apertures of the early *Castanopora* (e. g. *C. retrorsa*), then *Ubaghsia*, like *Steganopora*, is a derivative of *Castanopora* and differs from it by the possession of a lamina peristomica, and from *Steganopora* as well as *Castanopora* in having branched apertural spines.

The following scheme shows the suggested relationships:—



Key to the Genera of Castanoporinæ.

I. No tertiary front-wall formed.
- A. Small forms with comparatively few costæ (seldom more than about 16).
  - 1. Aviculœcia present, generally numerous, variously directed (figs. 47–50) .... I. *Carydiopora.*
  - 2. Aviculœcia absent, rare, or an apertural pair only.
    - *a.* No secondary aperture (figs. 51–2) .... II. *Anornithopora.*
    - *b.* A secondary aperture present.
      - *a.* Costæ finer, apertural ring solid (figs. 53–4). III. *Hesperopora.*
      - *b.* Costæ coarser; apertural ring with large perforations, or fenestræ (figs. 55–7) ...... IV. *Stichocados.*
- B. Large forms with numerous costæ (18 or more).
  - 1. If distally directed aviculœcia with very long rostra are present, they are sporadically distributed and rare.
    - *a.* No secondary apertures (figs. 58–62) .... V. *Rhiniopora.*
    - *b.* A secondary aperture present (figs. 63–4) ...... VI. *Phrynopora.*
  - 2. Frequent, generally paired, distally directed, aviculœcia with very long rostra present (figs. 65–70) .... VII. *Castanopora.*

II. A tertiary front-wall attained.
- A. Distal apertural spines not branched.
  - 1. Asty unilaminar .... VIII. *Steganopora.*
  - 2. Asty erect, bilaminar .... IX. *Disteganopora.*
- B. Distal apertural spines branched .... X. *Ubaghsia.*

I. CARYDIOPORA, Lang, 1916.

Carydiopora, gen. nov.; Lang, 1916, pp. 93, 94.

Diagnosis.—Castanoporinæ with no tertiary front-wall; of small size; with comparatively few costæ (10–20), and fairly numerous aviculœcia, variously oriented, though generally more-or-less proximally directed.

Genotype.—*Carydiopora nucula*, Lang.

Distribution.—Senonian, Càmpanian, zone of *A. quadratus* and Santonian, zone of *Marsupites.*

Remarks.—*Carydiopora* must be regarded as the least specialised of the Castanoporinæ, on account of its small size, the small number of costæ, pelmatidia, and costal fusions, but especially on account of its aviculœcia; these, in the less specialised lineage *Carydiopora nucula – C. myristica* are small, sporadically distributed, numerous, variously directed, with pointed, but not greatly elongated, rostra; in the lineage *C. nucella–C. gasteri* they are less numerous, apparently less elongate, but probably similar in other respects. The orthœcia of *C. nucula* are comparatively shorter than those of *C. nucella*, and the costæ fewer. The number of pelmatidia and costal fusions in both lineages appears to be two and three.

Key to the Species of *Carydiopora*.

A. Aviculœcia more numerous, costæ fewer, 10–14.
- I. No secondary aperture (fig. 47) .... 1. *C. nucula.*
- II. A secondary aperture present (fig. 48) .... 2. *C. myristica.*

B. Aviculœcia fewer, costæ more numerous, 16–20.
- I. No secondary aperture (fig. 49) .... 3. *C nucella.*
- II. A secondary aperture present (fig. 50) .... 4. *C. gasteri.*

1. Carydiopora nucula, Lang.

Carydiopora nucula, sp. n.; Lang, 1916, p. 94; *Marsupites*-zone; Brighton, Sussex.

Diagnosis.—*Carydiopora* with comparatively few (about 13) costæ; numerous aviculœcia; and no secondary aperture.

Description.—Asty unilaminar, incrusting; œcia dimorphic. Orthœcia about ·7 mm. long and about ·5 mm. wide, oval; extraterminal front-wall of small extent and more-or-less hidden by interœcial secondary tissue, which is rather scanty, and has large, elongate, or somewhat circular, lacunæ; intraterminal front-wall flatly arched, consisting of about twelve or fourteen costæ, each with two or three pelmatidia and two or three pairs of lateral fusions, and firmly united in a median band of fusion; apertural bar very wide with clearly-shown pelmatidia and a median process, but whether the latter was fused to the proximal pair of apertural spines is doubtful; aperture super-normal; apertural spines probably six in number, and somewhat thickened. Aviculœcia numerous, variously, but generally proximally, directed, with pointed, but not much elongated, rostra.

Distribution.—Senonian, Santonian, zone of *Marsupites.*

Type-specimen.—D. 28993. Brighton Cliffs, Sussex. Collected by C. T. A. Gaster, Esq., and presented by him, 1916.

Remarks.—Though more primitive than *Carydiopora nucella* in the number of costæ and aviculœcia, *C. nucula* is more advanced in the shape of the aviculœcia, which apparently are more elongate than those of *C. nucella* ; the apertural bar is more highly developed ; and the aperture is more advanced in shape than is that of *C. nucella.*

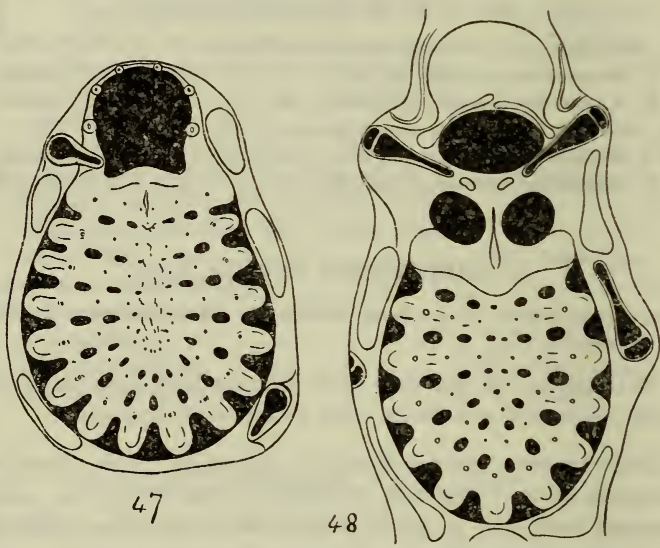


Fig. 47.—*Carydiopora nucula.* Diagram of an orthœcium and two aviculœcia from above. × about 75 diameters.

Fig. 48.—*Carydiopora myristica.* Diagram of an orthœcium with ovicell and three aviculœcia, from above. × about 75 diameters.

Figures.—Text-fig. 47. Orthœcium and two aviculœcia.

Plate III, fig. 5. Part of the type-specimen, showing three orthœcia and four aviculœcia. × about 27 diameters.

Specimens.—Type-specimen. Distribution and collection as above.

2. Carydiopora myristica *, new species.

Diagnosis.—*Carydiopora* with numerous aviculœcia; about 10–12 costæ; and a secondary aperture whose proximal shield is formed by the fusion of the median process of the apertural bar with the proximal pair of apertural spines, and often involves a pair of apertural aviculœcia.

Description.—Asty incrusting, unilaminar; œcia dimorphic. Orthœcia about ·7–·8 mm. long and ·4–·5 mm. wide, elliptical; extraterminal front-wall hidden beneath a rather abundant secondary tissue, which is full of irregularly-shaped, and sometimes mazy, lacunæ (*cf.* those of *Morphasmopora jukes-brownei*, fig. 12, p. 38); the intraterminal front-wall appears much flattened, mainly because it is sunk to the level of the interœcial secondary tissue, or below it; it consists of ten or twelve costæ, each of which has two or three pelmatidia, with as many lateral fusions at their levels, united in a median line of fusion; apertural bar wide, bearing one or two pairs of pelmatidia, and having a double median projection, which fuses with an enlarged proximal pair of apertural spines to form the proximal shield of a secondary aperture; two aviculœcia, obliquely and proximally directed, often lie along this pair of apertural spines, and their rostra, meeting, often join in the median fusion of the proximal apertural spines with the median process of the apertural bar; the distal shield of the secondary aperture is not so high as the proximal shield, and is formed by a general upgrowth of the distal apertural rim, reinforced by secondary tissue, which often has wavy median lacunæ; the apertural spines are, probably, six in number. Aviculœcia very numerous; nearly always an apertural pair, as already described, and many sporadically-distributed individuals, variously, and often proximally, directed; they vary somewhat in size and shape, but are generally nearly a third as long as the orthœcia; they are divided by a bar into a semicircular proximal portion and a very elongate-triangular rostrum; ovicells very conspicuous, often appearing at first sight as hyperstomial, but showing their endozoœcial nature by the profound position of their openings.

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* *Myristica*, the Nutmeg; referring to the general shape of the orthœcium.

Distribution.—Senonian, Santonian, zone of *Marsupites*, *Uintacrinus* band. Pit above Exceat New Barn, E. of Seaford, Sussex.

Type-specimen.—D. 29854. Collected by C. T. A. Gaster, Esq., and presented by him, 1919.

Remarks.—*Carydiopora myristica* may have been derived from *C. nucula* by the slight decrease in number of costæ, by the elongation of the aviculœcian rostra, and by the acquisition of a secondary aperture.

Figures.—Text-fig. 48. Orthœcium, and three aviculœcia.

Plate III, fig. 6. Part of the type-specimen, showing two complete ovicell-bearing orthœcia, each with a pair of apertural aviculœcia, other aviculœcia and parts of other orthœcia with ovicells. × about 27 diameters.

Specimens.—Type-specimen. Distribution and collection as above.

3. Carydiopora nucella, Lang.

Carydiopora nucella, sp. n.; Lang, 1916, p. 94; *A. quadratus*-zone, *E. depressus*-subzone; E. of Brighton, Sussex.

Diagnosis.—*Carydiopora* with comparatively many costæ (about 20); few aviculœcia; and no secondary aperture.

Description.—Asty incrusting, unilaminar; œcia dimorphic. Orthœcia about ·7 mm. long and ·4 mm. wide, elliptical; extraterminal front-wall of small extent, partly hidden by scanty interœcial secondary tissue with large elongate lacunæ; intraterminal front-wall well arched, consisting of about twenty costæ, each with three pelmatidia and two or three pairs of lateral fusions, and firmly united in a median band of fusion; apertural bar narrow with clearly-shown pelmatidia; aperture super-semicircular to subnormal; apertural spines apparently sometimes four and sometimes six, and somewhat thickened. Aviculœcia occasional, variously directed, apertures apparently somewhat pointed, but not much elongated; ovicells very prominent, but probably endozoœcial as in *C. myristica* and *C. gasteri* (which has very similar, but evidently endozoœcial, ovicells), much flattened above on the half nearest the aperture. (Hyperstomial ovicells are nearly always more-or-less keeled in that half.)

Distribution.—Senonian, Campanian, zone of *A. quadratus*, subzone of *E. scutata* var. *depressa*.

Type-specimen.—**D. 28995.** Cliffs between the last groyne East of Rottingdean Gap and Saltdean, East of Brighton, Sussex. Collected by C. T. A. Gaster, Esq., and presented by him, 1916.

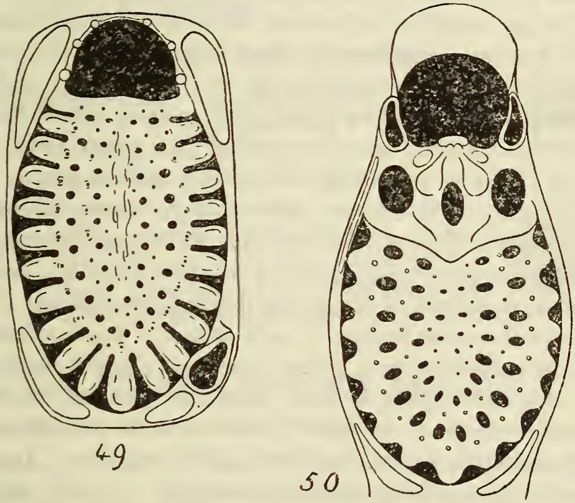


Fig. 49.—*Carydiopora nucella.* Diagram of an orthœcium and an aviculœcium, from above. × about 75 diameters.

Fig. 50.—*Carydiopora gasteri.* Diagram of an orthœcium with an ovicell and two aviculœcia, from above. × about 75 diameters.

Remarks.—See under *Carydiopora nucula.*

Figures.—Text-fig. 49. Orthœcium and aviculœcium.

Plate III, fig. 7. Part of the type-specimen, showing three complete orthœcia, one with an ovicell, and an aviculœcium. × about 27 diameters.

Specimens.—The type-specimen. Distribution and collection as above.

4. Carydiopora gasteri *, new species.

Diagnosis.—*Carydiopora* with few aviculœcia, about 16 costæ, and a secondary aperture whose proximal shield is formed by the fusion of a double process of the apertural bar with the proximal pair of apertural spines.

Description.—Asty unilaminar, incrusting; œcia dimorphic. Orthœcia about ·8 mm. long and ·4–·5 mm. wide, elliptical; extraterminal front-wall non-existent, or of very small extent, and then often hidden beneath a very scanty interœcial secondary tissue with narrow lacunæ; intraterminal front-wall well arched, and consisting of about sixteen costæ united in a median line of fusion; each costa has two or three pelmata and as many lateral fusions at their levels; apertural bar about as thick as a normal costa, having about two pairs of pelmatidia and a double median process with a perforation between the two halves; these halves, however, are fused distally with each other and with the enlarged proximal pair of apertural spines, thus forming the proximal shield of a secondary aperture; on the rim of the proximal shield, immediately distal to the proximal apertural spine of each side, is a small aviculœcium with a somewhat elongate, rather blunt, and slightly curved aperture; the distal shield is lower than the proximal shield, and apparently consists of the fused middle and distal pairs of apertural spines; apertural spines apparently six in number. Aviculœcia confined to the apertural pairs just described. Ovicells prominent, appearing at first sight hyperstomial, though not keeled like hyperstomial ovicells, but, on the contrary, much flattened above and on the half bearing the aperture, which is seen in perfect specimens to be profoundly situated, thus declaring its endozoœcial nature.

Distribution.—Senonian, Campanian, zone of *A. quadratus*, subzone of *A. quadratus*. Near Worthing, Sussex.

Type-specimen.—D. 29853.

Remarks.—*Carydiopora gasteri* may have been derived from *C. nucella* by a reduction in the number of costæ and the size of the aviculœcia, by bringing the aviculœcia into definitely fixed

* In recognition of the generosity of Mr. C. T. A. Gaster, of Lewes, who has presented to the Museum so many valuable Chalk Polyzoa.

positions, and by the formation of a secondary aperture. In connection with the proximal shield of the latter, it is of interest to note the partial separation between the two halves of the median process of the apertural bar—a process carried further in the Kelestominæ, so that in them the apertural bar becomes bifid.

Figures.—Text-fig. 50. Orthœcium and two aviculœcia.

Plate III, fig. 8. Part of the type-specimen, showing two complete orthœcia, each with an ovicell and a pair of apertural aviculœcia. × about 27 diameters.

LIST OF SPECIMENS.

D. 29853. Type-specimen. Senonian, Campanian, zone of *A. quadratus*, subzone of *A. quadratus*. Pit 7 of Gaster, Lambley's Lane, Sompting, N.E. of Worthing, Sussex. Collected by C. T. A. Gaster, Esq., and presented by him, Dec. 1919.

D. 29852. Paratype. Apparently with an erect unilaminar asty, but probably incrusting a perishable basis. From the same horizon as the last. Pit 9 of Gaster, Eastern pit E. of Charman Dean, N. of Broadwater, N. of Worthing, Sussex. Collected by C. T. A. Gaster, Esq., and presented by him, Dec. 1919.

II. ANORNITHOPORA, Lang, 1916.

Anornithopora, gen. nov.; Lang, 1916, p. 93.

Diagnosis.—Small Castanoporinæ with comparatively few costæ (20 or less), with no secondary aperture and no, or very few, aviculœcia.

Genotype.—*Anornithopora involucris*, Lang.

Distribution.—Senonian, Campanian, zone of *A. quadratus*.

Remarks.—*Anornithopora* may be regarded as derived from *Carydiopora* by the loss of aviculœcia. Of the three species composing the genus, *A. implumis* is the most primitive—*i. e.*, its œcia are small, the front-wall is less consolidated, and pelmatidia are fewer than in the other species. On the other hand, the number of costæ is greater than in *A. irrostrata*, which in this respect is either catagenetic or less advanced than *A. implumis*. *A. involucris* may have been derived directly from *A. implumis* by an increase in the number of pelmatidia and probably a catagenetic decrease in number of apertural spines. *A. irrostrata* is probably on a different lineage (though possibly also derived from *A. implumis*), being far more advanced in the consolidation of the intraterminal front-wall than either of the two preceding species (in fact, more than any other known Castanoporine), yet being more primitive in its apertural spines, at least than *A. involucris*, and having fewer pelmatidia than that species.

Key to the Species of *Anornithopora*.

A. Costæ about 15–20; intraterminal front-wall less consolidated.
- I. 2–3 pelmatidia and lateral costal fusions; apertural spines ? six .... 1. *A. implumis.*
- II. 6–7 pelmatidia and lateral costal fusions; apertural spines four (fig. 52) .... 2. *A. involucris.*

B. Costæ about 10–12; about 4 pelmatidia; apertural spines 5 (6 in early neanœcia); intraterminal front-wall more consolidated (fig. 51) .... 3. *A. irrostrata.*

1. Anornithopora implumis *, new species.

Diagnosis.—*Anornithopora* with a less consolidated intraterminal front-wall, about 15 costæ, 2 or 3 pelmatidia and lateral costal fusions, and, probably, 6 apertural spines.

Description.—Asty unilaminar, incrusting. Œcia monomorphic, about ·57 mm. long and ·3 mm. wide, elliptical; extraterminal front-wall of small extent; the intraterminal front-wall is very well arched, and consists of about fifteen costæ, each bearing a pelmatidium near its middle, but nearer the distal than the proximal end, and one or two pelmatidia between this and the distal end, with lateral fusions at the levels of the pelmatidia; the costæ are firmly fused in the mid-line; apertural bar flattened in a vertical plane and with a slight, wide, median projection; apertural spines probably six in number, rather large; apertures sub-normal.

Distribution.—Senonian, Campanian, zone of *A. quadratus*, upper part of the subzone of *E. scutata* var. *depressa*. Pit 4 of

* Implumis, "feather-less," *i. e.*, "bird-less," carrying on the idea in *Anornithopora* "having no aviculœcia."

Gaster, W. of Boundstone Lane, S. of Lancing Ring, N.E. of Worthing, Sussex.

Type-specimen.—D. 29855. Collected by C. T. A. Gaster, Esq., and presented by him, Dec. 1919.

Remarks.—*Anornithopora implumis* is easily distinguished from *A. involucris* by the fewness of its pelmatidia and lateral fusions; and from *A. irrostrata* by its more numerous costæ and its less-consolidated front-wall. It is the most primitive of the three species of *Anornithopora*, and almost certainly ancestral to *A. involucris*; it is also, possibly, the ancestor of *A. irrostrata*, which, while consolidating its intraterminal front-wall, retains a primitively small number of pelmatidia and lateral costal fusions.

Figures.—Plate III, fig. 9. Part of the type-specimen, showing five complete orthœcia, three of which bear broken ovicells. × about 27 diameters.

Specimens.—The type-specimen. Distribution and collection as above.

2. Anornithopora involucris, Lang.

Anornithopora involucris, sp. n.; Lang, 1916, p. 93; *A. quadratus*-zone, [*A. quadratus*-subzone]; N.E. of Worthing, Sussex.

Diagnosis.—*Anornithopora* with a less consolidated front-wall, about 18 costæ, many pelmatidia and lateral costal fusions (6–7), and 4 apertural spines.

Description.—Asty incrusting, unilaminar. Œcia monomorphic, about ·66 mm. long and ·33 mm. wide, elliptical; extraterminal front-wall of small extent, but not obscured by interœcial secondary tissue; intraterminal front-wall very well arched, consisting of about eighteen or more costæ, each with six or seven pelmatidia and lateral costal fusions, and firmly united in a median band of fusion; apertural bar much compressed in a proximal-distal direction, and with a slight median projection; apertural spines four and somewhat thickened; aperture super-semicircular.

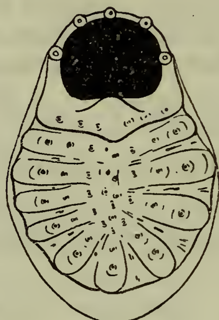
Distribution.—Senonian, Campanian, zone of *A. quadratus*, top of subzone of *E. scutata* var. *depressa*, and subzone of *A. quadratus*.

Type-specimen.—D. 28111.

Remarks.—See remarks under the genus *Anornithopora.*

Figures.—Text-fig. 52. An œcium.

Plate III, fig. 10. Part of the type-specimen, showing three complete orthœcia with broken ovicells. × about 27 diameters.



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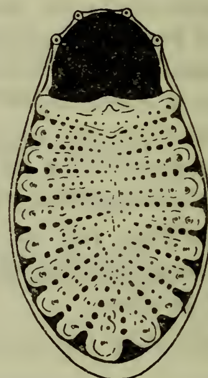

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Fig 51.—*Anornithopora irrostrata.* Diagram of an œcium, from above. × about 75 diameters.

Fig. 52.—*Anornithopora involucris.* Diagram of an œcium, from above. × about 75 diameters.

LIST OF SPECIMENS.

D. 28111. D. 28110. Type-specimen and paratype, incrusting Echinoids. Senonian, Campanian, zone of *A. quadratus*, subzone of *A. quadratus.* Pit 7 of Gaster, in Upton Lane (or Lambley's Lane) Sompting, N.E. of Worthing, Sussex. Collected and presented by T. H. Withers, Esq., F.G.S., 1914.

D. 29856. Senonian, Campanian, zone of *A. quadratus*, top of the subzone of *E. scutata* var. *depressa.* Pit 2 of Gaster, by reservoir, Hill Barn, North Lancing, Sussex. Collected by C. T. A. Gaster, Esq., and presented by him, 1919.

3. Anornithopora irrostrata, Lang.

Anornithopora irrostrata, sp. n.; Lang, 1916, pp. 93, 94; *A. quadratus*-zone, *O. pillula*-subzone; N.E. of Worthing, Sussex.

Diagnosis.—*Anornithopora* with a more consolidated front-wall, few costæ (10–12), few pelmatidia (about 4), and 5 apertural spines (6 in early neanœcia).

Description.—Asty incrusting, unilaminar. Œcia monomorphic. (a) *Ephebœcia.* Œcia about ·57 mm. long and ·38 mm. wide, oval; extraterminal front-wall of very small extent, but visible owing to the absence or rarity of interœcial secondary tissue; intraterminal front-wall moderately arched, but flat above, and consisting of about eleven costæ, which bear each about four pelmatidia, are firmly fused to their lateral neighbours, apparently have no perforations between (former) lateral fusions, and are firmly united medianly; apertural bar with a thick, median, distally-directed projection; five thickened apertural spines; aperture sub-circular, with flattened proximal edge.

(b) *Neanœcia.* Œcia about ·4 mm. long and ·2–·25 mm. wide, elliptical to elliptical-oval; extraterminal front-wall of very small extent, but not hidden by interœcial secondary tissue; intraterminal front-wall well arched, consisting of eighteen costæ, each of which bears about three pelmatidia, is firmly united to its lateral neighbours, apparently has no perforations between (former) lateral fusions, and is firmly fused medianly; apertural bar very high medianly; apertural spines six in the earliest stages, five in the later stages, thickened; aperture longer than wide, sub-circular, with flattened proximal edge, and slightly constricted laterally towards the proximal corners.

Distribution.—Senonian, Campanian, zone of *A. quadratus*, top of subzone of *E. scutata* var. *depressa.* Pit 2 of Gaster, by reservoir, near Hill Barn, North Lancing, N.E. of Worthing, Sussex.

Type-specimen.—**D. 28994.** Collected by C. T. A. Gaster, Esq., and presented by him, 1916.

Remarks.—See under remarks of the genus *Anornithopora.*

Figures.—Text-fig. 51. An œcium.

Plate III, fig. 11. The type-specimen, showing eight orthœcia, some in early astogenetic stages. × about 27 diameters.

Specimens.—The type-specimen. Distribution and collection as above.

III. HESPEROPORA, Lang, 1916.

[*Cribrilina*; Pergens, 1894, p. 187.]
Hesperopora, gen. nov.; Lang, 1916, pp. 93, 98.

Diagnosis.—Castanoporinæ of small size, with comparatively few costæ (about 17), no or very few aviculœcia, and a secondary aperture not perforated by fenestræ.

Genotype.—*Hesperopora occidentalis*, Lang.

Distribution.—Danian [and Senonian, Maastrichtian].

Remarks.—It is probable that *Hesperopora* arose from *Anornithopora* by acquiring a secondary aperture. Since, however, there are no known links between the two genera in the *B. mucronata* zone—in fact (except for the doubtful [*Hesperopora*] *walfordi*), anywhere between the *A. quadratus*-zone and the Danian,—it is possible that *Hesperopora* (and *Stichocados*) have been derived from *Castanopora* or *Rhiniopora* by a loss of the aviculœcia and a catagenetic reduction of size and of the number of costæ and pelmatidia. While the former derivation is provisionally assumed, the possibility of the latter should not be forgotten.

[*Hesperopora*] *walfordi* is a doubtful form, whose affinities can be but tentatively suggested. *H. occidentalis* is undoubtedly more primitive than *H. danica*, being smaller, having fewer pelmatidia and lateral costal fusions, and a less-developed secondary aperture. In both the intraterminal front-wall is well consolidated, resulting in but minute perforations between the costæ, and very small pelmatidia.

Key to the Species of *Hesperopora*.

I. Orthœcia nearly as wide as long; secondary aperture not so well formed and sub-circular.
  A. Costæ about 12; an occasional aviculœcium ...... 1. [*H.*] *walfordi*.
  B. Costæ about 16; no aviculœcia (fig. 53) .... 2. *H. occidentalis*.

II. Orthœcia nearly twice as long as wide; secondary aperture more tubular, and sub-triangular. Costæ about 16 (fig. 54) .... 3. *H. danica*.

1. [Hesperopora] walfordi (Pergens).

Cribrilina Walfordi, sp. n.; Pergens, 1894, p. 187, pl. xi, fig. 6 [not fig. 7 as stated in text]; Maestrichtien; Fauquemont.

Hesperopora walfordi (Pergens); Lang, 1916, p. 98; Maastrichtian; Fauquemont.

Diagnosis.—[*Hesperopora*] with orthœcia nearly as wide as long; secondary aperture not well formed, and sub-circular; costæ about 12; an occasional aviculœcium.

Distribution.—Senonian, Maastrichtian, Fauquemont, E. of Maastricht, Limbourg, Holland.

Type-specimen.—That figured by Pergens, 1894, pl. xi, fig. 6, is hereby selected.

Remarks.—From Pergen's figure and description it is not possible to place his *Cribrilina walfordi* more than provisionally in *Hesperopora.*

Specimens.—None in the Collection.

2. Hesperopora occidentalis, Lang.

Hesperopora occidentalis, sp. n.; Lang, 1916, p. 98; Danian; New Jersey.

Diagnosis.—*Hesperopora* with orthœcia not much longer than wide; secondary aperture not well formed, and sub-circular; costæ about 16.

Description.—Asty incrusting, unilaminar. Œcia monomorphic. (a) *Ephebœcia* about ·5 mm. long and ·35 mm. wide, oval; extra-terminal front-wall of small extent, but not hidden by interœcial secondary tissue; intraterminal front-wall well arched, consisting of about sixteen costæ, each bearing four or five very small pelmatidia, and having about the same number of wide lateral costal fusions, leaving but very small perforations between the costæ; costæ firmly united in a median band of fusion; apertural bar flattened in a distal-proximal direction and extended to form the proximal shield of a secondary aperture; primary aperture sub-normal or sub-circular; secondary aperture sub-circular; apertural spines four, somewhat thickened.

(b) *Ancestrœcium* about ·36 mm. long and ·18 mm. wide, elliptical; extraterminal front-wall of small extent, and not hidden by secondary tissue; intraterminal front-wall well arched, consisting of about twelve costæ, each with about three pelmatidia and three pairs of wide costal fusions, which leave but very small perforations between the costæ; costæ firmly united in a median band of fusion; apertural bar much raised in the neighbourhood of a pair of pelmatidia; aperture sub-circular, flattened proximally; apertural spines five.

Distribution.—Danian, Vincentown Limesand.

Type-specimen.—D. 19233.

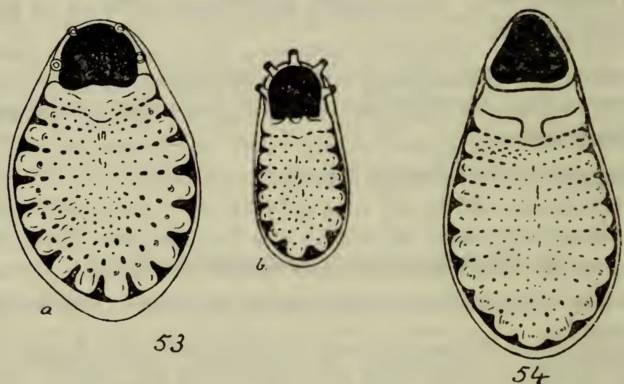


Fig. 53 *a*.—*Hesperopora occidentalis*. Diagram of an ephebœcium, from above. × about 75 diameters.

Fig. 53 *b*.—*Hesperopora occidentalis*. Diagram of an ancestrœcium, from above. × about 75 diameters.

Fig. 54.—*Hesperopora danica*. Diagram of an œcium, from above. × about 75 diameters.

Remarks.—The presence of five apertural spines in the ancestrœcium of *Hesperopora occidentalis* is of interest, as showing that the four ephebastic apertural spines are a reduction of a larger ancestral number. *H. occidentalis* is more primitive in many characters than *H. danica*, and it may be considered as ancestral to that form.

Figures.—Text-fig. 53 *a*, ephebœcium; 53 *b*, ancestrœcium.

Plate III, fig. 12. Part of the paratype, D. 18738, showing the ancestrœcium and nine succeeding orthœcia. × about 75 diameters.

LIST OF SPECIMENS.

D. 19233. D. 18738. Type-specimen and paratype, incrusting the Polyzoan *Coscinopleura digitata* (Morton). Both show early colonial growth-stages and, the latter, the ancestrœcium. Danian, Vincentown Limesand. Near Blackwoods Town, New Jersey, S.E. of Philadelphia, Pennsylvania. In exchange with United States National Museum. 1899.

3. Hesperopora danica, Lang.

Hesperopora danica, sp. n.; Lang, 1916, p. 98; Danian; Faxe, Denmark.

Diagnosis.—*Hesperopora* with orthœcia nearly twice as long as wide; secondary aperture well formed, tubular, and subtriangular; costæ about 16.

Description.—Asty incrusting, unilaminar. Œcia monomorphic, about ·6 mm. long and about ·3 mm. wide, elliptical, somewhat narrowed distally; extraterminal front-wall of small extent and not hidden by interœcial secondary tissue, but the costæ of the intraterminal front-wall are sometimes extended backwards across the interœcial valleys to meet the costæ of the neighbouring orthœcia; intraterminal front-wall well arched, consisting of about sixteen costæ, each with five or six pelmatidia and a corresponding number of pairs of lateral fusions, and firmly united medianly in a band of fusion; apertural bar flattened to form the proximal shield of a secondary aperture, which is tubular and somewhat triangular with the apex distally directed.

Distribution.—Danian, Faxe, Sjælland, Denmark.

Type-specimen.—D. 28304. F. H. Butler. 1913.

Remarks.—See remarks under the genus *Hesperopora* and under *H. occidentalis*.

Figures.—Text-fig. 54. An œcium.

Plate III, fig. 13. Part of the type-specimen, showing three complete orthœcia, with ovicells. × about 27 diameters.

Specimens.—The type-specimen. Distribution and collection as above.

IV. STICHOCADOS, Marsson, 1887.

Stichocados nov. gen.; Marsson, 1887, pp. 101, 109.
Stichados [sic]; Deecke, 1895, p. 80.
Stichocados; Lang, 1916, pp. 93, 98, 99.

Diagnosis.—Castanoporinæ of small size, with comparatively few costæ (7–14), no or very few aviculœcia, and a secondary aperture perforated by fenestræ.

Genotype.—*Stichocados verruculosus*, Marsson.

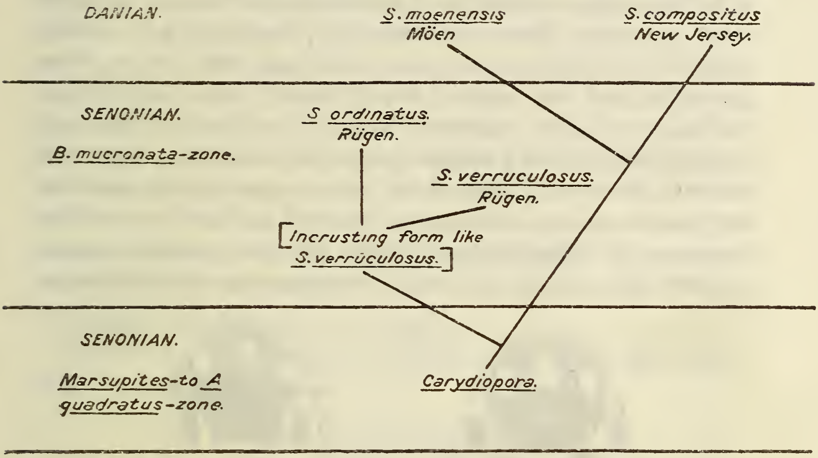
Distribution.—Senonian, Campanian, zone of *B. mucronata* to Danian.

Remarks.—*Stichocados,* with no or very few aviculœcia and with very few costæ, was probably independently evolved from *Carydiopora,* though, as in *Hesperopora,* the possibility that its primitive characters indicate catagenetic development should not be lost sight of.

The general evolutionary trend within the genus is to increase in orthœcial size, in the number of costæ, and in the number of pelmatidia and lateral costal fusions. The two species which do not possess aviculœcia, namely *Stichocados verruculosus* and *S. ordinatus,* both from the *B. mucronata*-zone of Rügen, lie on one lineage. Since, however, *S. ordinatus* is an incrusting and *S. verruculosus* a free form, it is necessary to suppose an incrusting form of *S. verruculosus* as the ancestor of *S. ordinatus.*

The Danian forms, *S. moenensis* and *S. compositus,* both have aviculœcia, and are, therefore, more primitive in this respect than *S. verruculosus* and *S. ordinatus,* if we are right in supposing *Stichocados* to have been derived from *Carydiopora* by the loss of the aviculœcia as well as by the acquisition of a secondary aperture. *S. moenensis* and *S. compositus* do not, however, form one lineage, for while *S. compositus* has aviculœcia in a more advanced stage of evolution than *S. moenensis,* it is more primitive than that species in orthœcial size, number of costæ, number of pelmatidia and lateral costal fusions, development of interœcial secondary tissue, and solidification of the secondary aperture.

The suggested relationships are shown in the following scheme :—



Key to the Species of *Stichocados*.

I. No aviculœcia.

- A. Costæ 6–7 ; 2 lateral costal fusions ; length about ·6 mm. (fig. 55) .... 1. *S. verruculosus.*
- B. Costæ about 12 ; 3 lateral costal fusions ; length about ·6–·7 mm. (fig. 56) .... 2. *S. ordinatus.*

II. Aviculœcia present.

- A. Costæ about 9 ; 3–4 lateral costal fusions ; length about ·5 mm. (fig. 57)........ 3. *S. compositus.*
- B. Costæ about 12–14 ; 4–5 lateral costal fusions ; length about ·8 mm. .... 4. *S. moenensis.*

1. Stichocados verruculosus, Marsson.

Stichocados verruculosus n. sp. ; Marsson, 1887, pp. 101, 109, pl. x, fig. 15 Senon, Schreibkreide ; Rügen.

Stichados [sic] *verruculosus* Marss. ; Deecke, 1895, p. 80 ; Senon ; Rügen.

Stichocados verruculosus, Marsson ; Lang, 1916, pp. 98, 99 ; *B. mucronata*-zone ; Rügen.

Diagnosis.—*Stichocados* with 6 or 7 costæ ; 2 lateral costal fusions ; orthœcial length about ·6 mm. ; no aviculœcia.

Description.—Asty free, unilaminar. Œcia monomorphic, about ·6 mm. long, and about ·4 mm. wide, oval and somewhat bottle-shaped; extraterminal front-wall either exceedingly small or hidden by the overlapping of neighbouring orthœcia; no interœcial secondary tissue; intraterminal front-wall well arched, consisting of about six or seven costæ, each with two or three pelmatidia and two pairs of lateral costal fusions, united in a median line of fusion; apertural bar bent proximally V-wise, and with a distally-directed median projection, which fuses right and left with the proximal ends of the costæ comprising the apertural bar, thus forming a bi-fenestrate proximal shield of a secondary aperture; by bifurcation and fusion the four apertural spines similarly form a distal shield with three fenestræ, while the fusion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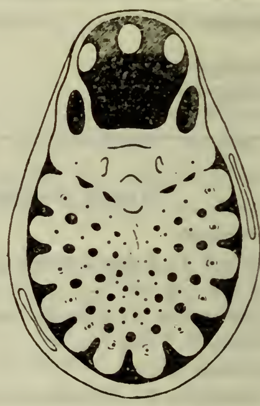
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Fig. 55.—*Stichocados verruculosus.* Diagram of an œcium, from above. × about 75 diameters.

Fig. 56.—*Stichocados ordinatus.* Diagram of an œcium, from above. × about 75 diameters.

of the rims of the proximal and distal shields forms two lateral fenestræ in the secondary aperture; this, at least, is the interpretation arrived at from examination of several broken fenestrate secondary apertures.

Distribution.—Senonian, Campanian, zone of *B. mucronata.* Rügen.

Type-specimen.—That figured by Marsson, 1887, pl. x, fig. 15, is hereby selected.

Remarks.—While there is no uncertainty about the identity of Marsson's species, the imperfection of the specimens renders it difficult to determine the architecture of the secondary aperture. It is probable that *Stichocados verruculosus* arose from some primitive form like *Carydiopora* by losing the aviculœcia and acquiring a secondary aperture. It is more primitive than the other species of *Stichocados* in the number of costæ, pelmatidia, and costal fusions, and (except for *S. compositus*) in size. But both *S. compositus* and *S. moenensis* have aviculœcia, which (if it is assumed that *Stichocados* arose from *Carydiopora*) prove them to be primitive in this respect.

Figures.—Text-fig. 55. An œcium.

Plate IV, fig. 1. Specimen **D. 15090**, consisting of eight orthœcia. × about 27 diameters.

LIST OF SPECIMENS.

D. 14998. D. 15090. D. 16649. D. 29036. Four small asties. Senonian, Campanian, zone of *B. mucronata*. Rügen. Agnes Laur collection. 1909.

2. **Stichocados ordinatus**, Lang.

Stichocados ordinatus, sp. n.; Lang, 1916, pp. 98, 99; *B. mucronata*-zone; Rügen.

Diagnosis.—*Stichocados* with about 12 costæ; 3 lateral costal fusions; œcial length about ·6–·7 mm.; no aviculœcia.

Description.—Asty unilaminar, incrusting. Œcia monomorphic, about ·6–·7 mm. long and ·4–·46 mm. wide, oval; extraterminal front-wall hidden beneath interœcial secondary tissue, which fills up the interœcial valleys, and has occasional slit-like lacunæ; intraterminal front-wall moderately arched, consisting of about twelve costæ, each with three or four pelmatidia and three pairs of lateral costal fusions, firmly united in a median band of fusion; apertural bar with a broad median process, which, fusing with the proximal pair of apertural spines, forms the proximal shield of a secondary aperture; a former fusion, as in *S. verruculosus*, between the median process and the proximal ends of the costæ composing the apertural bar, and forming an additional pair of fenestræ, appears to have been almost or quite masked by the infilling of the fenestræ; a distal shield is formed by the bifurcation and fusion of the distal apertural spines and the two shields linked up by the secondary apertural rim.

Distribution.—Senonian, Campanian, zone of *B. mucronota* Rügen.

Type-specimen.—D. 15115. A small asty incrusting a colony of the Cyclostome Polyzoan *Entalophora*. A. Laur collection. 1901.

Remarks.—Were it not that *Stichocados ordinatus* is incrusting, it might have been derived from *S. verruculosus*, by an increase in size, number of costæ, number of pelmatidia and lateral costal fusions, by development of interœcial secondary tissue, and by the tendency to fill in the fenestræ of the secondary aperture. It is necessary, therefore, to suppose an incrusting form resembling *S. verruculosus* and giving rise to that form and *S. ordinatus.*

Figures.—Text-fig. 56. An œcium.

Plate IV, fig. 2. Part of the type-specimen, showing three œcia. × about 27 diameters.

Specimens.—The type-specimen. Distribution and collection as above.

3. Stichocados compositus, Lang.

Stichocados compositus, sp. n.; Lang, 1916, pp. 98, 99; Danian; New Jersey.

Diagnosis.—*Stichocados* with about 9 costæ; 3 or 4 lateral costal fusions; length about ·5 mm.; a pair of small apertural aviculœcia.

Description.—Asty erect, free; œcia dimorphic. Orthœcia about ·5 mm. long and ·4 mm. wide, oval, bottle-shaped; extraterminal front-wall of very small extent; little or no interœcial secondary tissue; intraterminal front-wall well arched, consisting of about nine costæ, each with three or four pelmatidia and three or four pairs of lateral costal fusions, united in a median band of fusion; apertural bar probably formed as in the last species, that is, with a median projection that fuses with lateral structures, but in this case a pair of apertural aviculœcia replaces the proximal pair of apertural spines to form a fenestrated proximal shield of a secondary aperture ; the distal shield appears to be solid and formed by the upward prolongation of the apertural ring, which replaces the distal pair of apertural spines. Aviculœcia, a small apertural pair, carried up on the secondary apertural ring and replacing the proximal pair of apertural spines, directed towards the centre of the aperture of the orthœcium it accompanies, somewhat elongate, with rather blunt apertures.

Distribution.—Danian, Vincentown Limesand.

Type-specimen.—D. 18977. Near Blackwoods Town, New Jersey, S.E. of Philadelphia, Pennsylvania, United States. In exchange with the United States National Museum. 1899.

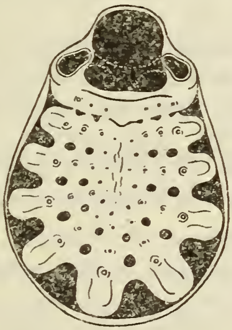


Fig. 57.—*Stichocados compositus.* Diagram of an orthœcium and two apertural aviculœcia, from above. × about 75 diameters.

Remarks.—Were it not for the presence of aviculœcia and the somewhat smaller size, *Stichocados compositus* might have been derived from *S. verruculosus.* On the assumption, however, that *S. verruculosus* was derived from *Carydiopora* by the loss of aviculœcia as well as by the acquisition of a secondary aperture, *Stichocados compositus*, which has not yet lost its aviculœcia, is more primitive in this respect.

Figures.—Text-fig. 57. An orthœcium and two apertural aviculœcia.

Plate IV, fig. 3. The type-specimen, consisting of three complete orthœcia and part of a fourth, each with a pair of apertural aviculœcia. × about 27 diameters.

Specimens.—The type-specimen. Distribution and collection as above.

4. Stichocados moenensis, Lang.

Stichocados möenensis, sp. n.; Lang, 1916, pp. 98, 99; Danian; Möen.

Diagnosis.—*Stichocados* with about 12 to 14 costæ; 4 or 5 lateral costal fusions; length about ·8 mm.; very small aviculœcia present.

Description.—Asty erect, cylindrical; œcia dimorphic. Orthœcia about ·8 mm. long and ·53 mm. wide, oval; extraterminal front-wall very small or obscured by interœcial secondary tissue; intraterminal front-wall well arched, consisting of about twelve to fourteen costæ with five or six pelmatidia and four or five pairs of lateral costal fusions, and united in a median line of fusion; secondary aperture tubular, with lateral fenestræ. Aviculœcia very small, occurring at the base of the apertural ring—as a rule, laterally and proximally placed with regard to the aperture.

Distribution.—Danian, Möen, S. of Sjaelland, Denmark.

Type-specimen.—In the collection of Mr. Canu.

Remarks.—The presence of aviculœcia removes *Stichocados moenensis* from the lineage of *S. verruculosus–S. ordinatus*. On the other hand, the aviculœcia, somewhat indefinitely placed and not carried up on the apertural ring, prove this species to be more primitive in this respect than *S. compositus*, though it is less primitive than that species in most characters. It probably, therefore, had a common origin with *S. compositus* from a primitive *Stichocados* that had not yet lost its ancestral aviculœcia, yet had advanced from *Carydiopora* by developing a secondary aperture.

Specimens.—Only a photograph of the type-specimen.

V. RHINIOPORA, Lang, 1916.

Repteseharella [partim]; d'Orbigny, 1853, p. 468, 1854, pp. 1097, 1106.
Reptoescharella [partim]; Coquand, 1860, p. 150.
? Non *Reptescharella*; Barrois, 1875, p. 25.
? *Cellepora* [partim]; Quenstedt, 1879, p. 312.
Reptescharella [partim]; Vine, 1885, p. 115.
Cribrilina [partim]; Marsson, 1887, pp. 97, 109.

Reptescharella [partim]; Marsson, 1887, p. 97.
? Non *Reptescharella*; Bristow, 1889, p. 272.
Cribrilina; Osswald, 1890, pp. 108–10.
Membranipora; Gregory, 1894, p. 62.
Cribillina [sic]; Deecke, 1895, p. 79.
Cribrillina [sic]; Deecke, 1895, p. 87.
? Non *Cribrilina* (*Reptescharella*) [partim]; Gamble, 1896, p. 6.
Membranipora [partim]; Gregory, 1896, pp. 212–4.
Cribrilina [partim]; Canu, 1900 [2], p. 445.
Cribrilina (*Cribrilina*) [partim]; Canu, 1900 [2], p. 448.
Reptescharella [partim]; Canu, 1900 [2], p. 448.
? Non *Cribrilina* [partim]; Jukes-Browne, 1904, p. 490.
Cribrilina; Levinsen, 1907, pp. 155–6, 158.
Cribrilina [partim]; Brydone, 1913, pp. 437–8.
Rhiniopora, gen. nov.; Lang, 1916, pp. 93, 96–97.
Rhiniopora; Lang, 1917, p. 172.

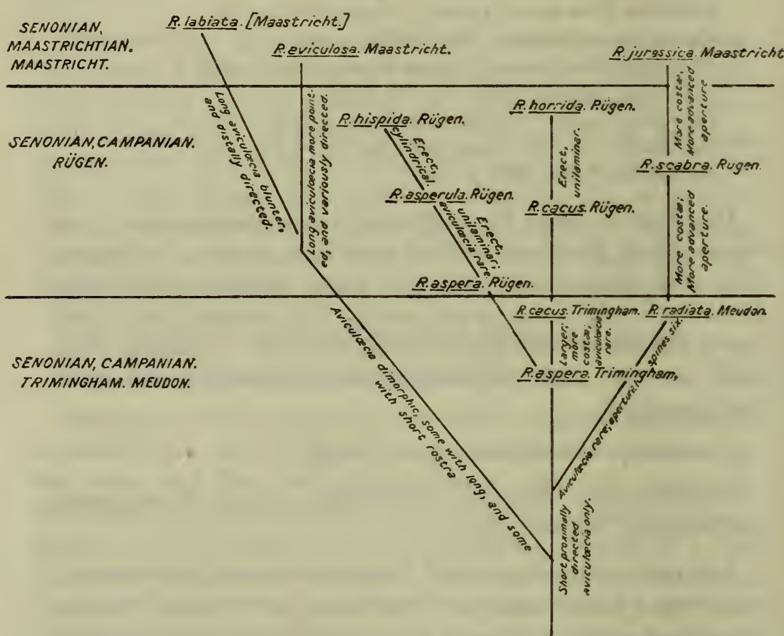
Diagnosis.—Large Castanoporinæ with numerous costæ; with no secondary front-wall and no secondary aperture; aviculœcia dimorphic, monomorphic, or none; when dimorphic, some aviculœcia have long rostra, others pointed (but comparatively short) rostra, the former variously directed, the latter (? always) proximally directed; when monomorphic, the aviculœcia are always of the latter type.

Genotype.—*Rhiniopora aspera*, Lang.

Distribution.—Senonian, Campanian, zone of *B. mucronata*, and Senonian, Maastrichtian.

Remarks.—*Rhiniopora* and *Castanopora* may have been derived from a form resembling *Carydiopora*, but in which there was dimorphism of the aviculœcia, both kinds being sharply rostrate, but one kind having elongate, and the other but short rostra. In *Castanopora* the first kind generally form an apertural pair and are always distally directed. In *Rhiniopora* they are still undifferentiated in position and direction. Evolution in *Rhiniopora* is shown in the loss of the aviculœcia, first of the variously-directed form with long rostrum, and next of the proximally-directed form with short rostrum. At the same time the other characters follow the usual course, namely (1) the orthœcia become larger, (2) the costæ increase in number, (3) the pelmatidia and lateral costal fusions increase in number, (4) the apertural spines decrease in number and increase in thickness, and (5) the aperture passes from a sub-semicircular to sub-normal shape. In these last five characters the lineages of *Rhiniopora* correspond with those of *Castanopora*, and the morphic equivalents in these genera form homœomorphic pairs.

The relationships of the species are shown in the following scheme:—



Key to the Species of *Rhiniopora*.

A. Aviculœcia dimorphic and numerous; some having long and others short rostra.

- I. The longer aviculœcia more pointed and generally proximally directed; costæ about 25–28; length 1·25–1·5 mm.; aperture normal (fig. 58)................ 2. *R. aviculosa.*
- II. The longer aviculœcia blunter and distally directed; costæ about 34; aperture sub-normal.................. 3. *R. labiata.*

B. Aviculœcia comparatively rare and consisting of the shorter kind only.

I. Length about 1 mm.; costæ about 16–20; five or six lateral costal fusions.
- a. Incrusting.
  - 1. Aviculœcia rare or absent; costæ 16–18; aperture sub-semicircular .... 4. *R. radiata.*
  - 2. Aviculœcia occasional; costæ 18–20; aperture normal to sub-circular; generally 5, sometimes 4 apertural spines (fig. 59) .... 5. *R. aspera.*
- b. Erect, unilaminar; aviculœcia rather rare; costæ 20–24; aperture sub-circular to super-normal; 4 apertural spines (fig. 60) .... 6. *R. asperula.*
- c. Erect, cylindrical; aviculœcia rather rare; [costæ 20–24; aperture sub-circular to super-normal; 4 apertural spines] .... 7. *R. hispida.*

II. Length 1·3 to 1·7 mm.
- a. Costæ 20–23; six or seven lateral costal fusions; length about 1·3–1·5 mm.; apertures normal to super-normal.
  - 1. Incrusting; apertural spines 4 or 5 .... 8. *R. cacus.*
  - 2. Erect, unilaminar; apertural spines 4 (fig. 61) ... 9. *R. horrida.*
- b. Costæ about 25; about seven lateral costal fusions; length 1·6–1·7 mm.; [incrusting]; apertures sub-normal to normal, and very wide; apertural spines 6 (fig. 62) .... 10. *R. scabra.*
- c. Costæ about 28–30; seven lateral costal fusions; length 1·5–1·7 mm.; incrusting; aperture sub-circular to normal, but very wide, apertural spines ? 4 .... 11. *R. jurassica.*

It is probable that *Cellepora perforata*, Quenstedt, also is a *Rhiniopora*, but its characters cannot be determined in sufficient detail to place it.

1. [Rhiniopora] perforata (Quenstedt).

Cellepora perforata; Quenstedt, 1879, p. 312, pl. cliv, fig. 37; Mastricht.
? *Rhiniopora perforata* (Quenstedt); Lang, 1916, p. 96; Maastricht.

Distribution.—Senonian, Maastrichtian. Maastricht.

Type-specimen.—That figured by Quenstedt, 1879, pl. cliv, fig. 37, is hereby selected.

Remarks.—Quenstedt's figure and description of *Cellepora perforata* are insufficient to allow of more than a provisional placing of this species in *Rhiniopora*, without further definition. It is thus impossible to compare it with the other species, beyond stating that apparently aviculœcia are few or absent, and that the number of costæ is small.

SPECIMENS.—None in the Collection.

2. Rhiniopora aviculosa, Lang.

Rhiniopora aviculosa, sp. n.; Lang, 1916, p. 96; Maastrichtian; Maastricht.

DIAGNOSIS.—*Rhiniopora* with dimorphic aviculœcia, one form of which has a long, sharply pointed rostrum, and is variously, but generally proximally, directed; and the other form has short blunter rostra, and is always proximally directed; numerous (25–28) costæ; length 1·25–1·5 mm.; aperture normal.

DESCRIPTION.—Asty erect, unilaminar; œcia dimorphic. Orthœcia about 1·25–1·5 mm. long and ·8 mm. wide; extraterminal front-wall of small extent and not much obscured by secondary interœcial tissue, though considerably so by aviculœcia; intraterminal front-wall well arched, consisting of about twenty-six costæ, each bearing six or seven pelmatidia, and with about six lateral costal fusions, and firmly united in a median band of fusion; apertural bar somewhat flattened, rather thin; aperture normal; apertural spines six. Aviculœcia dimorphic, consisting of those with a very long and sharp rostrum, and those whose rostrum is comparatively short and not so sharp; the former are numerous, sporadically distributed, variously, but generally proximally, directed; the latter are more numerous, sporadically distributed, and probably always proximally directed.

DISTRIBUTION.—Senonian, Maastrichtian. Maastricht, Limbourg, Holland.

TYPE-SPECIMEN.—In the collection of Mr. Canu of Versailles.

REMARKS.—*Rhiniopora avieulosa* and *R. labiata* differ from the other known species of the genus in retaining the two kinds of aviculœcia, having the long aviculœcia characteristic of *Castanopora*, as well as the short aviculœcia of the other species of *Rhiniopora*. But *Castanopora* has advanced from this primitive condition, in that it has defined the position and direction of the long aviculœcia and soon loses the short aviculœcia. Thus *Rhiniopora aviculosa* and *R. labiata* are primitive in respect of their aviculœcia, but not in their orthœcial size, the number of costæ, pelmatidia, and lateral costal fusions, or the shape of the aperture. *R. aviculosa* has six apertural spines, and this is probably a primitive number. The other species in which the number of

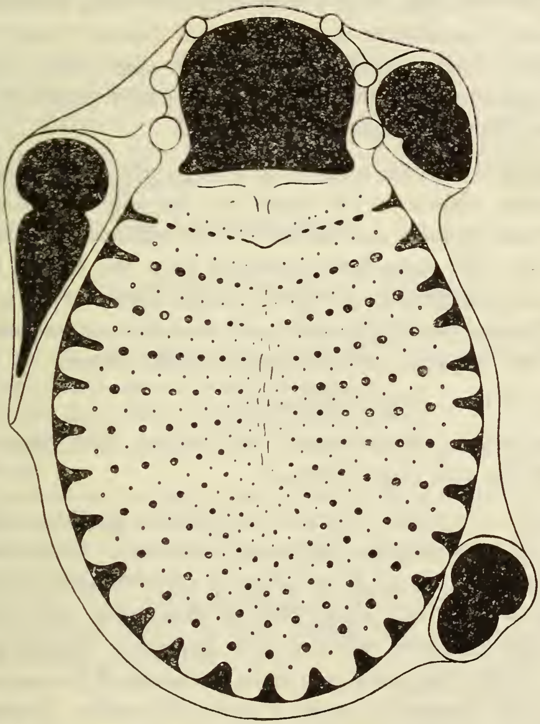


Fig. 58.—*Rhiniopora aviculosa.*—Diagram of an orthœcium, and one of the long, and two of the short kind of aviculœcium, from above. × about 75 diameters.

spines can be determined have five or four, except *R. scabra* and possibly *R. jurassica.* It is possible that the last two may be catagenetic in this respect.

Figures.—Text-fig. 58. An orthœcium, a long aviculœcium, and two short aviculœcia.

Specimens.—Only a photograph of the type-specimen.

3. Rhiniopora labiata (Levinsen).

Cribrilina labiata n. sp.: Levinsen, 1907, pp. 155–6, 158, plate opposite p. 160, figs. 1, 1 *a–f*; [Cretaceous].
Rhiniopora labiata (Levinsen); Lang, 1916, p. 96; [Cretaceous].

Diagnosis.—*Rhiniopora* with dimorphic aviculœcia, one form of which is very large with a very long but blunt rostrum, and is occasional, sporadically distributed, and directed distally; the other form is smaller with a comparatively short sharp rostrum, frequent, sporadically distributed, and proximally directed; costæ numerous (about 34); aperture sub-normal.

Description.—In the absence of a description of this species, the characters shown in the figure are the only ones available. Thus the colonial habit and the size of the orthœcia are unknown. In fact, the only characters discernible from the figures, besides those given as diagnostic, are the orthœcial shape, which is elliptical, and the nature of the interœcial secondary tissue, which is abundant and has large, sub-triangular, median lacunæ.

Distribution.—[Upper Senonian.]

Type-specimen.—That figured by Levinsen, 1907, plate opposite p. 160, fig. 1, is hereby selected.

Remarks.—Levinsen doubtless intended to publish a full description and account of this species in a later work. Unfortunately, there is little information to be obtained about it, except from his figure. It is from this alone that the diagnostic characters are taken, though the figure, which in some respects is detailed, *e. g.*, in the nature of the interœcial secondary tissue and of the long aviculœcia, in other respects is vague, *e. g.*, in the matter of apertural spines and the nature of the intraterminal front-wall. Levinsen does not give the horizon of this species—in fact, does not even state that it is a Cretaceous form,—but since, when their horizon is stated, the species discussed are all Cretaceous or Recent, and *C. labiata* is stated (p. 155) to be a fossil species, it is almost certainly Cretaceous; and since all the other known species of *Rhiniopora* occur in the top-most zone of the Campanian or in the Maastrichtian, it is probable that *R. labiata* comes from one of these two horizons.

R. labiata, like *R. aviculosa*, is more primitive than the other known species of *Rhiniopora* in respect of its aviculœcia, which are dimorphic, one form having a long and the other a short rostrum. But the long aviculœcia of *R. labiata* are blunt, always distally directed, very large, and occasional, whereas in *R. aviculosa* they are sharp and generally proximally directed, comparatively small, and frequent. *R. labiata* is thus not in a lineage with *R. aviculosa.*

On the other hand, *R. labiata* has affinities with *Castanopora*, since the long aviculœcia are distally directed; but they are not definitely placed as in that genus and, being far blunter, possibly represent a third type of aviculœcium different from the long aviculœcia of *Castanopora.*

Specimens.—None in the Collection.

4. Rhiniopora radiata (d'Orbigny).

Reptescharella radiata, d'Orb., 1851; d'Orbigny, 1852, legend on pl. 716, figs. 4–6; 1853, p. 468; 1854, pp. 1097, 1106; Sénonien; Meudon, près de Paris, and Saintes (Charente Inférieure).

Reptescharella Subradiata; d'Orbigny, 1854, p. 1106.

Reptoescharella [sic] *radiata*, d'Orb.; Coquand, 1860, p. 150; Santonien; Saintes.

? Non *Reptescharella radiata*, d'Orb.; Barrois, 1875, p. 25; zone à *M. coranguinum*; East Standen.

Reptescharella radiata, D'Orb.; Vine, 1885, p. 115; non = *Cribrilina radiata*, Moll, as there suggested.

Reptescharella radiata d'Orbigny; Marsson, 1887, p. 97.

? Non *Reptescharella radiata*, D'Orb.; Bristow, 1889, p. 272; Upper Chalk; East Standen; *fide* Barrois.

? Non *Cribrilina* (*Reptescharella*) *radiata* d'Orb.; Gamble, 1896, p. 6; Chalk; Chatham.

Cribrilina (*Cribrilina*) *Gaudryana* nom. nov., = *Reptescharella radiata* d'Orb.; Canu, 1900 [2], p. 448; Sénonien: [Canu, placing the species in *Cribrilina*, gave it a new trivial name, since a *Cribrilina radiata* Moll already existed].

? Non *Cribrilina radiata*, d'Orb.; Jukes-Brown, 1904, p. 490; zone of *Mic. cortestudinarium*; Charlton, Kent.

Rhiniopora radiata (d'Orbigny); Lang, 1916, pp. 96, 97; Senonian, [Campanian]; Meudon and Saintes, France.

Diagnosis.—Incrusting unilaminar *Rhiniopora* in which aviculœcia are absent or extremely rare; length about 1 mm.; costæ

16–18; pelmatidia and costal fusions 5 or 6; aperture sub-semicircular.

Distribution.—Senonian, Campanian, and Santonian. Meudon, S.W. of Paris, and Saintes, S.E. of Rochefort, Charente-Inférieure, France.

Type-specimen.—That figured by d'Orbigny, 1852, pl. 716, fig. 5, is hereby selected.

Remarks.—In its lack of aviculœcia, *Rhiniopora radiata* is more advanced than *R. aspera*, though in other respects, as in the number of costæ and the shape of the aperture, it is more primitive. It probably, therefore, arose from a form slightly more primitive than *R. aspera* by the loss of the fairly numerous aviculœcia of the supposed form.

Specimens.—None in the Collection.

5. Rhiniopora aspera, Lang.

? *Cribrilina Cacus*, sp. nov.; Brydone, 1913, pp. 437–8, pl. xiv, fig. 6.
Non *Cribrilina Cacus*, sp. nov.: Brydone, 1913, pp. 437–8, pl. xiv, figs. 7–8.
Rhiniopora aspera, sp. n.; Lang, 1916, pp. 96–7; *B. mucronata*-zone; Trimingham, Norfolk.
Rhiniopora aspera Lang; Lang, 1917, p. 172. Genolectotype of *Rhiniopora*.

Diagnosis.—Incrusting, unilaminar *Rhiniopora* with occasional, short, proximally-directed aviculœcia; with orthœcia about 1 mm. long; 18 to 20 costæ; 5 or 6 pelmatidia and lateral costal fusions; a normal to sub-circular aperture; and generally 5, sometimes 4, apertural spines.

Description.—Asty incrusting, unilaminar; œcia dimorphic. Orthœcia about 1 mm. long and ·5–·66 mm. wide, elliptical; extraterminal front-wall of very small extent, not obscured, or but little obscured, by interœcial secondary tissue; intraterminal front-wall well arched, consisting of eighteen to twenty costæ, each with five or six pelmatidia and five or six pairs of lateral costal fusions, firmly united in a median band of fusion; apertural bar thickened, but not very wide, with a small low median ridge or keel, which tends to be carried down the middle line of the intraterminal front-wall; aperture normal to sub-circular; apertural spines generally five, but occasionally only four, not very much thickened. Aviculœcia frequent, sporadically distributed, short, not sharply pointed, proximally directed.

DISTRIBUTION.—Senonian, Campanian, zone of *B. mucronata*. Rügen and Trimingham, Norfolk.

TYPE-SPECIMEN.—D. 15620.

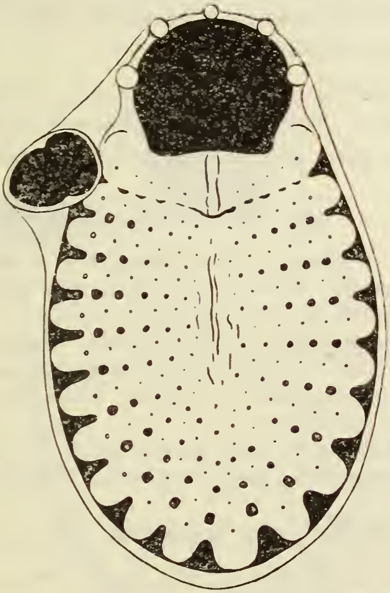


Fig. 59.—*Rhiniopora aspera.* Diagram of an orthœcium and an aviculœcium, from above. × about 75 diameters.

REMARKS.—Under this species are included forms both from Trimingham and Rügen. They vary somewhat, apparently irregularly, in the length of the orthœcium and in the number of costæ and apertural spines (5 or 4); the number of aviculœcia is less and the amount of thickening of the spines is considerably greater in some, but not all, of the Rügen specimens. This is to be expected, if, as is probable, the Rügen forms are, on the whole, higher than those from Trimingham—in other words, that the *B. mucronata*-chalk of Rügen includes the Trimingham horizons and higher beds.

Rhiniopora aspera is a radical form from which the other species of the genus, with the exception of *R. labiata*, *R. aviculosa*, and *R. radiata*, already considered, may have descended. It is possible, however, that *R. scabra* and *R. jurassica* may have been independently derived. The primitive features are the frequent aviculœcia; smaller orthœcia; fewer costæ, pelmatidia, and lateral costal fusions; the shape of the aperture; and the generally slighter apertural spines; possibly also the rather larger number (generally 5) of the apertural spines.

Figures.—Text-fig. 59. Orthœcium and aviculœcium.

Plate IV, fig. 4. Part of the type-specimen, showing two complete orthœcia, parts of others, and two aviculœcia. × about 27 diameters.

LIST OF SPECIMENS.

D. 15620. Type-specimen. A large fragment of an asty incrusting an Echinoid. Senonian, zone of *B. mucronata*. Trimingham, Norfolk. A. C. Savin Collection. 1910.

D. 14153. D. 14210. D. 15383. D. 16675. D. 16677. Paratypes. In D. 16677 the middle and distal pairs of apertural spines are unthickened. Senonian, zone of *B. mucronata*. Rügen. Agnes Laur Collection. 1906, 1909.

D. 15302. D. 15324. Asties with broken orthœcia. Senonian, zone of *B. mucronata*. Rügen. Agnes Laur Collection. 1909.

6. **Rhiniopora asperula** (Marsson).

Cribrilina asperula n. sp.; Marsson, 1887, pp .97, 109, pl. x, fig. 8; Senon, Weisse Schreibkreide; Rügen.

Cribrilina asperula Mars.; Osswald, 1890, pp. 108, 109, 110; Upper Senonian; Rügen, Moen, Malmoe. Danian; Maastricht, Faxe, Saltholm. Drift; Neubrandenburg, Malchin, Satow.

Cribillina [sic] *asperula* Marss.; Deecke, 1895, p. 79; Senon; Rügen.

Cribrillina [sic] *asperula* Marss.; Deecke, 1895, p. 87; Obersenon; Grimme.

Cribrilina asperula (Marss.); Canu, 1900 [2], p. 445.

Rhiniopora asperula (Marsson); Lang, 1916, pp. 96, 97; *B. mucronata*-zone; Rügen.

Diagnosis.—Erect, unilaminar *Rhiniopora* with rare, short, proximally directed aviculœcia; orthœcia about 1 mm. long; 20 to 24 costæ; 5 or 6 pelmatidia and lateral costal fusions; a subcircular to super-normal aperture; and 4 considerably thickened apertural spines.

Description.—Asty erect, unilaminar; œcia dimorphic. Orthœcia about 1 mm. long or slightly longer, and ·66 mm. wide, elliptical; extraterminal front-wall of small extent, and not hidden by interœcial secondary tissue (which is absent); intraterminal front-wall well arched, consisting of from twenty to twenty-four costæ, each with five or six pelmatidia and about five pairs of lateral costal fusions, and firmly united in a median band of fusion; apertural bar thick but not very wide, with a median ridge or keel,

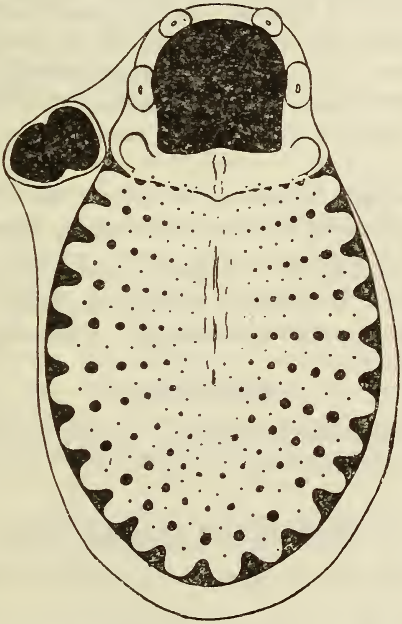


Fig. 60.—*Rhiniopora asperula.* Diagram of an orthœcium and aviculœcium, from above. × about 75 diameters.

which tends to be carried proximally along the middle line of the intraterminal front-wall; aperture sub-circular to super-normal; apertural spines four, considerably thickened. Aviculœcia very rare, short, not sharply pointed, and generally proximally directed.

Distribution.—Senonian, Campanian, zone of *B. mucronata,* Rügen.

Remarks.—Although no aviculœcia are shown in Marsson's figure, specimen **D. 14176**, which agrees closely with Marsson's description and figure of this species, possesses an occasional aviculœcium of the short type. One of the orthœcia, also, in Marsson's figure has many more than twenty-four costæ, but since Marsson in his description refers to the number of costæ simply as "numerous," there is no need to over-emphasize this discrepancy. *Rhiniopora asperula* may have been derived from *R. aspera* by assuming an erect habit, by acquiring more costæ and a more advanced aperture, by reducing the four, sometimes five, apertural spines of *R. aspera* to a constant four, and by considerably thickening the spines. It is also to be expected that the number of aviculœcia should lessen, since this tendency is found to be general in passing from the less to the more advanced species of *Rhiniopora*.

Marsson includes incrusting as well as erect forms in this species; but it is likely that the former are *R. aspera*.

Figures.—Text-fig. 60. Orthœcium and aviculœcium.

Plate IV, fig. 5. Part of specimen **D. 14176**, showing two complete orthœcia and an aviculœcium. × about 27 diameters.

SPECIMEN.

D. 14176. A small fragment of an asty. Senonian, zone of *B. mucronata*. Rügen. Agnes Laur Collection. 1906.

7. Rhiniopora hispida, Lang.

Rhiniopora hispida, sp. n.; Lang, 1916, pp. 96, 97; *B. mucronata*-zone; Rügen.

Diagnosis.—Erect, cylindrical *Rhiniopora* with very rare short aviculœcia; orthœcia about 1 mm. long; [costæ 20–24; 5 or 6 pelmatidia and lateral costal fusions; sub-circular to supernormal aperture].

Distribution.—Senonian, zone of *B. mucronata*. Rügen.

Type-specimen.—**D. 14996.** Agnes Laur collection. 1909.

Remarks.—*Rhiniopora hispida* appears to have the characters of *R. asperula*, with an erect cylindrical asty. Not all of these characters, however, are shown in the type-specimen, which is very imperfect; but it may be assumed, provisionally, that *R. aspera*–*R. asperula*–*R. hispida* form a lineage.

Specimens.—The type-specimen. Distribution and collection as above.

8. Rhiniopora cacus (Brydone).

Cribrilina Cacus, sp. nov.; Brydone, 1913, pp. 437, 438, pl. xiv, figs. 7–8; Trimingham.

? Non *Cribrilina Cacus*, sp. nov.; Brydone, 1913, pp. 437–8, pl. xiv, fig. 6, which is probably *Rhiniopora aspera*, q. v.

Rhiniopora cacus (Brydone); Lang, 1916, pp. 96, 97; *B. mucronata*-zone; Trimingham.

Diagnosis.—Incrusting, unilaminar *Rhiniopora* with few, short, proximally-directed aviculœcia; length well over 1 mm.; costæ about 23, each with six or seven pelmatidia and 5 or 6 pairs of costal fusions; aperture normal to super-normal.

Description.—Asty incrusting, unilaminar; œcia dimorphic. Orthœcia well over 1 mm. long, often as much as 1·5 mm. long, and at least ·75 mm. wide, elliptical; extraterminal front-wall small in extent, but clearly visible owing to the absence of interœcial secondary tissue; intraterminal front-wall well arched, consisting of about twenty-three costæ, each with six or seven pelmatidia and five or six pairs of lateral costal fusions, and firmly united in a median band of fusion; apertural bar not very wide, but thickened, especially laterally, and with a median ridge or keel; aperture normal to super-normal; apertural spines four (sometimes five in Trimingham specimens), much thickened. Aviculœcia occasional, proximally directed, shortly pointed, but not sharp.

Distribution.—Senonian, Campanian, zone of *B. mucronata*. Trimingham and Rügen.

Type-specimen.—That figured by Brydone, 1913, pl. xiv, fig. 7, is hereby selected.

Remarks.—*Rhiniopora cacus* differs from *R. aspera*, from which it was probably derived, chiefly in its greater size and in its greater number of costæ and pelmatidia; also in the comparative rarity of the aviculœcia, in the rather more advanced aperture, and in the greater thickness of the apertural spines. *R. cacus* in turn is the ancestor of *R. horrida*, of which it is an incrusting form.

LIST OF SPECIMENS.

D. 15591. An asty in several fragments, incrusting an Echinoid. Senonian, zone of *B. mucronata*. Trimingham, Norfolk. A. C. Savin collection. 1910.

D. 14167. D. 16676. Fragments of two small asties. Senonian, zone of *B. mucronata*. Rügen. Agnes Laur collection. 1906, 1909.

9. Rhiniopora horrida, Lang.

Rhiniopora horrida, sp. n.; Lang, 1916, pp. 96, 97; *B. mucronata*-zone. Rügen.

Diagnosis.—Erect, unilaminar *Rhiniopora* with very few, if any, aviculœcia; length well over 1 mm.; costæ about 21, each with 6 or 7 pelmatidia and 5 or 6 lateral costal fusions; aperture normal to super-normal; apertural spines 4.

Description.—Asty erect, unilaminar; [œcia dimorphic]. Orthœcia more than 1 mm. long and about ·75 mm. wide, elliptical; extraterminal front-wall of small extent, but not concealed by interœcial secondary tissue; intraterminal front-wall well arched, consisting of about 21 costæ, each bearing six or seven pelmatidia and five or six pairs of lateral costal fusions, and firmly united in a median band of fusion; apertural bar thinner than in *Rhiniopora cacus*, with a median ridge or keel; aperture normal to super-normal; apertural spines 4, considerably thickened.

Distribution.—Senonian, Campanian, zone of *B. mucronata*. Rügen.

Type-specimen.—D. 14171.

Remarks.—*Rhiniopora horrida* appears to be an erect form of *R. cacus*. It is interesting, in view of Brydone's description of *R. cacus* as always incrusting, that an erect form (*R. horrida*) should occur at Rügen, but not at Trimingham, while *R. cacus* is found at both. Moreover, the Rügen forms of *R. cacus* and *R. horrida* both, apparently, have four apertural spines only, while the Trimingham specimens of *R. cacus* may sometimes have five spines. This suggests that at Rügen there are horizons higher than those at Trimingham; since the incrusting *R. cacus* with four or five apertural spines occurs at Trimingham, *R. cacus* with only four spines at Rügen, and the erect *R. horrida* with four spines at Rügen only (see phylogeny, p. 182 and cf. *R. aspera*, p. 189).

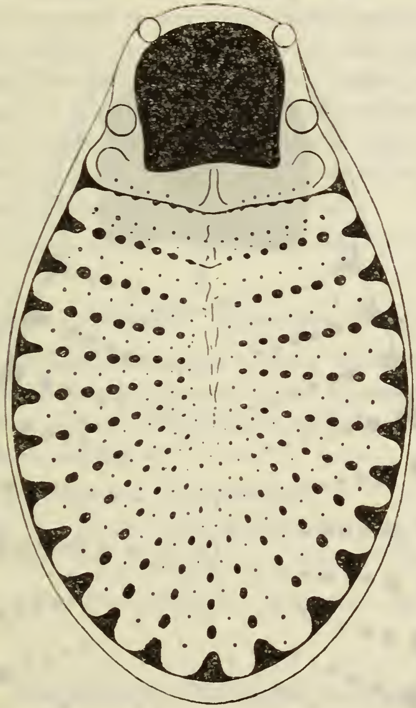


Fig. 61.—*Rhiniopora horrida.* Diagram of an orthœcium, from above. × about 75 diameters.

FIGURES.—Text-fig. 61. An orthœcium.

Plate IV, fig. 6. Part of the type-specimen, showing three orthœcia. × about 27 diameters.

LIST OF SPECIMENS.

D. 14171. Type-specimen. A small fragment of an asty, comprising four complete orthœcia and a piece of a fifth. Senonian, zone of *B. mucronata.* Rügen. Agnes Laur collection. 1906.

D. 15020. A fragment with broken-down intraterminal front-walls. Senonian, zone of *B. mucronata*. Rügen. Agnes Laur collection. 1909.

10. Rhiniopora scabra, Lang.

Rhiniopora scabra, sp. n.; Lang, 1916, pp. 96, 97; *B. mucronata*-zone; Rügen.

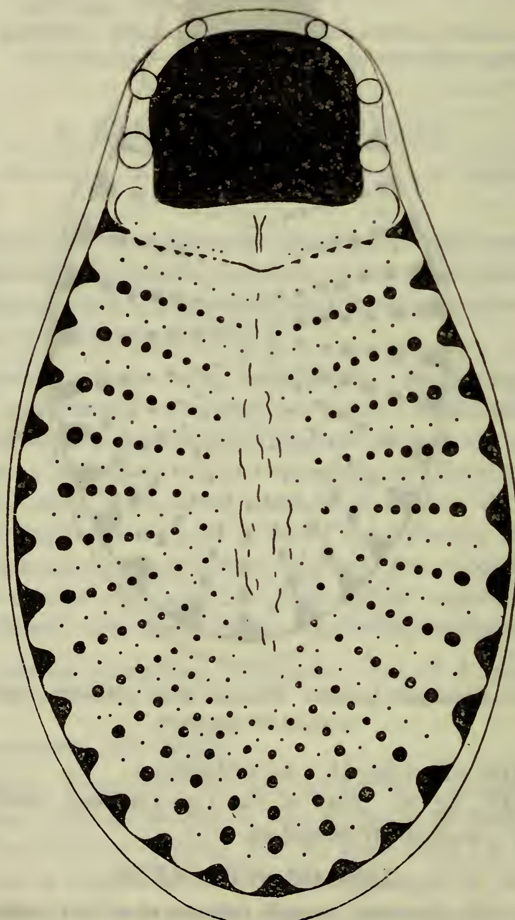


Fig. 62.—*Rhiniopora scabra*. Diagram of an orthœcium, from above. × about 75 diameters.

Diagnosis.—*Rhiniopora* with very few, if any, aviculœcia; orthœcial length about 1·6 mm.; costæ about 25, each with about eight pelmatidia and 7 or 8 lateral fusions; apertures sub-normal to normal and very wide.

Description.—Asty [incrusting], unilaminar; [œcia dimorphic]. Orthœcia about 1·6 mm. long and nearly 1 mm. wide, elliptical; extra-terminal front-wall of very small extent, but hidden by interœcial secondary tissue; intraterminal front-wall rather flat, consisting of about 25 costæ, each bearing about eight pelmatidia and about seven pairs of lateral fusions, and firmly united in a median band of fusion; apertural bar rather narrow, with a low median ridge; aperture sub-normal to normal, and very wide; six apertural spines, not much thickened.

Distribution.—Senonian, Campanian, zone of *B. mucronata*. Rügen.

Type-specimen.—D. 14207. Agnes Laur collection. 1906.

Remarks.—*Rhiniopora scabra*, with six little-thickened apertural spines, and very wide, rather primitive aperture, has probably been derived from a form resembling *R. radiata* and, in turn, has given rise to *R. jurassica*.

Figures.—Text-fig. 62. An orthœcium.

Plate IV, fig. 7. Part of the type-specimen showing an orthœcium and the distal end of another. × about 27 diameters.

Specimens.—The type-specimen. Collection and distribution as above.

11. Rhiniopora jurassica (Gregory).

Membranipora jurassica, n. sp.; Gregory, 1894, p. 62, text-fig. 1 on p. 62; Calcaire à polypiers (Bathonian). Ranville, Normandy.

Membranipora jurassica, Gregory, 1894; Gregory, 1896, pp. 212–214, text-fig. 21 on p. 213 [the same figure as Gregory, 1894, text-fig. 1 on p. 62]; Bathonian, Calcaire à polypiers; Ranville, France.

Rhiniopora jurassica (Gregory); Lang, 1916, pp. 96, 97; [Maastrichtian; Maastricht].

Diagnosis.—Incrusting unilaminar *Rhiniopora* with few aviculœcia, and with orthœcia of gigantic size, being from 1·5 to 1·75 mm. long; costæ about 28 or 30, bearing 7 or 8 pelmatidia and about 7 pairs of lateral fusions; aperture sub-circular to normal and very wide.

Distribution.—Senonian, Maastrichtian, Maastricht, Limbourg, Holland.

Type-specimen.—D. 180. Old collection.

Remarks.—Two orthœcia of the type-specimen of *Membranipora jurassica* have complete cribrimorph intraterminal front-walls, thus removing it from the genus *Membranipora*; and in the matrix of the type-specimen are at least three other species of Cheilostome Polyzoa, a fact that of itself renders it extremely unlikely that the rock is a piece of the Bathonian Calcaire à Polypiers—indeed, it is evidently a piece of Maastrichtian Kreidetuff. Moreover, the type-specimen apparently is conspecific with D. 3313 from the Maastrichtian; and, further, Gregory himself admits (1894, p. 63; 1896, p. 213) that its affinities are with Cretaceous species—and two of the species with which he compares it are Maastrichtian forms. It is unfortunate that the species was named *jurassica*, since the misleading name has to be retained.

The preservation both of the type-specimen and of D. 3313 is but poor; the detailed characters, therefore, are uncertain. But *Rhiniopora jurassica* appears to be a further development of *R. scabra*, with a larger number of costæ.

LIST OF SPECIMENS.

D. 180. The type-specimen, descr. and figd., Gregory, 1894, p. 62, text-fig. 1 on p. 62. Recorded as Bathonian, Calcaire à polypiers, Ranville, France; but, almost certainly, Maastrichtian, Maastricht. Old collection.

D. 3313. A large fragment of an asty with the orthœcia mostly broken down, but with a few more-or-less imperfect intraterminal front-walls. Maastrichtian. Maastricht. Old collection.

VI. PHRYNOPORA, Lang, 1916.

Ubaghsia [partim]; Jullien, 1886, pp. 610, 618, 620.
Steginopora (*Ubaghsia*) [partim]; Canu, 1900 [2], pp. 455–6.
Phrynopora, gen. nov.; Lang, 1916, pp. 93, 97–8.

Diagnosis.—Large Castanoporinæ with numerous costæ; aviculœcia monomorphic, generally proximally directed, sporadically distributed, with short pointed rostra ; at least the proximal shield of a secondary aperture present in the shape of a hoop formed by the fusion of the proximal pair of apertural spines.

Genotype.—*Phrynopora bufo*, Lang.

Distribution.—Senonian, Campanian, zone of *B. mucronata*. Rügen.

Remarks.—*Phrynopora* may have been directly derived from *Rhiniopora* by the acquisition of a secondary aperture, or at least its proximal shield. This is formed in *Phrynopora bufo* by the fusion of each of the proximal pair of apertural spines with its neighbour (one of the proximal-median pair of apertural spines), and by the fusion of the single spine thus formed with the corresponding structure on the opposite side, thus forming a hoop over the aperture (fig. 63). Apparently, in *P. arcifera* the apertural hoop is formed of the proximal pair of apertural spines only, which are enormously enlarged (fig. 64). Among Pelmatoporid genera, *Phrynopora* is remarkable for having more than six apertural spines.

Key to the Species of *Phrynopora*.

A. Apertural hoop comparatively thin, formed of the fused proximal and proximal-median apertural spines; aviculœcia larger (fig. 63) .... 1. *P. bufo*.

B. Apertural hoop formed of the enormously enlarged proximal pair of apertural spines only, aviculœcia smaller (fig. 64) .... 2. *P. arcifera*.

1. Phrynopora bufo, Lang.

Phrynopora bufo, sp. n.; Lang, 1916, pp. 97, 98; *B. mucronata*-zone; Rügen.

Diagnosis.—*Phrynopora* with the proximal shield of the secondary aperture comparatively slightly-built, and formed by the fused proximal and proximal-median pairs of apertural spines; aviculœcia larger than those of *P. arcifera*.

Description.—Asty erect, unilaminar; œcia dimorphic. Orthœcia about 1·2 mm. long and ·85 mm. wide, oval; extraterminal front-wall of small extent, and not hidden by interœcial secondary tissue; intraterminal front-wall rather flat, consisting of about twenty costæ, each bearing about seven pelmatidia and six pairs of lateral fusions, and firmly united in a median line of fusion; apertural bar low, rather thin, with a median ridge; proximal shield of secondary aperture formed by apertural spines of the proximal pair, which fuse with their neighbours, the proximal-median pair of apertural spines; the combined spine so produced then fuses with the corresponding structure across the aperture, forming an apertural hoop; there does not appear to be any distal

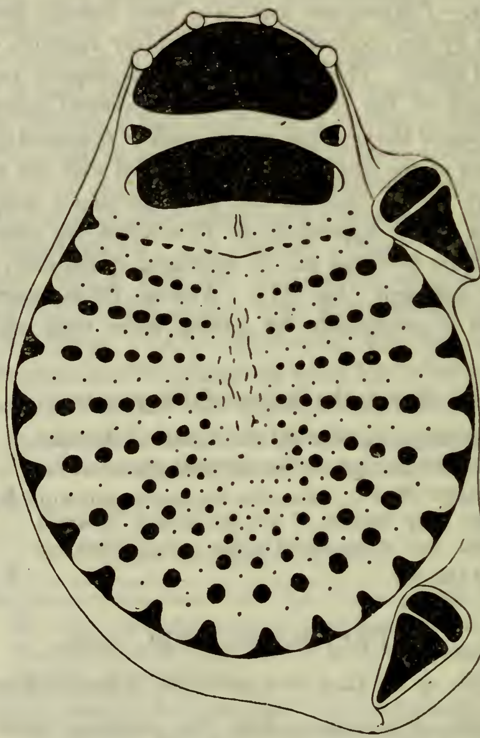


Fig. 63.—*Phrynopora bufo.* Diagram of an orthœcium and two aviculœcia, from above. × about 75 diameters.

shield; apertural spines six or more. Aviculœcia numerous, sporadically distributed, proximally directed, larger than those of *P. arcifera,* divided by a transverse bar into a shorter, more-or-less semicircular proximal portion and a somewhat elongate triangular rostrum. Ovicells globular, with a slight median keel proximally, perforated with numerous pores.

Distribution.—Senonian, Campanian, zone of *B. mucronata.* Rügen.

Type-specimen.—D. 14974.

Remarks.—*Phrynopora bufo* does not appear to be closely related to *P. arcifera*, and in some respects bears a closer resemblance to *Rhiniopora.* In its numerous aviculœcia it is more primitive than those species of *Rhiniopora* which approach it in size. It probably diverged from *Phrynopora arcifera* at a point very close to where both diverged from a rather primitive *Rhiniopora* stock.

Figures.—Text-fig. 63. Orthœcium and two aviculœcia.

Plate IV, fig. 8. Part of the type-specimen, showing two orthœcia, that on the right having the hoop-like fusion of the proximal pair of apertural spines complete; three aviculœcia; and a broken and an unbroken ovicell. × about 27 diameters.

LIST OF SPECIMENS.

D. 14974. D. 14160. D. 15030. The type-specimen and two paratypes. Senonian, Campanian, zone of *B. mucronata.* Rügen. Agnes Laur collection. 1906, 1909.

2. Phrynopora arcifera (Jullien).

Ubaghsia arcifera J. Jullien; Jullien, 1886, pp. 618, 620, pl. xx, figs. 2–4; Sénonien; Moulineaux near Meudon.

Ubaghsia arcifer; Jullien, 1886, p. 610; Craie; Meudon.

Steginopora (*Ubaghsia*) *arcifer* J. Jullien; Canu, 1900 [2], pp. 455–6, text-fig. 67 on p. 455 [a reduced copy of Jullien, 1886, pl. xx, figs. 2–4].

Phrynopora arcifera (Jullien); Lang, 1916, pp. 97, 98; Campanian; Meudon.

Diagnosis.—*Phrynopora* with the proximal shield of the secondary aperture consisting of a hoop formed by the fusion of the enormously swollen proximal pair of apertural spines; aviculœcia small.

Description.—Asty unilaminar, erect; œcia dimorphic. Orthœcia elliptical; extraterminal front-wall of very limited extent, not hidden by interœcial secondary tissue; intraterminal front-wall rather flat, consisting of about fifteen costæ, each with about three pairs of lateral fusions; aperture semicircular; apertural spines four to six or seven in number, often much thickened, the proximal pair always so and to a remarkable degree; each spine of the proximal pair bends hoop-wise over the aperture and fuses with the other in the middle line. Aviculœcia numerous, sporadic, generally proximally directed, small, with the aperture divided by a transverse bar into a semicircular proximal portion and a shortly-triangular rostrum.

Distribution.—Senonian, Campanian, zone of *B. mucronata*, Craie de Meudon. Carrière de Moulineaux, Meudon, S.W. of Paris.

Type-specimen.—That figured by Jullien, 1886, pl. xx, fig. 2, is hereby selected.

Fig. 64.—*Phrynopora arcifera.* Diagram of the aperture, from above, showing the proximal shield of the secondary aperture, consisting of a hoop formed by the greatly enlarged proximal pair of apertural spines. × about 75 diameters.

Remarks.—See under *Phrynopora bufo.*

Figures.—Text-fig. 64. The aperture of an orthœcium.

Specimens.—None in the Collection.

VII. CASTANOPORA, Lang, 1916.

Escharipora [partim]; d'Orbigny, 1851, legend to pl. 686, figs. 1–5, 1852, pp. 227, 235, 1854, p. 1097.

Reptescharipora [partim]; d'Orbigny, 1853, p. 494, 1854, p. 1098.

Escharipora [partim]; Coquand, 1860, p. 181.

Escharipora; Ubaghs, 1865, p. 51.

Cribrilina (*Cribrilina*) [partim]; Canu, 1900 [2], p. 447.

Escharipora [partim]; Canu, 1900 [2], p. 447.

Reptescharipora [partim]; Canu, 1900 [2], p. 457.

Cribrilina [partim]; Brydone, 1906, p. 297.
Cribrilina [partim]; White, 1909, pp. 34, 39.
Cribrilina [partim]; Brydone, 1913, pp. 437–8.
Escharipora; Brydone, 1913, p. 437.
Castanopora, gen. nov.; Lang, 1916, pp. 93–96.
Escharipora; Lang, 1916, p. 95.
Castanopora; Lang, 1919 [3], p. 105.

Diagnosis.—Large Castanoporinæ with numerous costæ, no tertiary front-wall and no secondary aperture; paired, distally-directed aviculœcia, having apertures with elongate pointed rostra, are present, and some species have proximally-directed aviculœcia also, with short rostra.

Genotype.—*Castanopora castanea*, Lang.

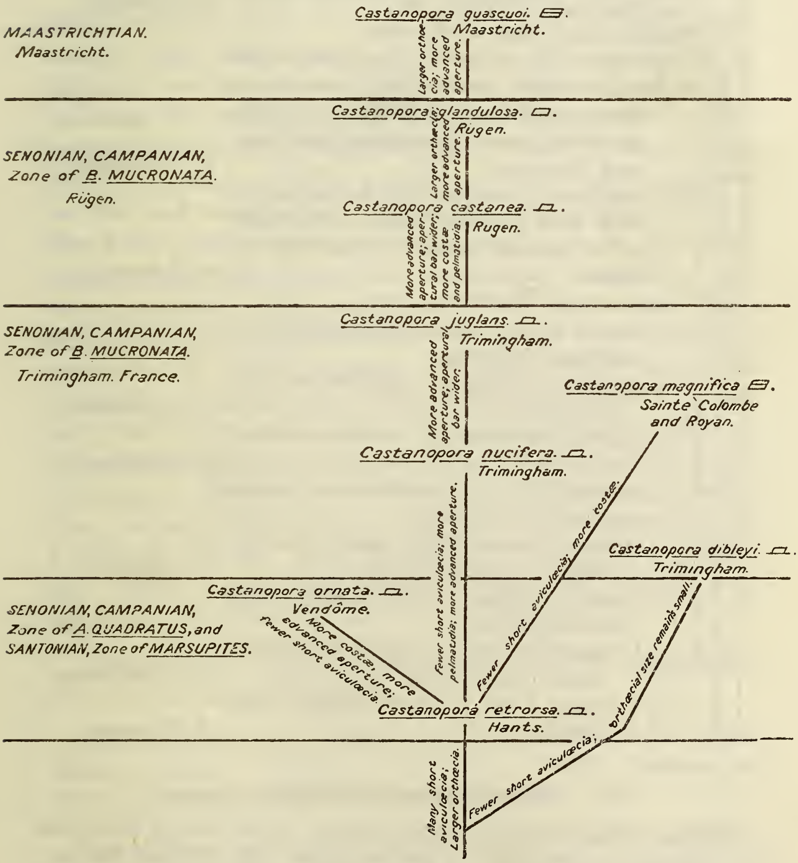
Distribution.—Senonian, Santonian, zone of *Marsupites*, to Maastrichtian.

Remarks.—*Castanopora* may have been derived from a form resembling a primitive *Rhiniopora*—that is, a form like *Carydiopora*, but with aviculœcia of both the long- and short-rostrate types, of which the long type was often paired and always distally directed instead of sporadically distributed and variously directed as in *Rhiniopora*. As evolution proceeded, the short type of aviculœcium was dropped, and only the paired distally-directed aviculœcia were retained, whereas, in *Rhiniopora*, it was the long aviculœcia that were dropped first during evolution and the short ones but gradually.

In other respects the lineages of *Castanopora* run a similar evolutionary course to those of *Rhiniopora*, and form a series of generally homœomorphic forms, e. g. *Rhiniopora jurassica* and *Castanopora guascoi*, *Rhiniopora scabra* and *Castanopora glandulosa*; the species of *Castanopora* are, however, on the whole, less coarse than those of *Rhiniopora*. In the evolution, then, of *Castanopora*, (*a*) the size of the orthœcium increases, (*b*) the number of costæ increases, (*c*) the number of pelmatidia and lateral costal fusions increases, (*d*) the aperture increases in height, compared with its width, passing from sub-semicircular to sub-normal. The apertural spines are four in number in the primitive species, but apparently increase to five or six in *C. glandulosa*. This tendency, contrary to the general trend of Pelmatoporidæ, which typically and primitively have six apertural spines, generally reduced during evolution to four, is paralleled in the genus *Rhiniopora* by the species *R. scabra*, which has six apertural spines, and in the genus *Phrynopora*, a derivative of *Rhiniopora*, which has six or more apertural spines; but it is probable that while this increase in the number of apertural spines is a primitive feature in *Rhiniopora* and its derivative *Phrynopora*, it is in *Castanopora* a catagenetic feature indicating a secondary return to more primitive conditions. Probably it has no connection with the apparent multiplication of apertural spines produced in the genus *Ubaghsia* by the branching of these structures.

Castanopora retrorsa, from the *Marsupites*-zone of Hampshire, is undoubtedly the most primitive form. In this the short proximally-directed aviculœcia are abundant, the number of pelmatidia and lateral costal fusions is few, and the aperture is super-semicircular. In respect of size and number of costæ *C. dibleyi* is more primitive than *C. retrorsa* and cannot be considered as directly derived from that form. However, in having fewer, short, proximally-directed aviculœcia, more pelmatidia and costal fusions, and sub-normal to normal or even super-normal apertures, *C. dibleyi* is more advanced than *C. retrorsa*. *C. magnifica* and *C. ornata*, known only from d'Orbigny's figures and descriptions, are difficult to correlate with the other species of *Castanopora*. They are more advanced in the number of their costæ than any of the other species, but in other respects do not appear to be specially differentiated. Of the two, *C. magnifica* appears to be more primitive than *C. ornata*, having fewer costæ and a less advanced aperture, but there is probably no close relationship between them, and both may have been independently derived from some ancestor resembling *C. retrorsa*. The remaining species appear to form a fairly direct lineage based on *C. retrorsa*. *C. nucifera*, from Trimingham, is larger than *C. retrorsa*, has more pelmatidia, and an aperture slightly more advanced—that is, sub-normal rather than super-semicircular. *C. juglans*, also from Trimingham, has a sub-normal to normal aperture and a wider apertural bar than its ancestor *C. nucifera*. *C. juglans* probably gave rise to *C. castanea*, a Rügen form with more costæ, more pelmatidia, a decidedly normal aperture, and a still wider apertural bar. *C. glandulosa*, a Rügen form, probably arose from *C. castanea* by increasing its size, by acquiring a normal to super-normal aperture, and by increasing the apertural spines to five or six. Finally, *C. guascoi*, from Maastricht, so far as its characters can be determined, appears to have been derived from *C. glandulosa*, and differs from that species by a still further increase in size and by a still higher aperture. The character of the colonial habit has not been considered in the above evolutionary sketch; but it is in keeping with this evolution. Thus, *C. retrorsa*, *C dibleyi*, *C. nucifera*, *C. juglans*, *C. castanea*, and *C. ornata* are incrusting and unilaminar; *C. glandulosa* is erect and unilaminar; and *C. magnifica* and *C. guascoi* are erect and bilaminar.

The following scheme represents the phylogeny proposed * :—



* The signs after the names mean incrusting (oblong with one side produced each way), erect unilaminar (single oblong), and erect bilaminar (double oblong).

Key to the Species of *Castanopora*.

A. Short, proximally-directed aviculœcia abundant; length about 1 mm.; costæ 23 or less; 4 or 5 pelmatidia on each costa; incrusting, unilaminar; aperture super-semicircular (fig. 65) .... 1. *C. retrorsa.*

B. Short proximally-directed aviculœcia few or absent.

- I. Orthœcia not more than ·9 mm. long; costæ about 18; pelmatidia 6 or 7 on each costa; orthœcia very short compared with their width; incrusting, unilaminar; aperture sub-normal to somewhat super-normal (fig. 66) .... 2. *C. dibleyi.*
- II. Orthœcia about 1 mm. or more long.
  - *a.* Costæ 29–33; about 6 pelmatidia on each costa.
    - 1. Costæ about 29; aperture sub-normal to sub-circular; aviculœcia distally and laterally placed with regard to the orthœcial apertures; erect, bilaminar .... 3. *C. magnifica.*
    - 2. Costæ about 33; aperture super-normal; aviculœcia more proximally placed with regard to the orthœcial apertures; incrusting, unilaminar .... 4. *C. ornata.*
  - *b.* Costæ not more than 25.
    - 1. Costæ 20–22; 6 or 7 pelmatidia on each costa; incrusting, unilaminar.
      - *α.* Aperture sub-normal; apertural bar narrower (fig. 67) .... 5. *C. nucifera.*
      - *β.* Aperture sub-normal to normal; apertural bar wider (fig. 68) .... 6. *C. juglans.*
    - 2. Costæ 20–25; 7 or 8 pelmatidia on each costa; apertural bar very wide.
      - *α.* Aperture normal; length about 1 mm.; incrusting, unilaminar (fig. 69) .... 7. *C. castanea.*
      - *β.* Aperture normal to super-normal; length more than 1 mm.
        - 1. Length 1·25–1·5 mm.; aperture less high; erect, unilaminar (fig. 70) .... 8. *C. glandulosa.*
        - 2. Length 2 mm.; aperture higher; erect, bilaminar .... 9. *C. guascoi.*

1. Castanopora retrorsa, Lang.

Cribrilina dibleyi Brydone; White, 1909, pp. 34, 39; zone of *Marsupites*, *Uintacrinus* Band; N.W. of Newland's Farm [S.E. of Odiham, Hants].

Non *Cribrilina Dibleyi*, sp. nov.; Brydone, 1906, p. 297, text-fig. 8 on p. 297; Trimmingham.

Castanopora retrorsa, sp. n.; Lang, 1916, pp. 94, 95; *Marsupites*-zone; Odiham, Hants.

Diagnosis.—*Castanopora* with numerous proximally-directed aviculœcia with comparatively short rostra, as well as distally directed, generally paired aviculœcia with very elongate rostra; orthœcial length about 1 mm.; costæ 23 or less; 4 or 5 pelmatidia and pairs of lateral fusions to each costa; incrusting unilaminar asty; aperture super-semicircular.

Description.—Asty incrusting, unilaminar; œcia dimorphic. Orthœcia about 1 mm. long and ·61 mm. wide, elliptical; extra-terminal front-wall of very small extent, but not hidden by interœcial secondary tissue; intraterminal front-wall well arched, consisting of twenty-three costæ or less, each bearing four or five pelmatidia and a corresponding number of pairs of lateral costal fusions, and firmly united in a median band of fusion; apertural bar thin and compressed in a proximal-distal direction, so as to form a low proximal shield to the aperture; aperture super-semicircular; apertural spines four. Aviculœcia dimorphic, some having apertures with comparatively short rostra, and others having the rostrum drawn out into a long fine point; the short aviculœcia are directed variously, but nearly always more-or-less proximally; while the long aviculœcia are always distally directed; both kinds are generally placed laterally and rather proximally to the apertures; and each aperture has one and sometimes a pair attending it; both kinds are divided by a constriction (probably, when perfect, by a bar) into a semicircular proximal portion and a triangular rostrum. Ovicells apparently hyperstomial, globular, but slightly longer than wide; the pillar-like distal pair of apertural spines form the sides of their apertures.

Distribution.—Senonian, Santonian, zone of *Marsupites*, *Uintacrinus*-band, Hampshire.

Type-specimen.—D. 21170. N.W. of Newland's Farm, Odiham, Hants. Recorded as *Cribilina dibleyi*, Brydone, by White, 1909, pp. 34, 49. L. Treacher collection. 1911.

Remarks.—*Castanopora retrorsa* still retains numerous short, proximally-directed aviculœcia, and in this respect, as well as in the small number of its pelmatidia and in the super-semicircular aperture, it is the most primitive known *Castanopora*. From it the other species, except *C. dibleyi*, may have been derived. In the small size of the orthœcia *C. dibleyi* is more primitive than *C. retrorsa*, and must be looked upon as having diverged from the primitive *Castanopora*-stock before the appearance of *C. retrorsa*. Thus, except for *C. dibleyi*, *C. retrorsa* may be looked upon as a radical from which the other species arose.

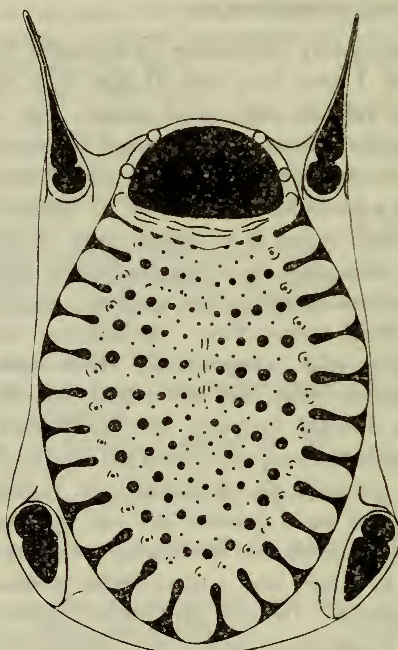


Fig. 65.—*Castanopora retrorsa*. Diagram of an orthœcium with two long distally directed and two short proximally-directed aviculœcia, from above. × about 75 diameters.

Figures.—Text-fig. 65. Orthœcium, two long and two short aviculœcia.

Plate IV, fig. 9. Part of the type-specimen, showing two complete orthœcia; parts of four others; three distally-directed aviculœcia with long rostra; and seven proximally-directed aviculœcia with short rostra. Two orthœcia bear complete ovicells and one a broken ovicell. × about 27 diameters.

Specimens.—The type-specimen. Distribution and collection as above.

2. Castanopora dibleyi (Brydone).

Cribrilina Dibleyi, sp. nov.; Brydone, 1906, p. 297, text-fig. 8 on p. 297; [Senonian, zone of *B. mucronata*]; Trimmingham.

Non *Cribrilina dibleyi* Brydone; White, 1909, pp. 34, 39 [= *Castanopora retrorsa* Lang, q.v.].

Cribrilina Dibleyi, mihi; Brydone, 1913, pp. 437–8, pl. xiv, fig. 9; [Senonian, zone of *B. mucronata*;] Trimingham.

Castanopora dibleyi (Brydone); Lang, 1916, pp. 94, 95; *B. mucronata*-zone; Trimingham, Norfolk.

Diagnosis.—*Castanopora* with few proximally-directed aviculœcia with comparatively short rostra, and with a pair of distally-directed aviculœcia with long rostra to each orthœcial aperture; length about ·8 mm.; costæ about 18; 6 or 7 pelmatidia and the same number of pairs of costal fusions on each costa; incrusting, unilaminar; aperture sub-normal to somewhat super-normal.

Description.—Asty incrusting, unilaminar; œcia dimorphic.

(a) *Ephebœcia.*—Orthœcia about ·8 mm. long and ·66 mm. wide, oval; extraterminal front-wall rather pronounced at the extreme proximal end of the œcium, otherwise of very small extent and not hidden by interœcial secondary tissue; intraterminal front-wall arched, but rather flat above, consisting of about eighteen costæ, each with six or seven pelmatidia and the same number of pairs of costal fusions, and united in a median line of fusion; apertural bar thin, somewhat compressed in a proximal-distal direction, with a median ridge; aperture sub-normal to somewhat super-normal; apertural spines four (sometimes five, according to Brydone). Aviculœcia dimorphic, some having apertures with comparatively short rostra and others having the rostra drawn into a long point; the short aviculœcia are rare, proximally directed, and placed at the sides of orthœcial apertures; the long aviculœcia are numerous, one or a pair being placed laterally to the aperture of each orthœcium; the apertures of both kinds of aviculœcia are divided by a transverse bar into a semicircular proximal portion and a triangular rostrum. Ovicells, apparently hyperstomial, globular, and, according to Brydone, "with faint radial markings"; suggestions of these are visible in one ovicell in specimen **D. 8003**; the apertures of the ovicells are bounded by the distal pair of apertural spines.

(b) *Later neanœcia.*—Orthœcia about ·66 mm. long and about ·5 mm. wide, oval to sub-circular; extraterminal front-wall of very small extent, even proximally, and not hidden by interœcial secondary tissue; intraterminal front-wall consisting of about eighteen costæ, each with six or seven pelmatidia and about six pairs of costal fusions, united in a median line of fusion; apertural bar fairly thick, with a well-marked median ridge; aperture normal. Aviculœcia as in ephebastic stages.

(c) *Ancestrœcium.*—About ·4 mm. long and about ·25 mm. wide, elliptical; extraterminal front-wall of very small extent, even proximally; intraterminal front-wall well arched, consisting of thirteen costæ, each with four or five pelmatidia and three or four pairs of costal fusions; apertural bar thin, with no median ridge; aperture sub-normal; apertural spines four.

Distribution.—Upper Senonian, Campanian, zone of *B. mucronata.* Trimingham, Norfolk.

Type-specimen.—That figured by Brydone, 1906, text-fig. 8, on p. 297, is hereby selected.

Remarks.—By the small size of the orthœcia *Castanopora dibleyi* is shown to be more primitive than *C. retrorsa*, which, however, is less advanced in other characters than *C. dibleyi*. Thus the two species appear to be on different lineages, and to have diverged early in the history of *Castanopora* from a common ancestral form. *C. dibleyi* resembles very closely *C. nucifera*, but has a more advanced aperture than that species, so can hardly have given rise to it; while *C. nucifera*, being larger than *C. dibleyi*, could not have been its ancestor. *C. nucifera* was probably derived from *C. retrorsa*. The condition of the specimen **D. 20609** is peculiar. It is presumably of this species, but the orthœcia are smaller than is normal, and all are entirely closed—that is, they have no apertures and their proximal and distal ends are alike. This seems to have been brought about by the inturning of the apertural spines to join the intraterminal front-wall. Such "closed œcia" are common among Membranimorphs, but otherwise unknown to me among Cribrimorphs.

FIGURES.—Text-fig. 66 *a*. Orthœcium, two long aviculœcia, and one short aviculœcium. Text-fig. 66 *b*. Ancestrœcium.

Plate IV, fig. 10. Part of specimen **D. 8003**, showing three complete orthœcia, parts of three others, and four pairs of apertural aviculœcia. × about 27 diameters.

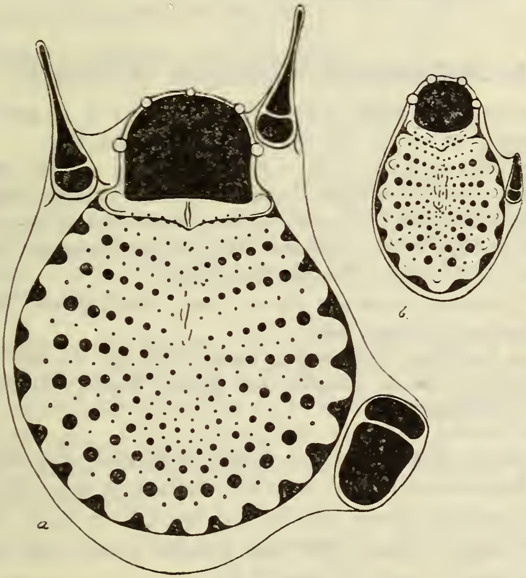


Fig. 66.—*Castanopora dibleyi.* Diagrams: (*a*) of an ephebastic orthœcium with an apertural pair of long distally-directed aviculœcia and a single, short, proximally-directed aviculœcium; and (*b*) of the ancestrœcium with a long distally-directed aviculœcium; both from above. × about 75 diameters.

LIST OF SPECIMENS.

D. 8003. An asty showing the ancestrœcium, neanastic, and ephebastic stages. Metatype. Senonian, Campanian, zone of *B. mucronata*. Trimingham, Norfolk. Presented by R. M. Brydone, Esq., F.G.S., 1907.

D. 8004. An asty showing rather large ephebœcia. Metatype. Horizon, locality, and acquisition as **D. 8003**.

D. 15599. A large piece of an asty showing ancestrœcium, neanastic, and ephebastic stages. Senonian, Campanian, zone of *B. mucronata*. Trimingham, Norfolk. A. C. Savin collection. 1910.

D. 20609. An asty, probably of this species, consisting entirely of small closed orthœcia, the closure being, apparently, effected by the in-turning of the apertural spines to join the intraterminal front-wall, since no apertures are visible, the proximal and distal ends of the intraterminal front-wall being alike. Senonian [Campanian, zone of *B. mucronata*]. Norwich. T. G. Bayfield collection.

3. Castanopora magnifica (d'Orbigny).

Escharipora magnifica, d'Orb.; d'Orbigny, 1851, legend on pl. 686, figs. 1–5; Sénonien.

Escharipora pretiosa, d'Orb., 1851; d'Orbigny, 1852, pp. 227, 235, 1854, p. 1097; Sénonien; environs de Sainte-Colombe (Manche), and Royan (Charente-Inférieure); "les cellules de ces dernières sont plus petites."

Escharipora pretiosa, d'Orb.; Coquand, 1860, p. 181; Campanien; Royan.

Escharipora pretiosa d'Orb.; Ubaghs, 1865, p. 51.

Cribrilina (Cribrilina) magnifica d'Orb.; Canu, 1900[2], p. 447; Sénonien; =*Escharipora pretiosa* d'Orb.

Castanopora magnifica (d'Orbigny); Lang, 1916, pp. 94, 95; Senonian [Campanian]; Sainte Colombe and Royan, France; = *Escharipora pretiosa*, d'Orbigny.

Diagnosis.—*Castanopora* in which proximally-directed aviculœcia are rare or absent, and in which there is a pair of distally-directed aviculœcia placed distally and laterally to each orthœcial aperture; length about 1·25 mm.; costæ about 29; about 7 pelmatidia and 6 pairs of lateral fusions to each costa; erect, bilaminar; aperture normal to sub-circular; apertural spines probably numerous.

Distribution.—Senonian [Campanian]. Environs de Sainte-Colombe, Manche; and Royan, Charente-Inferieure.

Type-specimen.—That figured by d'Orbigny, 1851, pl. 686, fig. 2, is hereby selected.

Remarks.—With d'Orbigny's figures and description alone available for the elucidation of this species, it is not possible to compare it certainly with other forms of *Castanopora*, especially with regard to detailed characters such as the number of apertural spines. The number of costæ, however, appears to be greater than in any other species except *C. ornata*.

Moreover, it seems likely that two forms are included by d'Orbigny under one name, since he remarks of those from Royan that they have smaller orthœcia than the specimens from Sainte-Colombe. D'Orbigny further complicates the matter by calling the species *C. pretiosa* in the text and *C. magnifica* in the legend on the plate. The latter name is here retained because the plate was published prior to the text.

Specimens.—None in the Collection.

4. Castanopora ornata (d'Orbigny).

Reptescharipora ornata, d'Orb., 1851; d'Orbigny, 1852, pl. 720, figs. 6–8, 1853, p. 494, 1854, p. 1098; Sénonien; Vendôme (Loir-et-Cher).
Reptescharipora ornata; Canu, 1900 [2], p. 457; "Ne correspond pas."
Castanopora ornata (d'Orbigny); Lang, 1916, pp. 94, 95; Senonian; Vendôme, France.

Diagnosis.—*Castanopora* in which proximally-directed aviculœcia are rare or absent, and in which there is a pair of aviculœcia in the proximal-lateral corners of each orthœcial aperture; length about 1·25 mm.; costæ about 33; about 7 pelmatidia and six pairs of lateral fusions to each costa; incrusting, unilaminar; aperture super-normal.

Distribution.—Senonian [Santonian]. Vendôme, Loir-et-Cher.

Type-specimen.—That figured by d'Orbigny, 1852, pl. 720, fig. 7, is hereby selected.

Remarks.—It is only by the large number of costæ that *Castanopora ornata* can be certainly diagnosed; and, as with *C. magnifica*, the other detailed characters are more or less uncertain, owing to the inadequacy of d'Orbigny's figure and description. Indeed, it is only on the interpretation that the structures at the proximal-lateral corners of the aperture are distally-directed aviculœcia that the species is included in the genus *Castanopora*. Its detailed affinities, like those of *C. magnifica*, must, therefore, remain doubtful until new material or more detailed description of d'Orbigny's type-material is available.

Specimens.—None in the Collection.

5. Castanopora nucifera, Lang.

Castanopora nucifera, sp. n.; Lang, 1916, p. 95; *B. mucronata*-zone; Trimingham, Norfolk.

Diagnosis.—Castanoporinæ with few proximally-directed aviculœcia and one, or a pair, of distally-directed aviculœcia placed laterally to each orthœcial aperture; length about 1 mm.; costæ 20–22, with 6 or 7 pelmatidia and 5 or 6 pairsof lateral fusions to each costa; incrusting, unilaminar; aperture sub-normal; apertural bar rather narrow.

Description.—Asty incrusting, unilaminar; œcia dimorphic. Orthœcia about 1 mm. long and ·6 mm. wide, elliptical; extraterminal front-wall of very small extent, not concealed by interœcial secondary tissue; intraterminal front-wall moderately arched, consisting of from twenty to twenty-two costæ, each with six or seven pelmatidia and five or six pairs of lateral fusions, and united in a median band of fusion; apertural bar rather narrow, somewhat compressed in a proximal-distal direction, and bearing a median ridge; aperture sub-normal; apertural spines four. Aviculœcia dimorphic; proximally-directed aviculœcia rare, and probably sporadically distributed; distally-directed aviculœcia one or a pair placed laterally to each orthœcial aperture, having their apertures divided by a transverse bar into a semi-circular proximal portion and a very elongated-triangular rostrum.

Distribution.—Senonian, Campanian, zone of *B. mucronata*. Trimingham, Norfolk.

Type-specimen.—D. 15600. A. C. Savin collection. 1910.

Remarks.—*Castanopora nucifera* may have been directly derived from *C. retrorsa* by the loss of many of the proximally-directed aviculœcia, by an increase in the number of pelmatidia and lateral costal fusions, and by an advance in the shape of the aperture. The aperture, however, is not so advanced as that of *C. dibleyi*, so that *C. nucifera* cannot have been derived from that form.

Figures.—Text-fig. 67. Orthœcium and two distally-directed aviculœcia.

Plate IV, fig. 11. Part of the type-specimen, showing two complete orthœcia and six distally-directed aviculœcia. × about 27 diameters.

Specimens.—The type-specimen. Distribution and collection as above.

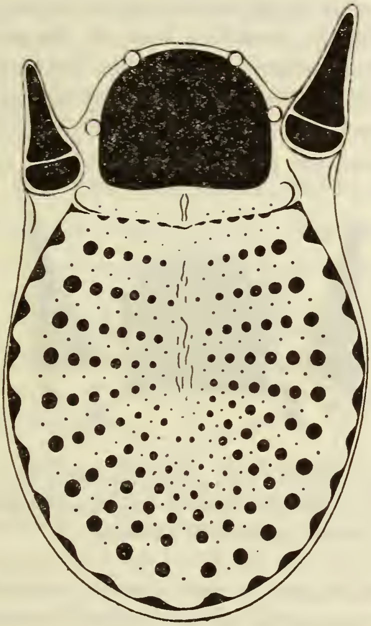


Fig. 67.—*Castanopora nucifera.* Diagram of an orthœcium with an apertural pair of long distally-directed aviculœcia, from above. × about 75 diameters.

6. Castanopora juglans, Lang.

Castanopora juglans, sp. n.; Lang, 1916, p. 95; *B. mucronata*-zone; Trimingham, Norfolk.

Diagnosis.—*Castanopora* in which proximally-directed aviculœcia are few or absent, and one, or a pair, of distally-directed aviculœcia is placed laterally to each orthœcial aperture; length about 1 mm.; costæ 20–22; with 6 or 7 pelmatidia and 5 or 6 pairs of lateral fusions to each costa; incrusting, unilaminar; aperture sub-normal to normal; apertural bar rather wide.

Description.—Asty incrusting, unilaminar; œcia dimorphic. Orthœcia about 1 mm. long and ·6 mm. wide; extraterminal front-wall hardly to be seen except proximally, and not concealed by interœcial secondary tissue; intraterminal front-wall arched, but flattish above, consisting of from twenty to twenty-two costæ each bearing six or seven pelmatidia and five or six pairs of lateral fusions, and united in a median band of fusion; apertural bar rather wide, with a median ridge; aperture sub-normal to normal; apertural spines four. Aviculœcia probably of two kinds, but the proximally-directed kind is rare and possibly absent; the distally-directed aviculœcia are placed laterally to the apertures of the

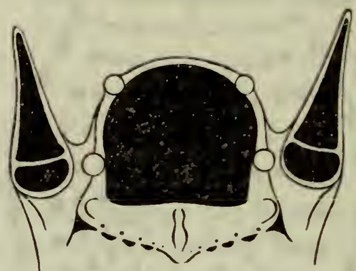


Fig. 68.—*Castanopora juglans.* Diagram of the distal end of an orthœcium with an apertural pair of long distally-directed aviculœcia, from above. × about 75 diameters.

orthœcia, generally a pair to each aperture; each is divided by a transverse bar into a semi-circular proximal portion and an elongate-triangular rostrum.

Distribution.—Senonian, Campanian, zone of *B. mucronata.* Trimingham, Norfolk.

Type-specimen.—D. 15608.

Remarks.—*Castanopora juglans* differs from *C. nucifera*, from which clearly it has been derived, only in the shape of the aperture and in the width of the apertural bar. It is of interest as being, in both respects, a connecting-link between *C. nucifera* and *C. castanea.*

Figures.—Text-fig. 68. Apertural end of an orthœcium with a pair of aviculœcia.

Plate V, fig. 1. Part of the type-specimen, showing three complete orthœcia, two distally-directed aviculœcia (one of which is imperfect), and a large lacuna. × about 27 diameters.

LIST OF SPECIMENS.

D. 15608. Type-specimen. Senonian, Campanian, zone of *B. mucronata*. Trimingham, Norfolk. A. C. Savin collection. 1910.

D. 30110. A specimen with rather small orthœcia, incrusting the so-called "*Ostrea lunata*" of Trimingham. Horizon, locality, and collection as above.

7. Castanopora castanea, Lang.

Castanopora castanea, sp. n.; Lang, 1916, p. 95; *B. mucronata*-zone; Rügen.

Diagnosis.—*Castanopora* in which proximally-directed aviculœcia are few or absent and a pair of distally-directed aviculœcia is placed laterally to each orthœcial aperture; length about 1 mm.; costæ about 20, with 7 or 8 pelmatidia and 6 or 7 pairs of lateral fusions to each costa; incrusting, unilaminar; aperture normal; apertural bar very wide.

Description.—Asty incrusting, unilaminar; œcia dimorphic. Orthœcia about 1 mm. long and ·6 mm. wide, elliptical; extraterminal front-wall of small extent, but generally quite visible laterally, and comparatively well developed proximally, not concealed by interœcial secondary tissue; intraterminal front-wall arched laterally, but rather flattened above, consisting of some twenty costæ, each with seven or eight pelmatidia and six or seven pairs of lateral fusions, and firmly united in a median line of fusion; apertural bar very broad, somewhat triangular with the apex directed proximally, and with a median ridge; aperture normal; apertural spines four, much thickened. Aviculœcia apparently of one kind only, distally directed, but possibly there are occasional proximally-directed ones; the distally-directed aviculœcia are in pairs, one on each side of the aperture of every orthœcium; their proximal ends are about at the level of the proximal pair of apertural spines; their apertures are divided by a transverse bar into a semi-circular proximal portion and an elongate-triangular rostrum.

Distribution.—Senonian, Campanian, zone of *B. mucronata*. Rügen.

TYPE-SPECIMEN.—D. 16654.

REMARKS.—*Castanopora castanea* may have been derived directly from *C. juglans* by an increase in the number of pelmatidia and lateral costal fusions, in the width of the apertural bar, and in the thickness of the apertural spines. Being found at Rügen, it probably occurs at a higher horizon than *C. juglans*, which is a Trimingham species.

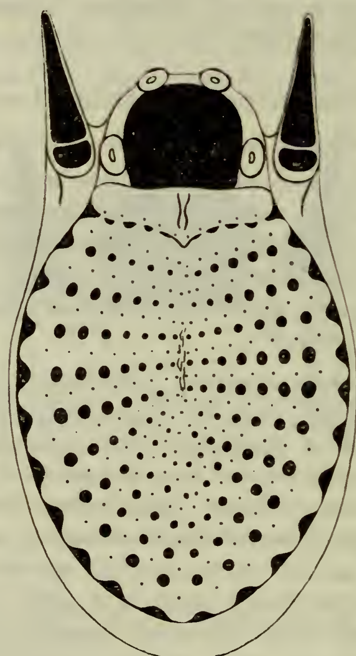


Fig. 69.—*Castanopora castanea.* Diagram of an orthœcium with an apertural pair of long distally-directed aviculœcia, from above. × about 75 diameters.

FIGURES.—Text-fig. 69. Orthœcium and its accompanying pair of aviculœcia.

Plate V, fig. 2. Part of the type-specimen, showing three complete orthœcia, each with an apertural pair of aviculœcia, and parts of others. The lowest complete orthœcium has a double proximal end, and is described below. × about 27 diameters.

LIST OF SPECIMENS.

D. 16654. Type-specimen. One orthœcium has a single aperture and a double proximal end, the whole œcium being like a "twinned" crystal, bilaterally symmetrical about a plane of symmetry. Senonian, Campanian, zone of *B. mucronata*. Rügen. Agnes Laur collection. 1909.

D. 14990. An asty, probably of this species, with broken-down œcia. Horizon, locality, and collection as the last.

D. 15347. An asty, apparently erect, unilaminar, but this may be due to its having incrusted a perishable base. Horizon, locality, and collection as the last.

8. Castanopora glandulosa, Lang.

Castanopora glandulosa, sp. n.; Lang, 1916, pp. 95, 96; *B. mucronata*-zone; Rügen.

Diagnosis.—*Castanopora* in which proximally-directed aviculœcia are few or absent and a pair of distally-directed aviculœcia is placed laterally to each orthœcial aperture; length about 1·25 to 1·5 mm.; costæ about 25, with 7 or 8 pelmatidia and 6 or 7 pairs of lateral fusions to each costa; erect, unilaminar; aperture normal to super-normal; apertural spines four.

Description.—Asty erect, unilaminar; œcia dimorphic. Orthœcia about 1·25 mm. to 1·5 mm. long and ·66 mm. wide; extraterminal front-wall of very small extent, except proximally, where it is fairly conspicuous, not hidden beneath interœcial secondary tissue; intraterminal front-wall fairly well arched, consisting of about twenty-five costæ, each bearing seven or eight pelmatidia and six or seven pairs of lateral fusions, and firmly united in a median line of fusion; apertural bar generally very wide, somewhat triangular, with apex proximally directed; with a median ridge absent or very feebly developed; aperture normal to super-normal; apertural spines five, and not much, if at all, thickened. Aviculœcia, apparently of one kind only, distally directed and arranged in pairs, one on each side of every orthœcial aperture, their proximal ends about at the level of the proximal pair of apertural spines; the apertures divided by a constriction (probably a transverse bar when perfect) into a proximal semicircular portion and an elongate-triangular rostrum.

Distribution.—Senonian, Campanian, zone of *B. mucronata*; Rügen.

Type-specimen.—D. 15009. Agnes Laur collection. 1909.

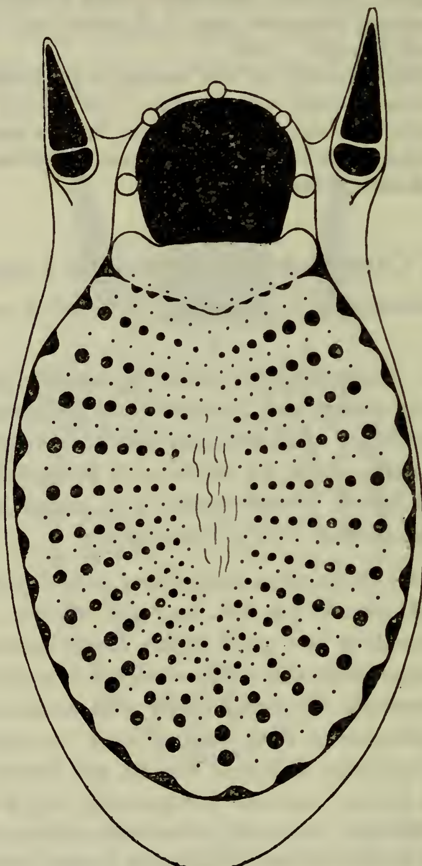


Fig. 70.—*Castanopora glandulosa.* Diagram of an orthœcium with an apertural pair of long distally-directed aviculœcia, from above. × about 75 diameters.

Remarks.—Though it is possible that *Castanopora glandulosa* is directly derived from *C. castanea* by an increase in size and number of costæ, and by an advance in apertural shape, the fact that the number of apertural spines is four, and that these are not markedly thickened as in *C. castanea*, suggests as an alternative that *C. castanea* has arisen from a more primitive stock, such as *C. dibleyi*. In the former case the larger number of apertural spines is a catagenetic character, in the latter case a primitive character. An exact parallel is seen in the species *Rhiniopora scabra*, which resembles *R. cacus*, but is more advanced and has six apertural spines which are but little thickened, while *R. cacus* has but four or five, and these decidedly thickened. In fact, the four species form two homœomorphic pairs, and are, moreover, morphic equivalents. *R. jurassica* and *Castanopora guascoi* form a third pair, one at the distal end of each of these series.

Figures.—Text-fig. 70. Orthœcium and two aviculœcia.

Plate V, fig. 3. Part of the type-specimen, showing two complete orthœcia, parts of another, and six aviculœcia. × about 27 diameters.

Specimens.—The type-specimen. Distribution and collection as above.

9. Castanopora guascoi (Ubaghs).

Escharipora Guascoi nov. sp., Ubaghs; Ubaghs, 1865, p. 51, pl. ii, fig. 3 *a–c*; Ober Bryozoenschichte, horizon f. (see p. 38); Valkenburg.

Cribrilina Guascoi, Ubaghs, sp.; Brydone, 1913, p. 437.

Castanopora guascoi (Ubaghs); Lang, 1916, pp. 95, 96; Maastrichtian; Valkenburg, near Maastricht.

Diagnosis.—*Castanopora* in which proximally-directed aviculœcia are rare or absent—a pair of distally-directed aviculœcia is placed laterally to each aperture; length about 2 mm.; costæ about 23; with 7 or 8 pelmatidia and 6 or 7 pairs of lateral fusions to each costa; erect, bilaminar; aperture normal to supernormal.

Distribution.—Senonian, Maastrichtian. Valkenburg (Fauquemont), E. of Maastricht, Limbourg, Holland.

Type-specimen.—That figured by Ubaghs, 1865, pl. ii, fig. 3 *b*, is hereby selected.

Remarks.—Such characters as are given in the diagnosis are deduced from Ubagh's figured description, and, if correct, show *Castanopora guascoi* to be a bilaminar and comparatively gigantic modification of *C. glandulosa*, exactly comparable with—in fact, a homœomorph and morphic equivalent of—*Rhiniopora jurassica*. Moreover, their respective horizons and localities correspond, for both *Castanopora guascoi* and *Rhiniopora jurassica* are Maastrichtian forms, while their supposed ancestors, *Castanopora glandulosa* and *Rhiniopora scabra* come from Rügen.

VIII. STEGANOPORA, d'Orbigny.

Steginopora [sic], d'Orb., 1851 [partim]; d'Orbigny, 1852, pp. 236–7, 1853, pp. 499, 501, 502 (non pp. 500, 503), 1854, p. 1098.
Steginopora [partim]; Jullien, 1886, p. 612.
Steginopora (*Steginopora*) [partim]; Canu, 1900 [2], pp. 454–5.
Steginopora, d'Orbigny; Lang, 1916, pp. 93, 100.
Steginopora, d'Orbigny [partim]; Lang, 1917, pp. 172–3.
Steginopora; Lang, 1919 [3], p. 105.

Diagnosis.—Castanoporinæ in which there is a tertiary front-wall, the 'lamina peristomica' of Jullien, largely, if not entirely, formed by the up-growth and lateral expansion of paired apertural aviculœcia; apertural spines not branched; asty unilaminar.

Genolectotype.—*Steganopora ornata*, d'Orbigny.

Distribution.—Senonian.

Remarks.—d'Orbigny founded the genus *Steganopora* to include four species, namely, *S. irregularis*, *S. ornata*, *S. aculeata*, and *S. pulchella*. Of these, the first does not appear to have a Cribrimorph front-wall, and the last, though a Cribrimorph, does not show Pelmatoporid characters. Of the remaining two species, *S. ornata* was selected as the genotype of *Steganopora* by Lang (1916, p. 100). In this species (and in *S. aculeata*) the tertiary front-wall appears to be formed by the expansion of the distal ends of paired aviculœcia placed at the proximal-lateral corners of each orthœcial aperture. It is possible, however, that these structures are the proximal pair of apertural spines, and, until well-preserved material is available, this point must remain doubtful. *Steganopora* was probably derived from *Castanopora*, or possibly, if the structures just considered are proximal apertural spines, from a very primitive *Phrynopora*.

Key to the Species of *Steganopora*.

A. Larger; paired aviculœcia do not project above the tertiary front-wall .... 1. *S. ornata.*
B. Smaller; paired aviculœcia project above the tertiary front-wall .... 2. *S. aculeata.*

1. Steganopora ornata, d'Orbigny.

Steginopora [sic] *ornata*, d'Orb., 1851; d'Orbigny, 1852, pl. 721, figs. 1–4, 1853, p. 501, 1854, p. 1098; Sénonien; Sainte-Colombe (Manche).
Steginopora ornata d'Orb.; Jullien, 1886, p. 612.
Steginopora (*Steginopora*) *ornata* d'Orb.; Canu, 1900 [2], p. 455; Sénonien.
Steginopora ornata, d'Orbigny; Lang, 1916, p. 100; Senonian; Sainte-Colombe, France; genolectotype of *Steginopora*.
Steginopora ornata d'Orbigny; Lang, 1917, p. 173.

Diagnosis.—A *Steganopora* which is larger than *S. aculeata*, and in which the supposed paired aviculœcia do not project above the tertiary front-wall.

Distribution.—Senonian. Sainte-Colombe, Manche, France.

Type-specimen.—That figured by d'Orbigny, 1852, pl. 721, fig. 2, is hereby selected.

Remarks.—It is probable that *Steganopora ornata*, with its less differentiated aviculœcia, is more primitive than *S. aculeata*.

Specimens.—None in the Collection.

2. Steganopora aculeata, d'Orbigny.

Steginopora [sic] *aculeata*, d'Orb., 1851; d'Orbigny, 1852, pl. 721, figs. 5–8, 1853, p. 502, 1854, p. 1098; Sénonien; Sainte-Colombe (Manche).
Steginopora aculeata d'Orb.; Jullien, 1886, p. 612.
Steginopora (*Steginopora*) *aculeata* d'Orb.; Canu, 1900 [2], p. 454; Sénonien.
Steginopora aculeata, d'Orbigny; Lang, 1916, p. 100; Senonian; Sainte-Colombe, France.
Steginopora aculeata d'Orbigny; Lang, 1917, p. 173.

Diagnosis.—A *Steganopora* which is smaller than *S. ornata*, and in which the supposed paired aviculœcia project above the tertiary front-wall.

Distribution.—Senonian. Sainte-Colombe, Manche, France.

Type-specimen.—That figured by d'Orbigny, 1852, pl. 721, fig. 6, is hereby selected.

Remarks.—See under *S. ornata*.

Specimens.—None in the Collection.

IX. DISTEGANOPORA, d'Orbigny, 1852.

Eschara [partim]; d'Orbigny, 1850, p. 264.
Disteginopora [sic], d'Orb., 1851; d'Orbigny, 1852, pp. 235–7 (non 1853, p. 498).
Disteginopora [partim]; Pictet, 1857, p. 113.
Disteginopora; Jullien, 1886, p. 612.
Thoracophora; Jullien, 1886, pp. 610, 619.
? *Cribrilina* (*Disteginopora*); Vine, 1893, pp. 323, 326.
Steginopora (*Thoracophora*) [partim]; Canu, 1900 [2], p. 456.
Disteginopora (*Thoracophora*); Harmer, 1901, p. 16.
? *Cribrilina* [partim]; Jukes-Browne, 1904, p. 490.
Disteginopora, d'Orbigny, 1852; Lang, 1916, pp. 93, 100.
Escharina; Lang, 1917, p. 173.
Thoracophora; Lang, 1917, p. 173.
Disteginopora; Lang, 1917, p. 173.

Diagnosis.—Castanoporinæ in which there is a tertiary front-wall, the lamina peristomica of Jullien, largely, if not entirely, formed by the up-growth and lateral expansion of paired aviculœcia; apertural spines not branched; asty erect, bilaminar.

Genotype.—*Disteganopora horrida* (d'Orbigny).

Distribution.—Senonian [Campanian, zone of *B. mucronata*]. Meudon, S.W. of Paris.

Remarks.—*Disteganopora*, by d'Orbigny's definition and the evidence of d'Orbigny's figures, is an erect bilaminar *Steganopora*, and, if so, would be more conveniently regarded as congeneric with it. But, pending the examination of well-preserved material of both genera, it is better to keep the genera apart provisionally.

1. Disteganopora horrida (d'Orbigny).

Eschara horrida, d'Orb., 1850; d'Orbigny, 1850, p. 264; Sénonien; Meudon.
Disteginopora [sic] *horrida*, d'Orb., 1851; d'Orbigny, 1851, pl. 603, figs. 16–19, pl. 687 *bis*, figs. 1–5, 1852, p. 237, 1853, p. 499, 1854, p. 1098; Sénonien; Meudon, près de Paris.

Disteginopora horrida, d'Orb.; Pictet, 1857, p. 113; Craie de Meudon,
Thoracophora horrida (d'Orbigny); Jullien, 1886, pp. 610, 612, 619; Craie de Moulinaux, Meudon; [genotype of *Thoracophora*].
? Non *Cribrilina* (*Disteginopora*) *horrida* (d'Orb.); Vine, 1893, pp. 323, 336; zone of *Micras. coranguinum*; Witherington near Salisbury.
Steginopora (*Thoracophora*) *horrida* d'Orb.; Canu, 1900 [2], p. 456, text-fig. 68 on p. 456. [A copy of d'Orbigny, 1857, pl. 687 *bis*, figs. 3, 4.]
Disteginopora (*Thoracophora*) *horrida* D'Orbigny; Harmer, 1901, p. 16, footnote.
? Non *Cribrilina horrida*, d'Orb.; Jukes-Browne, 1904, p. 490; zone of *Mic. coranguinum*; Salisbury.
Disteginopora horrida (d'Orbigny); Lang, 1916, p. 100; Senonian [Campanian]; Meudon, France.
Disteginopora horrida (d'Orbigny); Lang, 1917, p. 173.

Diagnosis.—As for the genus.

Distribution.—Senonian, Campanian, zone of *B. mucronata*. Meudon, S.W. of Paris.

Type-specimen.—That figured by d'Orbigny, 1851, pl. 687 *bis*, fig. 3, is hereby selected.

Remarks.—See under remarks on the genus.

X. UBAGHSIA, Jullien, 1886.

Steginopora; Ubaghs, 1865, p. 55.
Steginopora [partim]; Jullien, 1886, pp. 609, 612, 614, 615, 619, 620.
Ubaghsia [partim]; Jullien, 1886, pp. 610, 613, 616, 620.
Steginopora [partim]; Canu, 1900 [2], pp. 453, 454.
Ubaghsia; Lang, 1916, pp. 99, 100.

Diagnosis.—Castanoporinæ in which there is a tertiary front-wall (lamina peristomica of Jullien), largely, if not entirely, formed by the secondary thickening and lateral spreading of the apertural spines until neighbouring expansions meet and fuse; the distal apertural spines are branched.

Genotype.—*Steginopora reticulata*, Ubaghs.

Distribution.—Senonian, Campanian, and Maastrichtian.

Remarks.—*Ubaghsia* may be looked upon as a development of *Castanopora*, having a lamina peristomica and branched apertural spines.

Key to the Species of *Ubaghsia*.

A. Apertural spines with few branches.

I. Apertures, aviculœcia, and other spaces in the tertiary front-wall form a regular pattern ; a shallow median longitudinal groove placed proximally to the aperture in the tertiary front-wall .... 1. *U. ocellata.*

II. Apertures, aviculœcia, and other spaces in the tertiary front-wall very irregularly arranged ; no well-marked shallow groove as in I. .... 2. *U. reticulata.*

B. Apertural spines with many branches.

I. Smaller ; apertures, aviculœcia, and other spaces in the tertiary front-wall form a regular pattern ; a shallow, median, longitudinal groove placed proximally to the aperture in the tertiary front-wall ... 3. *U. demorgani.*

II. Larger ; apertures, aviculœcia, and other spaces in the tertiary front-wall very irregularly arranged ; no well-marked shallow groove as in I. .... 4. *U. meudonensis.*

1. Ubaghsia ocellata (Jullien).

Steginopora ocellata J. Jullien; Jullien, 1886, pp. 614, 609, 620, pl. xix, figs. 1–3 ; Sénonien ; Port Brehay.

Steginopora ocellata J. Jullien ; Canu, 1900 [2], pp. 453–4, text-fig. 66 on p. 453 [a reduced copy of Jullien, 1886, pl. xix, figs. 1–3].

Ubaghsia ocellata (J. Jullien) ; Lang, 1916, p. 99 ; Senonian [Campanian] ; Port Brehay, France.

Diagnosis.—*Ubaghsia* with few branches to the apertural spines ; the various perforations of the tertiary front-wall are more-or-less regularly arranged, and there is a median, longitudinal, shallow groove in the tertiary front-wall proximal to each aperture.

Distribution.—Senonian, [Campanian] ; Port Brehay, N.W. of Carentan, Manche, France.

Type-specimen.—That figured by Jullien, 1886, pl. xix, fig. 1, is hereby selected.

Remarks.—Having simpler apertural spines than *Ubaghsia demorgani* and *M. meudonensis*, *M. ocellata* is probably more primitive than these ; its relationship to *M. reticulata* is doubtful.

Specimens.—None in the Collection.

2. Ubaghsia reticulata (Ubaghs).

Steginopora reticulata n. sp.; Ubaghs, 1865, p. 55, pl. ii *a*, figs. 7 *a–d*; horizon *f*, obere Bryozoen-schichte (see p. 38); bei Valkenburg und Geulem.

Ubaghsia reticulata (Ubaghs); Jullien, 1886, pp. 616, 610, 612, 620, pl. xviii, figs. 4–5; Craie de Maestricht.

Ubaghsia reticulata (Ubaghs); Lang, 1916, p. 99; Maastrichtian; Valkenburg and Geulem near Maastricht.

Diagnosis.—*Ubaghsia* with few branches to the apertural spines; the various perforations in the tertiary front-wall are very irregularly arranged, and there is no well-marked, median, longitudinal groove on the tertiary front-wall proximal to the aperture.

Distribution.—Senonian, Maastrichtian, obere Bryozoen-schichte, horizon *f* of Ubaghs. Valkenburg (Fauquemont), E. of Maastricht, and Geulem, N.E. of Maastricht, Limbourg, Holland.

Type-specimen.—That figured by Ubaghs, 1865, pl. ii *a*, fig. 7 *c*, is hereby selected.

Remarks.—See under *Ubaghsia ocellata*.

Specimens.—None in the Collection.

3. Ubaghsia demorgani (Jullien).

Steginopora de Morgani J. Jullien; Jullien, 1886, pp. 615, 620, pl. xix, figs. 4–5, pl. xx, fig. 1; Sénonien, craie de Meudon; les Moulineaux.

Ubaghsia demorgani (Jullien); Lang, 1916, pp. 99, 100; Senonian [Campanian]; near Meudon, France.

Diagnosis.—*Ubaghsia* with many branches to the apertural spines; the various perforations in the tertiary front-wall are arranged in a more-or-less regular pattern, and there is a shallow, median, longitudinal groove in the tertiary front-wall proximal to the aperture; a smaller form than *U. meudonensis*.

Distribution.—Senonian, Campanian, zone of *B. mucronata*, Craie de Meudon. Les Moulineaux, Meudon, S.W. of Paris.

Type-specimen.—That figured by Jullien, 1886, pl. xix, fig. 4, is hereby selected.

Remarks.—*Ubaghsia demorgani* and *U. meudonensis* are more advanced in respect of their apertural spines than *U. ocellata* and *U. reticulata*, but their mutual relationship is doubtful.

Specimens.—None in the Collection.

4. Ubaghsia meudonensis (Jullien).

Steginopora Meudonensis J. Jullien; Jullien, 1886, pp. 614, 619, 620, pl. xvii, figs. 1–5 and pl. xviii, figs 1–3; Sénonien; Les Moulinaux près Meudon.
Ubaghsia meudonensis (Jullien); Lang, 1916, pp. 99, 100; Senonian [Campanian]; near Meudon, France.

Diagnosis.—*Ubaghsia* with many branches to the apertural spines; the various perforations of the tertiary front-wall are very irregularly arranged, and there is no well-marked median groove in the tertiary front-wall as in *U. demorgani*; a larger form than that species.

Distribution.—Senonian, Campanian, zone of *B. mucronata*, Craie de Meudon. Les Moulineaux, Meudon, S.W. of Paris.

Type-specimen.—That figured by Jullien, 1886, pl. xvii, fig. 3, is hereby selected.

Remarks.—See under *Ubaghsia demorgani.*

Specimens.—None in the Collection.

g. DIACANTHOPORINÆ, Lang, 1916.

Diacanthoporinæ, subfam. nov.; Lang, 1916, pp. 84, 100–1.

Diagnosis.—Pelmatoporinæ whose costæ bear each a pelma at the proximal end and a pelmatidium at the distal end.

Distribution.—Danian.

Remarks.—Diacanthoporinæ comprise four Danian forms, three from New Jersey and the other from Denmark, quite isolated from the rest of the Pelmatoporidæ by possessing a single pelma on each costa at its proximal end—the pelmata thus forming a marginal row on the intraterminal front-wall—and a single pelmatidium at its distal end, the pelmatidia similarly forming a double median row. It is not proposed to insist upon a fundamental distinction between a pelma and a pelmatidium—rather to use these as general terms to distinguish an apparently broken upturned costal prolongation with a large lumen from one with a small lumen; it is, nevertheless, remarkable that in the sub-families of the Pelmatoporidæ hitherto considered, these supposed broken upturned ends are invariably small in cross-section, while the marginal row in the Diacanthoporinæ and all those of the Pelmatoporinæ are large. The median paired row of the Diacanthoporinæ is small in cross-section, and consequently described as consisting of pelmatidia. The costæ of the Diacanthoporinæ are stout and rather far apart; their median fusion is marked by a rather strong ridge, its prominence being mainly due to the raised rims of the pelmatidia, so that, on the whole, the median ridge tends to be moniliform. But the most remarkable feature of the Diacanthoporine costa is that, although the primary pelma is at its proximal end, there is no corresponding lateral costal fusion. In all other Pelmatoporidæ the evidence points to the primary pelmata or pelmatidia having retreated from the middle line towards the proximal end of the costa, and having taken with them part of the median band of fusion by which they were laterally attached to their neighbours. The absence of lateral fusions accompanying the pelmata of the Diacanthoporinæ suggests that these may not have retreated during phylogeny from the mid-line, but represent a spine-like branch of the costa that has arisen as such in its present position, and, in consequence, may not be regarded as a strict homologue of a pelma or pelmatidium; the median double row of pelmatidia, on the other hand, are true pelmatidia. This point cannot, however, be determined without further evidence. But it is enough to make it likely that the Diacanthoporinæ are not closely related to any other Pelmatoporid sub-families, but must be independently descended from some primitive Pelmatoporid ancestor.

I. DIACANTHOPORA, Lang, 1916.

Escharipora [partim]; Gabb & Horn, 1862, pp. 148–9–50.
Reptescharipora; Gabb & Horn, 1862, p. 151.
Escharipora [partim]; Meek, 1864, p. 3.
Raptascharipora [sic]; Meek, 1864, p. 3.
Escaripora [sic] [partim]; Conrad in Cook, 1868, p. 722.
Reptescaripora [sic]; Conrad in Cook, 1868, p. 722.
Escharipora [partim]; Vine, 1885, p. 168.
Reptescharipora; Vine, 1885, p. 168.

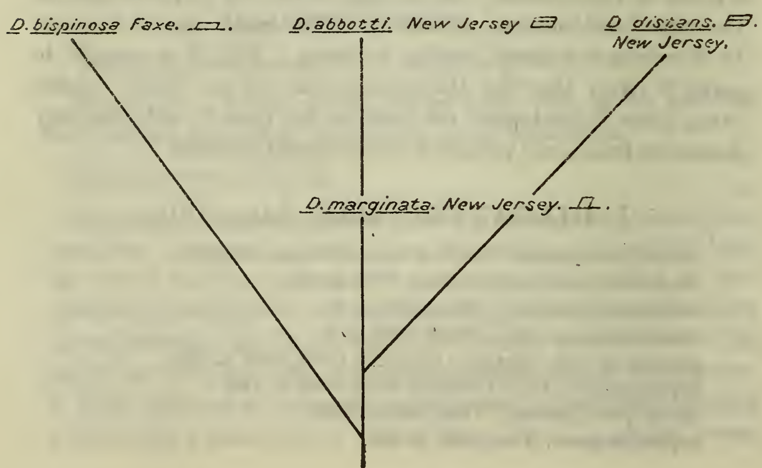
Escharipora [partim]; Nickles & Bassler, 1900, p. 156.
Reptescharipora; Nickles & Bassler, 1900, p. 156.
Membraniporella [partim]; Ulrich, 1900, p. 287.
Escharipora [partim]; Johnson, 1905, p. 5.
Membraniporella; Weller, 1907, pp. 167, 342–4.
Escharipora; Canu, 1911, p. 251.
Diacanthopora, gen. nov.; Lang, 1916, pp. 100–101.

Diagnosis.—As for the sub-family.

Genotype.—*Diacanthopora bispinosa*.

Distribution.—Danian.

Remarks.—The Danish species *Diacanthopora bispinosa* appears to be somewhat remote from the three American species of this genus, having a different arrangement of the paired apertural aviculœcia. Among the American species it is difficult to estimate the relationship of *D. marginata* and *D. distans*, especially as it is necessary to rely upon figures published by Gabb & Horn for their elucidation. *D. abbotti* is, however, by definition an erect bilaminar form of *D. marginata*, and undoubtedly descended from it; so that it is reasonable to interpret *D. marginata* from the available specimens of the former species. *D. distans*, then, apparently differs from *D. marginata* in its erect and bilaminar asty and in having the orthœcia more widely spaced. The evolutionary significance of the latter character is not clear; therefore the phylogeny suggested below is but tentative:—



Key to the Species of *Diacanthopora*.

A. Aviculœcia occasional in occurrence, distally placed with regard to each orthœcial aperture, and directed obliquely and proximally (fig. 71) .... 1. *D. bispinosa.*

B. Aviculœcia generally consisting of a pair proximally placed with regard to each orthœcial aperture, and directed obliquely and distally.

- I. Orthœcia fairly close together.
  - *a.* Incrusting, unilaminar .... 2. *D. marginata.*
  - *b.* Erect, bilaminar (fig. 72) .... 3. *D. abbotti.*
- II. Orthœcia widely spaced .... 4. *D. distans.*

1. Diacanthopora bispinosa, Lang.

Diacanthopora bispinosa, sp. n.; Lang, 1916, pp. 100, 101; Danian; Faxe, Denmark.

Diagnosis.—*Diacanthopora* in which the apertural aviculœcia are occasional in occurrence, are distally and laterally placed with regard to the orthœcial apertures, and directed obliquely and proximally.

Description.—Asty incrusting, unilaminar; œcia dimorphic. Orthœcia about ·8 mm. long and ·57 mm. wide, elliptical; extra-terminal front-wall extensive, so that the orthœcia appear widely spaced, but hidden beneath interœcial secondary tissue; intra-terminal front-wall somewhat flat, consisting of from nine to eleven stout, rather widely-spaced costæ, each bearing a pelma at its proximal end and a pelmatidium at its distal end; they are united medianly but have no lateral fusions; apertural bar very wide and stout, but not vertically produced to form a proximal apertural shield; aperture large and sub-circular, surrounded laterally and distally by a rim of secondary tissue. Aviculœcia occasional, placed distally and laterally with regard to the apertures of the orthœcia, and directed obliquely and proximally; small, the apertures divided by a constriction into a smaller and blunter proximal portion and a larger, more elongate, and somewhat pointed rostrum.

Distribution.—Danian, Faxe, Sjælland, Denmark.

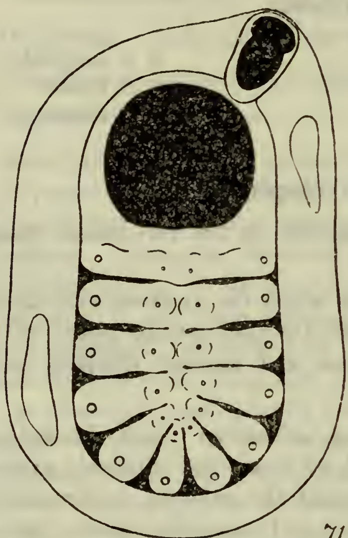
Type-specimen.—D. 8986. Caroline Birley bequest. 1907.

Remarks.—See remarks under the genus *Diacanthopora*.

Figures.—Text-fig. 71. Orthœcium and aviculœcium.

Plate V, fig. 4. Part of the type-specimen, showing three orthœcia and an aviculœcium. × about 27 diameters.

Specimens.—The type-specimen. Distribution and collection as above.



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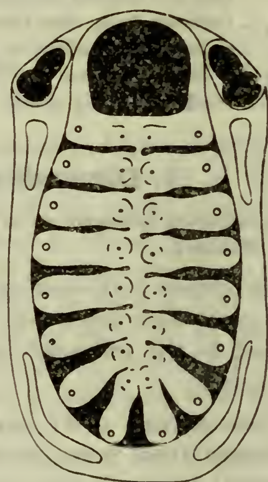

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Fig. 71.—*Diacanthopora bispinosa.* Diagram of an orthœcium and an aviculœcium, from above. × about 75 diameters.

Fig. 72.—*Diacanthopora abbotti.* Diagram of an orthœcium and an apertural pair of aviculœcia, from above. × about 75 diameters.

2. Diacanthopora marginata (Gabb & Horn).

Repteschariporа marginata, n. s.; Gabb & Horn, 1862, pp. 151, 149, pl. xx, fig. 35; Cretaceous; near Mullica, New Jersey.

Reptascharipora [sic] *marginata*, Gabb & Horn; Meek, 1864, p. 3; Cretaceous; N.J.

Reptescaripora [sic] *marginata*. Gabb & Horn; Conrad in Cook, 1868, p. 722; Cretaceous; New Jersey.

Repteschariporа marginata, Gabb & H.; Vine, 1885, p. 168; Cretaceous; Mallica Hill.

Repteschariporа marginata n. sp., Gabb & Horn; Nickles & Bassler, 1900, p. 156; Cretaceous; Mullica Hill, New Jersey.

Repteschripora marginata G. & H.; Weller, 1907, pp. 342–3, pl. xxiv, fig. 14 [a copy of Gabb & Horn, 1862, pl. xx, fig. 35]; Vincentown Limesand; New Jersey.

Non=*Escharipora abbottii* Gabb & Horn, 1862, p. 149, pl. xx, fig. 33; as stated by Weller, 1907, p. 342.

Diagnosis.—Incrusting, unilaminar *Diacanthopora*, which have an apertural pair of aviculœcia placed proximally to each orthœcial aperture; the orthœcia lie fairly close together.

Distribution.—Danian, Vincentown Limesand. New Jersey, U.S.A.

Type-specimen.—That figured by Gabb & Horn, 1862, pl. xx, fig. 35, is hereby selected.

Remarks.—See remarks under the genus *Diacanthopora*.

Specimens.—None in the Collection.

3. Diacanthopora abbotti (Gabb & Horn).

Escharipora Abbottii, n. s.: Gabb & Horn, 1862, pp. 149, 152, pl. xx, fig. 33; Cretaceous; near Mullica Hill, N.J.

Escharipora Abbottii, Gabb & Horn; Meek, 1864, p. 3; Cretaceous; N.J.

Escaripora [sic] *Abbottii*. Gabb & Horn; Conrad in Cook, 1868, p. 722; Cretaceous; New Jersey.

Escharipora Abbottii, Gabb & H.; Vine, 1885, p. 168; Cretaceous; Mallica Hill.

Escharipora Abbottii n. sp., Gabb & Horn; Nickles & Bassler, 1900, p. 156; Cretaceous; Mullica Hill, New Jersey.

Membraniporella Abbottii, G. & H. sp.; Ulrich, 1900, legend to text-fig. 479 on p. 287; Cretaceous; N.J.; [Copy Gabb & Horn, 1862, pl. xx, fig. 33].

Escharipora abbottii G. & H.: Johnson, 1905, p. 5.

Membraniporella abbottii (Gabb & Horn); Weller, 1907, pp. 342, 167, pl. xxiv, fig. 13; [copy of Gabb & Horn, 1862, pl. xx, fig. 33]; Vincentown Limesand; Vincentown, locality 154 at N. bank of Rancocas Creek N.W. of Vincentown, and Mullica Hill, New Jersey.

Non=*Escharipora marginata*, Gabb & Horn, 1862, pp. 151, 149, pl. xx, fig. 35; Cretaceous; near Mullica Hill; as stated by Weller, 1907, p. 342.

Escharipora Abboti [sic] Gabb et Horn; Canu, 1911, pp. 251, 282; Danian, New Jersey.

Diacanthopora abbottii (Gabb & Horn); Lang, 1916, pp. 100, 101; Danian; New Jersey, U.S.A.

Diagnosis.—Erect bilaminar *Diacanthopora*, in which there is generally an apertural pair of aviculœcia, placed proximally to most of the orthœcial apertures; the orthœcia lie fairly close together.

Description.—Asty erect, bilaminar, œcia dimorphic. Orthœcia about ·8 mm. long and ·44 mm. wide, elliptical; extraterminal front-wall fairly well developed, but entirely hidden by interœcial secondary tissue, which is abundant and tends to overflow the intraterminal front-wall; there are in it long slot-like lacunæ, which are not, however, deep enough to expose the extraterminal front-wall; intraterminal front-wall flat and immersed in interœcial secondary tissue, which tends to overflow its sides; it consists of about ten to thirteen widely-spaced costæ, each bearing a pelma at its proximal end and a pelmatidium at its distal end, with a moniliform median ridge of fusion, but no lateral fusions; apertural bar hardly stouter than the normal costæ, and otherwise resembling these, bearing the proximal pelma and distal pelmatidium; aperture sub-circular, somewhat flattened proximally, and slightly constricted laterally towards the proximal corners; surrounded laterally and distally with a rim of secondary tissue, which swamps the apertural spines; the spines are probably four in number; they may be seen in some specimens lying against the apertural ring within the secondary aperture. Aviculœcia, a pair lying rather proximally than distally, one on each side of each orthœcial aperture, directed distally, but also at an angle of about 45° towards the mid-line of the orthœcium which it attends; they are somewhat elongate, rather pointed, and their apertures are divided by a constriction into a more-or-less semicircular proximal portion and a sub-triangular rostrum.

Distribution.—Danian, Vincentown Limesand. New Jersey, U.S.A.

Type-specimen.—That figured by Gabb & Horn, 1862, pl. xx, fig. 33, is hereby selected.

Remarks.—See remarks under the genus *Diacanthopora*.

Figures.—Text-fig. 72. Orthœcium and two aviculœcia.

Plate V, fig. 5. Part of the specimen **D. 18954**, showing two complete orthœcia, parts of three others, and three aviculœcia. × about 27 diameters.

LIST OF SPECIMENS.

D. 18942. D. 18954. D. 19192–3. D. 19274. Five fragmentary asties. Danian, Vincentown Limesand. Near Blackwoods Town, New Jersey, S.E. of Philadelphia, Pennsylvania, United States. In exchange with United States National Museum. 1899.

4. Diacanthopora distans (Gabb & Horn).

Escharipora distans, n. s.; Gabb & Horn, 1862, p. 148, pl. xx, fig. 32; Cretaceous; Timber Creek, N.J.

Escharipora distans, Gabb & Horn; Meek, 1864, p. 3; Cretaceous; N.J.

Escaripora [sic] *distans*. Gabb & Horn; Conrad in Cook, 1868, p. 722; Cretaceous; New Jersey.

Escharipora distans, Gabb & H.: Vine, 1885, p. 168; Cretaceous; Timber Creek, N.J.

Escharipora distans n. sp., Gabb & Horn; Nickles & Bassler, 1900, p. 156; Cretaceous; Timber Creek, New Jersey.

Membraniporella distans (Gabb & Horn); Weller, 1907, p. 344, pl. xxv, fig. 1 [a copy of Gabb & Horn, 1862, pl. xx, fig. 32]; Vincentown Limesand; Timber Creek, New Jersey. [Records loss of the type-specimen.]

Escharipora distans Gabb et Horn; Canu, 1911, pp. 251, 282; Danian; New Jersey.

Diacanthopora distans (Gabb & Horn); Lang, 1916, pp. 100, 101; Danian; New Jersey, U.S.A.

Diagnosis.—Erect bilaminar *Diacanthopora* having an apertural pair of aviculœcia proximally placed with regard to the orthœcial aperture; the orthœcia lie far apart from one another.

Distribution.—Danian, Vincentown Limesand. New Jersey, United States.

Type-specimen.—That figured by Gabb & Horn, 1862, pl. xx, fig. 32. It appears to have been unique (see Weller, 1907, p. 344).

Remarks.—See remarks under the genus *Diacanthopora*.

Specimens.—None in the Collection.

h. PELMATOPORINÆ.

Pelmatoporinæ, subfam. nov.; Lang, 1916, pp. 84, 101.

Pelmatoporinæ; Lang, 1919 [1], pp. 191–228.

Diagnosis.—Pelmatoporidæ with stout costæ and one or more series of pelmata.

Distribution.—Turonian to Danian.

Remarks.—The Pelmatoporinæ constitute the largest subfamily of the Pelmatoporidæ, and include all Pelmatoporids with pelmata as opposed to pelmatidia, except the few species of *Diacanthopora* (Diacanthoporinæ), which have a single pelma and a single pelmatidium on each costa. The radical genus is *Pelmatopora*, and its most primitive species, *P. calceata*, differs but little from the hypothetical ancestral Pelmatoporine (see p. 16, fig. 4*b*)—indeed, this hypothetical ancestral form, if it were found, would be placed in the genus *Pelmatopora*. Further evolution in *Pelmatopora* mainly consisted in the acquisition of secondary and tertiary pelmata with a corresponding number of costal fusions; and, finally, in the attainment and elaboration of a pair of structures resembling aviculœcia on the distal rim of the aperture.

Early in its evolutionary history a Pelmatoporine stock produced an apertural bar with a median projection, which probably fused with the proximal pair of apertural spines, and thus formed the proximal shield of a secondary aperture. This stock is the genus *Sandalopora*.

The aviculœcia of *Pelmatopora* are sporadic in distribution and primitively of small size; in some species, e. g. *P. orbignyi*, they tend to become definite in position, and to be confined to a pair situated at the side of each orthœcial aperture. A stock in which this tendency became fixed and, as evolution proceeded, the aviculœcia became considerably enlarged forms the genus *Ichnopora*.

The three genera *Pelmatopora*, *Sandalopora*, and *Ichnopora* acquire in their most advanced members a secondary aperture. In *Pelmatopora* it is very imperfect, being composed of a partial distal shield chiefly formed of the structures like aviculœcia and already mentioned as being present on the distal rim of the aperture in the most advanced forms, but partly of a rim of secondary tissue which obliterates the apertural spines; and there is no proximal shield. The genus *Decurtaria* was probably derived from an advanced *Pelmatopora* by the formation of a complete distal shield composed of a thick growth of secondary tissue round the distal rim of the aperture, involving two pairs of aviculœcia.

Thus, while the secondary apertures of *Pelmatopora* and *Decurtaria* have distal shields only, that of *Sandalopora* has only a proximal shield; and in *Ichnopora* the distal shield, when well developed, is formed of the fused and branched apertural spines, while the proximal shield is formed by the large apertural aviculœcia, which fuse with one another and form an arch over the apertural bar. The proximal shield in *Batrachopora* is formed in the same way as in *Ichnopora*, and this genus was probably derived from a fairly primitive *Ichnopora*, and at least before that stock had differentiated its distal apertural spines to form a distal shield. For at first the distal shield of *Ichnopora* is formed by a rim of secondary tissue growing up round the distal pair of apertural spines and masking them, but later the apertural spines grow more rapidly, and, fusing in the mid-line, they project from the secondary apertural rim as an apertural shield.

Ichnopora also, probably, gave rise to *Pachydera*. The secondary aperture of *Pachydera* is complete, tubular, and may be prolonged. Its structure is not easy to elucidate, but, apparently, the proximal and distal shields, constructed as in primitive species of *Batrachopora*, grow at a uniform rate and fuse to build the tubular secondary aperture, leaving, however, fenestræ corresponding to the spaces over the apertural bar and between the proximal and distal pairs of apertural spines. The most difficult point to determine is the number and distribution of the aviculœcia, since there are depressions between the fenestræ—and whether or not these are aviculœcia is by no means clear in any given instance.

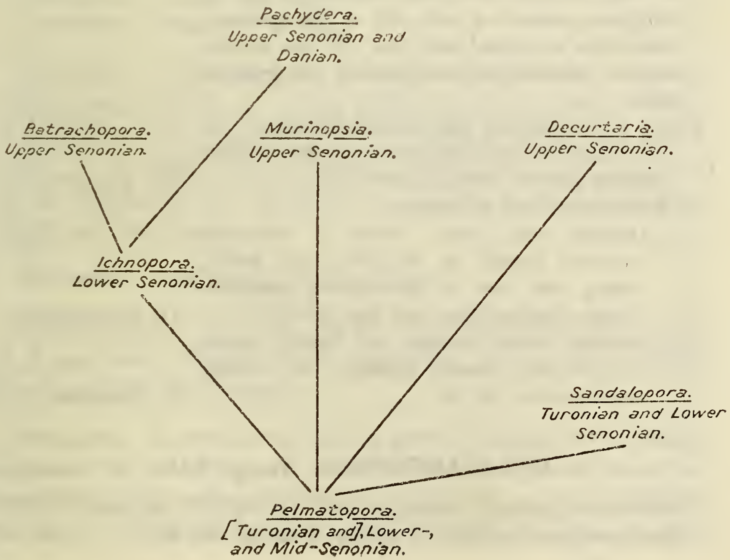
The remaining genus *Murinopsia* may have been derived from an advanced *Pelmatopora*, i. e., one in which secondary and tertiary pelmata were already acquired, but structures like aviculœcia had not yet appeared on the distal rim of the aperture. One or more pairs of aviculœcia, however, are present; they lie distal to the aperture but do not take part in the distal shield, which consists of a rim of secondary tissue filling the spaces between the proximal and distal pairs of apertural spines, and between the distal spines themselves. A more-or-less defined proximal shield may be formed by the flattening of the apertural bar in a vertical plane.

It will be seen from the above remarks that the generic characters are chiefly those of the secondary aperture and the structures involved in it—namely, the apertural bar, the apertural spines, and the apertural aviculœcia. That is, the main lineages, while evolving along parallel lines with regard to certain characters, show divergence in the architecture of the secondary aperture. It is desirable briefly to review the evolution of those characters that run a more-or-less parallel course in the various lineages.

The asty passes from an incrusting to an erect habit, and from a unilaminar to a bilaminar and multilaminar or cylindrical shape. The orthœcia increase in size, but in some cases may become smaller catagenetically; and they pass from an outline tending to be oval or elliptical to one with parallel sides. The extraterminal front-wall remains fairly constant in extent, but becomes, during evolution, obliterated by interœcial secondary tissue. The vaulting of the intraterminal front-wall becomes less. The number of costæ at first increases, but may be very much reduced catagenetically. The primary pelmata (as described above, p. 6, fig. 2) retreat from the middle line towards the proximal end of the costæ, and secondary and tertiary pelmata (in their earliest appearance small and not to be distinguished from pelmatidia) are added to the distal ends; at the same time lateral costal fusions at the level of the pelmata are carried proximally with the migrating pelmata. The aviculœcia, compared with those of some other sub-families, have a very restricted evolution; but, in so far as they do evolve, they follow the usual rule for the family—namely, becoming less numerous, more definite in position, larger and more pointed; throughout the subfamily they are monomorphic (except in *Ichnopora* and its derivatives) and distally directed.

The Pelmatoporinæ range from the Turonian to the Danian, but fall into three groups according to their horizontal distribution within these limits: namely, a low-zonal group, ranging from Turonian to Senonian, mid-*M. coranguinum*-zone; a mid-zonal group, ranging from the extreme top of the *M. coranguinum*-zone to the top of the *A. quadratus*-zone; and a high-zonal group ranging from the Senonian, *B. mucronata*-zone to the Danian. There is a barren horizon between the ranges of the low- and mid-zonal groups (namely, in the upper part of the zone of *M. coranguinum*) and probably between the ranges of the mid- and high-zonal groups (namely, at the extreme top of the zone of *A. quadratus*). The low-zonal genera are *Sandalopora*, *Ichnopora*, and the more primitive species of *Pelmatopora*—namely, those with the apertural spines still visible and no structures resembling aviculœcia on the distal rim of the aperture. The mid-zonal forms are *Murinopsia galeata*, *Decurtaria cornuta* (also high-zonal), and the more advanced species of *Pelmatopora*—namely, those in which the apertural spines are obliterated by secondary tissue and the apertural rim bears structures resembling aviculœcia on its distal edge. The high-zonal forms are the genera *Decurtaria* (also mid-zonal), *Batrachopora*, and *Pachydera*, and the species *Murinopsia francqana*. It is of interest to note that the Cretaceous Starfishes were divided by W. K. Spencer (1913) into low-, mid-, and high-zonal groups; but their ranges do not exactly coincide with those of the Pelmatoporine groups. The low- and mid-zonal were divided at a point three-quarters way down the *M. coranguinum*-zone; and his mid- and high-zonal groups between the subzones of *O. pillula* and *A. quadratus* in the *A. quadratus*-zone.

The following scheme shows the distribution and supposed relationships of the Pelmatoporine genera :—



Key to the Genera of Pelmatoporinæ.

A. Secondary aperture, when present, formed of the distal shield only (the flattened apertural bar may be considered to form an ill-defined proximal shield in *Murinopsia*).

- I. Distal shield, when present, includes a pair of aviculœcia or structures resembling aviculœcia.
  - *a.* Distal shield, when present, incomplete and weak (figs. 74–102) .... I. *Pelmatopora.*
  - *b.* Distal shield present, complete and very stout (figs. 123–4) .... VI. *Decurtaria.*
- II. Distal shield present, and formed of a rim of secondary tissue connecting the apertural spines; one or more pairs of aviculœcia are present distal to the aperture and excluded from the distal shield (fig. 125) .... VII. *Murinopsia.*

B. Secondary aperture, in so far as it can be considered present, consists of a proximal shield only, formed by a median projection of the apertural bar which, probably, ultimately fuses with the proximal pair of apertural spines (figs. 103–106) .... II. *Sandalopora.*

C. Secondary aperture, in so far as it is present, consists of both proximal and distal shields; a pair of aviculœcia present on each side of the aperture; these often are raised and fuse with one another over the apertural bar, thus forming the proximal shield.

- I. One row of pelmata only (a doubtful second row is sometimes distinguishable); apertures neither tubular nor very wide (figs. 107–113) .... III. *Ichnopora.*
- II. Two or more rows of pelmata.
  - *a.* Apertures very wide; tissue of secondary aperture spreads on all sides, and, finally, fusing with that of neighbouring apertures, forms a tertiary front-wall (figs. 114–120) .... IV. *Batrachopora.*
  - *b.* Apertures become tubular, and further growth of secondary tissue prolongs the tubular aperture (figs. 121–2) .... V. *Pachydera.*

I. PELMATOPORA, Lang, 1916.

Escharipora [partim]; d'Orbigny, 1852, pp. 222, 228, 229, 233.
Semieschcharipora [partim]; d'Orbigny, 1853, pp. 480, 487.

Escharipora ; Coquand, 1860, p. 121.
Semiescharipora [partim] ; Coquand, 1860, p. 150.
Semiescharipora [partim] ; Vine, 1885, pp. 116, 156.
Cribrilina ; Pergens, 1893, pp. 202, 216.
? *Cribrilina* [partim] ; Vine, 1893, pp. 313, 323, 326.
Cribrilina ; Canu, 1900, p. 409.
Cribrilina [*Cribrilina*] [partim] ; Canu, 1900[2], pp. 448–9, 458.
Cribrilina [*Decurtaria*] ; Canu, 1900[2], p. 450.
? *Escharipora* [partim] ; Canu, 1900[2], p. 457.
Cribrilina ; Rowe, 1900, p. 341.
? *Cribrilina* [partim] ; Jukes-Browne, 1904, p. 490.
Cribrilina ; Brydone, 1906, pp. 290, 300.
Cribrilina ; Brydone, 1910, p. 77.
Cribrilina ; White, 1910, pp. 55, 56.
Cribrilina ; Brydone & Griffith, 1911, p. 4.
Cribrilina ; Canu, 1911, pp. 252, 280, 282, 286.
Cribrilina [partim] ; White, 1912, pp. 35, 43.
Cribrilina [partim] ; Brydone, 1913, pp. 436–8.
Cribrilina ; Lang, 1913, p. 171.
Cribrilina [partim] ; White, 1913, pp. 24, 27, 30, 32, 38.
Pelmatopora, gen. nov. ; Lang, 1916, pp. 101–107.
Cribrilina [partim] ; Brydone, 1917, pp. 50, 52, 495–6.
Pelmatopora ; Lang, 1919[3], p. 107.
Pelmatopora ; Lang, 1919[1], pp. 191–4, 197–201, 204–5, 210–226.
Cribrilina ; Lang, 1919[4], p. 213.

Diagnosis.—Pelmatoporinæ in which the secondary aperture, when present, consists of a distal shield only, formed of a low rim of secondary tissue and of a pair of structures resembling aviculœcia ; if no distal shield is present, *Pelmatopora* may be known by the undifferentiated apertural bar, and the small sporadically-distributed aviculœcia.

Genotype.—*Pelmatopora pero*, Lang.

Distribution.—Senonian, zone of *M. cortestudinarium* to zone of *A. quadratus*, subzone of *A. quadratus* ; but probably ranges downwards into the Turonian.

Remarks.—In many respects the genus *Pelmatopora* typically expresses the evolution of a temporarily dominant group of organisms. It is unfortunate that the bulk of material available for study is collected from one part of the world only—namely, North-Western Europe; so that the locality where *Pelmatopora* arose cannot be demonstrated, nor can its migration from that unknown centre be followed. But the fact that a species—*P. insignis*—has been described from S. America makes it probable that the range of *Pelmatopora* was world-wide; and during Lower Senonian times, at least in North-western Europe, this genus was dominant among the Cribrimorph Polyzoa.

It is interesting to note the main features of this dominance. Though almost certainly arising in the Turonian (since *Sandalopora*, an obvious derivative, has occurred in the Turonian of France) the earliest-known forms of *Pelmatopora* are found at the base of the Senonian, and immediately appear in great numbers both of species and, in some species, of individuals. These species, though showing a general evolution, are comparatively primitive in organisation and fairly continuous in variation; so that, though many lineages are evidently present, they are very difficult to disentangle from the evolutionary flux; and, when separated, are almost impossible to diagnose. As, however, the evolutionary trend of each lineage becomes more clearly expressed, these difficulties lessen, so that to diagnose the lineages by the characters of their later representatives is a comparatively simple matter.

Already, in this first outburst of evolutionary activity, well-marked lineages strike out on original lines—these are the genera *Sandalopora* and *Ichnopora*; and it is of interest that of these early novelties *Sandalopora* ran but a short course in geological time, while the derivatives of *Ichnopora* outlasted the main Pelmatoporine stock. It has been postulated (Vol. III. p. 1) as a general rule that, during evolution, Cretaceous Cribrimorph Polyzoa lay down secondary tissue along three main tracts—namely, in the interœcial valleys, in the intraterminal front-wall, and in the neighbourhood of the aperture; and the three processes are independent of one another, so that secondary tissue may be elaborated in more than one tract simultaneously or successively. Now, during this first evolutionary outburst of the main Pelmatoporine stock, emphasis was laid on the elaboration of the intraterminal front-wall, while in *Sandalopora* and *Ichnopora* the focus of energy was shifted to the aperture, and each genus built a secondary aperture on different lines. Well into the hemera of *M. coranguinum* several lineages of *Pelmatopora* are found in which the front-walls have already become considerably elaborated; but in the higher part of the zone there is a scarcity of *Pelmatopora*. On the extreme top of the zone *Pelmatopora* is found again rather plentifully, and in the two next zones is abundant; but, except for one or two species, all these higher forms probably arose from a single lineage persisting from mid-*M. coranguinum* times. The one or two exceptional species (occurring in the zone of *A. quadratus*) are probably the sole survivors of the rest of the numerous lineages of the lowest Senonian.

Thus the great outburst of activity that accompanied the appearance of *Pelmatopora* had died down towards the top of the *M. coranguinum* zone. This horizon is very barren in other Polyzoa, and the scarcity of *Pelmatopora* may be due to conditions unfavourable to the preservation of its remains, or to the migration of *Pelmatopora* to some undiscovered locality, rather than to the decease of many of its lineages. But, however this may be, when *Pelmatopora* again is readily found—namely, at the extreme top of the *M. coranguinum*-zone,—the species and individuals are comparatively few, may nearly all be derived from the single lineage *Pelmatopora calceata–P. solearis–P. plantaris*, and are characterized by an elaborate intraterminal front-wall with primary, secondary, and tertiary pelmata, and a rim of secondary tissue growing up round the apertures and tending to obliterate the apertural spines. This last character indicates the trend in this lineage, with the intraterminal front-wall already complicated, for the focus of secondary deposit to be shifted to a fresh structure—namely, the aperture; and this fresh concentration heralds a fresh outburst of evolutionary activity.

For, while fairly abundant in the *Marsupites*-zone, *Pelmatopora* displays a second maximum of activity in the lower part of the zone of *A. quadratus*, manifested in a profusion of species and, in some species, of individuals—at first varying more or less continuously, but gradually, as the lineages emerge from the developmental flux, becoming more stable and definite in their characters. As, during the earlier outburst, all the lineages were characterised by parallel elaborations of the intraterminal front-wall, and their diagnostic characters had to be sought in details only of this structure or in the modifications of other structures; so, in this later outburst, all the evolving lineages concentrate upon the elaboration of the aperture along essentially similar lines, and their diagnostic characters are seen in details of this elaboration and in the modifications of other structures, of which the most interesting are catagenetic tendencies of former developments.

The beginnings of the elaboration of the aperture were already seen in the species occurring at the extreme top of the zone of *M. coranguinum*. In these, a rim of secondary tissue was arising round the aperture and tending to swamp the apertural spines; at about the time at which these spines became totally immersed, what appears to be a new structure occurred on the distal edge of the secondary apertural rim, corresponding in position to the obliterated distal pair of apertural spines, though probably lying just outside them; it is even possible that the apparently new structure was a new development of the apertural spines, as the evidence of specimen **D. 23397** of *P. brydonei* is not altogether conclusive (see under that species). In this specimen the right distal apertural spine and the new structure on the same side are both present and seem to be separate. On the other hand, the astogenetic evidence of *Pelmatopora saltdeanensis* points to this supposed new structure being but a development of the distal pair of apertural spines. The new structure is a pair of peg-like projections, somewhat pointed and hollowed on their distal faces. It is probable that, if not developments of apertural spines, these projections are aviculœcia, and that the pointed depressions on their distal surfaces are the rostra. During evolution they enlarge, lengthen, and become bifid; and one of the two bifurcations becomes longer than the other—very markedly so in certain lineages.

This second outburst of evolutionary activity ended with the incoming of the sub-hemera of *A. quadratus*, and in this subzone occur the most elaborate forms of *Pelmatopora*. By the hemera of *B. mucronata* the genus *Pelmatopora* apparently had become extinct, and, though it left a few descendants in the diminished and specialised genera *Murinopsia* and *Decurtaria*, the stock never again became dominant.

It is worth while to summarize the features of this generic dominance for purposes of comparison with other dominant groups of organisms, whether species, genera, or systematic aggregates of yet higher order. The first feature is the sudden onset of the dominance; at a given horizon the genus is there, having given no warning of its advent, widely distributed, numerous in individuals, various in form, inventive, and generally expressing an abundant and energetic vitality. It may be readily supposed that long-pent potentialities of the undifferentiated stock had become actual by the sudden removal of inhibitive factors. The environment may have been an agent in this removal, the factors may have been controlled by Mendelian laws, or other causes may have acted, alone or combined with one or both of these. The result is a flood of tendencies let loose, and expressed in various lines of evolution, which are seen in the several lineages of the genus; finally, as they become more and more markedly expressed in differentiated and complex structures, the potentialities become, so to speak, dissipated, and there is no further progress in these directions.

Secondly, at this first outburst of activity, variation is manifold and more-or-less laterally continuous, until the lineages can be sorted out and each followed along its own lines.

Thirdly, although striking out in various directions, most of the lineages follow the same general lines of evolution, and differ from one another chiefly in apparently trivial details.

Again, certain lineages strike out in original directions, forming new genera, which may or may not have a long evolutionary run. These original genera emerge from the evolutionary flux at the beginning of the first outburst of activity. In another category of genera are the specialised modifications either of these original genera or of the advanced species of the parent stock.

A final feature is the periodic occurrence of dominance. On the hypothesis suggested above, it may be said that, having exhausted certain liberated potentialities by transforming them into material structures, the stock is able, should the requisite stimulus be forthcoming before extinction has taken place, to liberate another brood of potentialities, with the result that a second outburst of evolutionary activity occurs; the genus again becomes dominant, until the actual forces are exhausted in building up a new set of structures. So long as these pent-up potentialities are present, the stock has always the chance, if it can liberate them at the right moment, of postponing extinction.

From the foregoing remarks it is evident that the species of *Pelmatopora* fall into two groups—a lower, consisting of those forms with visible apertural spines, and a higher, containing those with structures resembling aviculœcia on the distal rim of the aperture, and with their apertural spines obliterated by an upgrowth of secondary tissue. These two groups are connected by the lineage *Pelmatopora calceata–P. solearis–P. plantaris–P. pero–P. brydonei–P. marsupitum–P. somptingensis–P. gregoryi–P. palmata–P. damicornis.* Of this series the species from *P. calceata* to *P. pero* have visible apertural spines and no 'secondary aviculœcia'; *P. brydonei* had both visible apertural spines and secondary aviculœcia; those from *P. marsupitum* to *P. damicornis* have secondary aviculœcia only. It is convenient to treat this lineage as the typical development and to consider the other lineages with reference to it. It should be noted that in writing out this lineage as a continuous series, the colonial habit has been disregarded, and in some cases erect uniserial forms are placed as if they were the ancestors of incrusting uniserial forms. This is for simplicity's sake. To correct it, hypothetical incrusting forms must be placed instead of the forms *P. pero*, *P. brydonei*, and *P. somptingensis* in the main lineage, and the three species mentioned must be independently and respectively derived from these three hypothetical forms.

The species *P. calceata–P. gasteri–P. interrupta–P. simplex* form a second lineage with the secondary branches *P. gasteri–P. coryli* and *P. gasteri–P. repleta.* In these forms the aperture is small, and tends to be somewhat narrowed distally; the primitive orthœcial shape with curved sides is retained as far as *P. gasteri*; otherwise the characters run the same course as in the typical lineage, except that *P. simplex* is catagenetic in respect of length.

The forms *P. suffulta* and *P. insignis* were probably independently derived from *P. calceata*, though approaching in general character the forms of the last lineage, particularly in the small apertures and in the bowed outline of the orthœcia. Both are primitive in having little or no interœcial secondary tissue. *P. insignis* is chiefly remarkable for its great size; and *P. suffulta* for the tendency of the aviculœcia, while remaining primitively small, to become definite in position, one at each lateral-proximal corner of every orthœcial aperture.

The same tendency of the aviculœcia to take up definite positions in apertural pairs is characteristic of the lineage *P. calceata–P. crepidaria–P. d'orbignyi*. The last species has its aviculœcia somewhat enlarged, and it is possible that it should be placed in the genus *Ichnopora*, though it is more probable that *Ichnopora* did not arise directly from this stock.

The French species *P. larva*, *P. chrysalis*, and *P. striata* form yet another lineage characterised by a flattish intraterminal front-wall, and comparatively large apertures, which tend to become narrowed distally; the orthœcial length remains about constant, and the pelmata do not retreat from the middle line.

The lineage *P. pauciclavia–P. fragilis* is characterised by very few costæ, and the lineage *P. quadrata–P. filliozati* by very small orthœcia. *P. fecampensis* is an isolated form with a rather large aperture and shows some affinity with *P. interrupta*.

Of the species of *Pelmatopora* hitherto considered, two only transgress the upper boundary of the *M. coranguinum*-zone; these are *P. simplex* from the *A. quadratus*-zone and *P. coryli* from the *Marsupites*-zone and the lower and middle parts of the *A. quadratus*-zone. The succeeding species may all have been derived from *P. brydonei*, and range from the top of the *M. coranguinum*-zone to the top of the zone of *A. quadratus*. They are all characterised by the absence of apertural spines and the presence of secondary aviculœcia on the apertural rim; they also possess complex intraterminal front-walls. The main lineage *P. brydonei–P. marsupitum–P. somptingensis–P. gregoryi–P. palmata–P. damicornis* has already been mentioned. *P. quadrivolucris*, with four secondary aviculœcia, occurs in the top of the *M. coranguinum*-zone, and may have been derived from an incrusting form of *P. brydonei*; and *P. roedeanensis* is an erect derivative of *P. marsupitum*. The secondary aviculœcia of this lineage increase in size and breadth, and, finally, become bifid; and, though one fork (that on the outer side) of the bifurcation is more developed than the other, it does not become greatly prolonged; breadth rather than length characterises the secondary aviculœcia of this lineage (fig. 73 *a–d*). There is also a slight catagenesis in the size of the orthœcia.

In the remaining forms the secondary aviculœcia increase in size and also bifurcate; but one horn of the bifurcation (again that on the outer side) is greatly prolonged and the other hardly

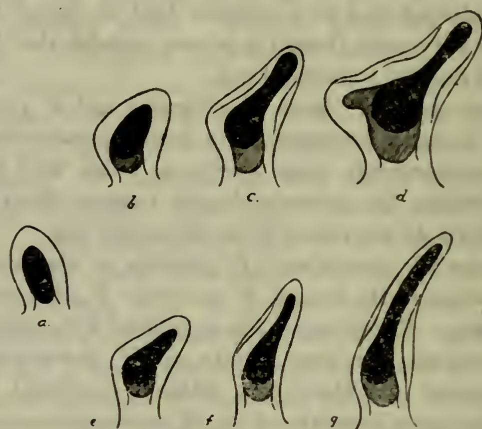
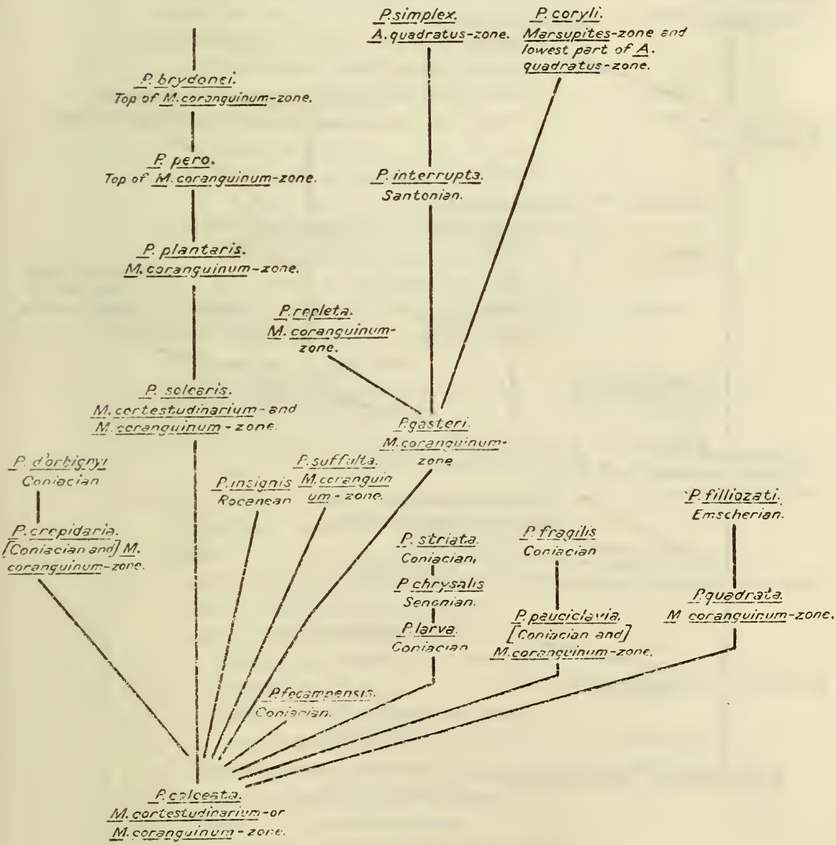


Fig. 73.—Diagrams showing two lines of evolution in the structures resembling aviculœcia lying on the distal edge of the apertural rim in the following species of *Pelmatopora*:—(a) *P. brydonei*; (b) *P. marsupilum*; (c) *P. somptingensis*; (d) *P. palmata*; (e) *P. danktonensis*; (f) *P. bidens*; and (g) *P. lancingensis*.

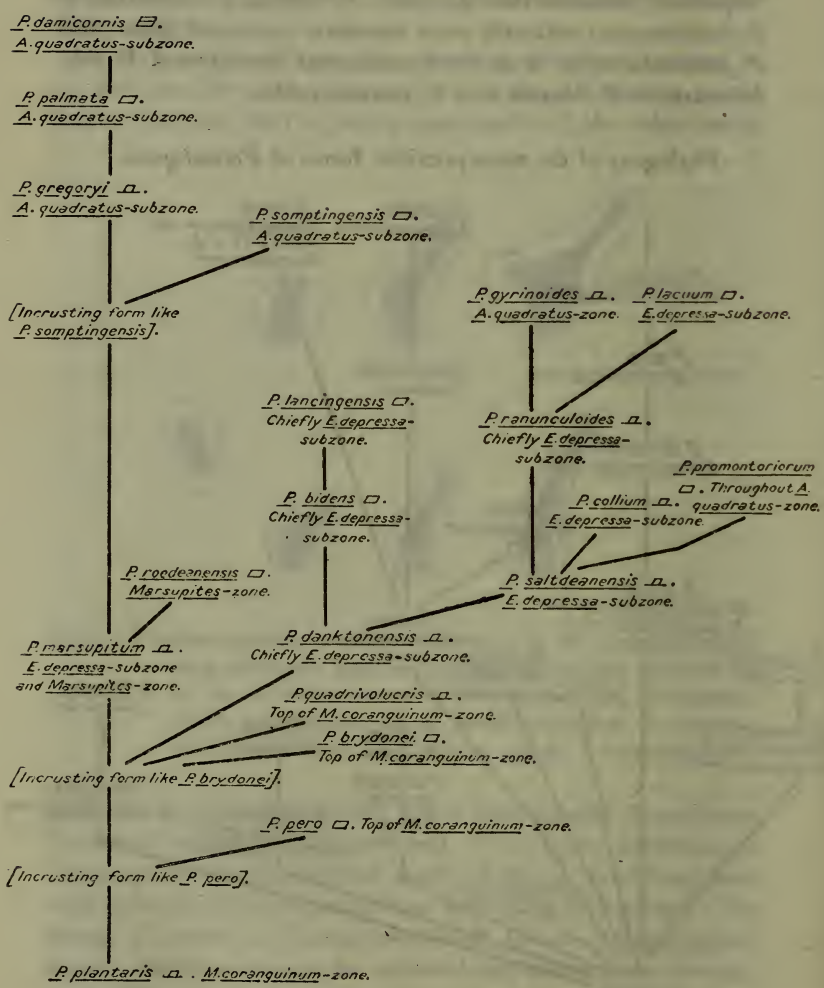
at all developed; so that length rather than breadth characterises these secondary aviculœcia (fig. 73 *e–g*). *Pelmatopora danktonensis* is a comparatively unspecialised species of this series and may have been derived from an incrusting form resembling *P. brydonei*. The lineage *P. brydonei–P. danktonensis–P. bidens–P. lancingensis* shows a slight catagenesis in orthœcial size and a great development of the secondary aviculœcia.

P. danktonensis–P. saltdeanensis–P. ranunculoides–P. gyrinoides is a lineage which also has lengthened secondary aviculœcia, but shows, too, a strong catagenesis with regard to orthœcial size and to the number of costæ; the length of the orthœcium, too, decreases more rapidly than the breadth, so that these forms have "squatter" orthœcia than the rest. *P. collium* is a derivative of *P. saltdeanensis* with still more secondary interœcial tissue; and *P. promontoriorum* is an erect unilaminar derivative of *P. saltdeanensis*, as *P. lacuum* is of *P. ranunculoides*.

Phylogeny of the more primitive forms of *Pelmatopora*.



Phylogeny of the more advanced species of *Pelmatopora.*



Key to the Species of *Pelmatopora*.

A. If pelmatidia arise in the median area of fusion and follow the primary pelmata in their retreat along the costa from its distal end proximally, they soon become as large as the pelmata—in fact, develop into secondary pelmata.

I. Secondary structures like aviculœcia do not replace the distal apertural spines.

a. Median area of fusion is imperforate, and there are no well-developed secondary pelmata (fig. 74).

1. Intraterminal front-wall well arched; aviculœcia small and blunt or pointed.

α. Little or no interœcial secondary tissue; aviculœcia very small and blunt or slightly pointed.

1. Aviculœcia sporadically distributed (fig. 74) .... 1. *P. calceata*.

2. Aviculœcia tend to be arranged in two circum-apertural pairs (fig. 75)...... 2. *P. crepidaria*.

β. A fair amount of interœcial secondary tissue; aviculœcia blunt (fig. 76)...... 3. *P. solearis*.

2. Intraterminal front-wall flattish; aviculœcia larger and pointed.

α. Asty erect, unilaminar (fig. 77) .... 4. *P. larva*.

β. Asty erect, bilaminar.

1. Costæ about 20 (fig. 78) .... 5. *P. chrysalis*.

2. Costæ 25 or more .... 6. *P. striata*.

b. Median area of fusion with two rows of perforations; secondary pelmata present (fig. 79).

1. A pair of aviculœcia placed laterally with regard to each orthœcial aperture.

α. Less secondary tissue.

a. Aperture not pointed, sub-normal to normal (fig. 83) .... 13. *P. suffulta*.

b. Aperture more pointed, normal to super-normal (fig. 85) .... 16. *P. interrupta*.

β. More secondary tissue (fig. 79) .... 7. *P. d'orbignyi*.

2. Aviculœcia sporadically distributed.

α. Costæ 11–16; apertures large.

1. Intraterminal front-wall distinctly arched.

- *a.* Costæ 11 or 12 (fig. 80) .... 8. *P. pauciclavia*
- *β.* Costæ 15 (fig. 81 *a*, *b*) .... 10. *P. quadrata.*
- 2. Intraterminal front-wall nearly flat . 9. *P. fragilis.*
- *β.* Costæ 16 or more; length about 1 mm.
  - 1. Less interœcial secondary tissue.
    - *a.* Length just less than 1 mm. (fig. 83). 13. *P. suffulta.*
    - *β.* Length well over 1 mm. (fig. 82) . 12. *P. insignis.*
  - 2. More interœcial secondary tissue.
    - *a.* Length less than 1 mm.
      - *a.* Apertures smaller, tending to be pointed............................ 15. *P. repleta.*
      - *β.* Apertures larger, tending to be rounded (fig. 88).................. 19. *P. fecampensis.*
    - *β.* Length well over 1 mm. (fig. 90)... 21. *P. pero.*
- *γ.* Costæ more than 16; length about ·66 mm.
  - 1. Apertures larger (fig. 81 *c*) .... 11. *P. filliozati.*
  - 2. Apertures smaller (fig. 84) .... 14. *P. gasteri.*
- *c.* Median area of fusion with more than two rows of perforations; secondary and tertiary pelmata present (fig. 86).
  - 1. Incrusting; length less than 1 mm.
    - *a.* Costæ about 14; apertural spines less obscured; aviculœcia sporadic (fig. 89). 20. *P. plantaris.*
    - *β.* Costæ about 16; apertural spines more obscured; aviculœcia paired (fig. 86). 17. *P. simplex.*
  - 2. Erect, unilaminar; length more than 1 mm. (fig. 90) .... 21. *P. pero.*

II. Secondary structures like aviculœcia replace the apertural spines.

- *a.* Both pairs of apertural spines are thus replaced (fig. 92) .... 23. *P. quadrivolucris.*
- *b.* The distal pair only of apertural spines is thus replaced.
  - 1. The proximal pair of apertural spines is often still visible and sometimes the distal pair too (fig. 91) .... 22. *P. brydonei.*
  - 2. Apertural spines entirely obscured by a secondary apertural ring (often visible, however, in neanastic stages).
    - *a.* Secondary aviculœcia short and peg-like; costæ 15–18.
      - *a.* Incrusting, unilaminar (fig. 93) ...... 24. *P. marsupitum.*
      - *b.* Erect, unilaminar .... 25. *P. roedeanensis.*

β. Secondary aviculœcia slender and lengthened.

a. Secondary aviculœcia never large or very long; incrusting, unilaminar (fig. 96) .... 30. *P. danktonensis.*

b. Some secondary aviculœcia often very small, and others sometimes rather large and rather long; erect, unilaminar (fig. 97) .... 31. *P. bidens.*

c. Secondary aviculœcia large and long.

1. Costæ about 15–20.

a. Length about 1 mm.; erect, unilaminar (fig. 98) .... 32. *P. lancingensis.*

β. Length less than 1 mm.; outermost intercostal perforations less slot-like than in α.

a. Incrusting.

1. Less interœcial secondary tissue (fig. 99) .... 33. *P. saltdeanensis.*

2. More interœcial secondary tissue (fig. 100) .... 34. *P. collium.*

b. Unilaminar, erect .... 35. *P. promontoriorum.*

2. Costæ about 12–15; outermost intercostal perforations circular; length considerably less than 1 mm.

α. Incrusting (fig. 101) .... 36. *P. ranunculoides.*

β. Unilaminar, erect .... 37. *P. lacuum.*

3. Costæ 9; otherwise as (2); incrusting (fig. 102) .... 38. *P. gyrinoides.*

γ. Secondary aviculœcia flattened and broad distally, and tending to bifurcate (fig. 94) .... 26. *P. somptingensis.*

δ. Secondary aviculœcia very broad distally and distinctly bilobed.

a. Incrusting, unilaminar .... 27. *P. gregoryi.*

b. Erect, unilaminar (fig. 95) .... 28. *P. palmata.*

c. Erect, bilaminar .... 29. *P. damicornis.*

B. Secondary pelmata have not entirely passed out of the pelmatidial stage when they migrate proximally along the costa from the median area of fusion; consequently, there is a conspicuous contour on the intraterminal front-wall, marked by the line of pelmata with their intercostal fusions (fig. 87) .... 18. *P. coryli.*

1. Pelmatopora calceata, Lang.

Pelmatopora calceata, sp. n.; Lang, 1916, pp. 102, 103; Lower Senonian; Chatham, Kent.

Pelmatopora calceata, Lang; Lang, 1919 [4], pp. 191–4, 196, 210–13, 218–20, 223–5, fig. 1 on p. 193, fig. 49 on p. 211.

Diagnosis.—*Pelmatopora* in which secondary aviculœcia do not replace the apertural spines; the median area of fusion is imperforate, and there are no well-developed secondary pelmata; the intraterminal front-wall is well arched; there is little or no interœcial secondary tissue; and the aviculœcia are small, blunt, and sporadically distributed.

Description.—Asty incrusting, unilaminar; œcia dimorphic. Orthœcia ·5–·65 mm. long and ·32 mm. wide, elliptical rather than parallel-sided; extraterminal front-wall rather extensive and not hidden by interœcial secondary tissue; the intraterminal front-wall is well arched, and consists of fourteen to sixteen costæ lying rather close together, with no lateral fusions, and each bearing a single pelma near the median area of fusion, which is imperforate; the apertural bar bears no processes; the four apertural spines are well developed, but not secondarily enlarged; the aperture is supernormal, and not complicated by any growth of secondary tissue. Aviculœcia fairly numerous, sporadic, placed on the sides of the orthœcia rather than exactly between two of them, variously directed, small, and blunt; the rostrum is larger than the proximal part of the aperture.

Distribution.—Lower Senonian, base of zone of *M. coranguinum* or zone of *M. cortestudinarium*; Chatham, Kent.

Type-specimen.—**D. 4032.** W. Gamble Collection. 1898.

Remarks.—*Pelmatopora calceata* is decidedly more primitive than any other known species of its genus, and closely approaches the hypothetical primitive Pelmatoporine (fig. 4 *b*, p. 16). It has advanced from this form by increasing the number of its costæ and decreasing that of the apertural spines; the shape of its aperture also is less primitive. It may be regarded, however, as a radical form from which it is possible to derive the rest of the known species of *Pelmatopora*, as well as the other Pelmatoporine genera.

Figures.—Text-fig. 74. Orthœcium and two aviculœcia.

Plate V, fig. 6. Part of the type-specimen, showing five complete orthœcia, parts of others, and twelve aviculœcia. × about 27 diameters.

Specimens.—The type-specimen. Distribution and collection as above.

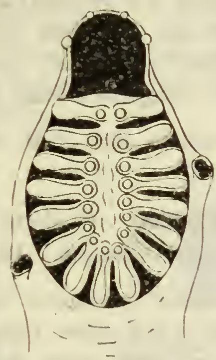


Fig. 74.—*Pelmatopara calceata.* Diagram of an orthœcium and two aviculœcia, from above. × about 75 diameters.

2. Pelmatopora crepidaria, Lang.

Pelmatopora crepidaria, sp. n.; Lang, 1916, pp. 102, 103; *M. coranguinum*-zone; Wooburn Green, Bucks.

Pelmatopora crepidaria, Lang; Lang, 1919 [4], pp. 211–13, 222, 224–5, fig. 47 on p. 211.

Diagnosis.—*Pelmatopora* in which secondary aviculœcia do not replace the apertural spines; the median area of fusion is imperforate, and there are no secondary pelmata; the intraterminal front-wall is well arched; there is little or no interœcial secondary tissue; the aviculœcia are small, blunt or slightly pointed, and tend to be arranged in two circum-apertural pairs.

Description.—Asty incrusting (or possibly erect), unilaminar; œcia dimorphic. Orthœcia about ·8 mm. long and ·4 mm. wide, elliptical; extraterminal front-wall fairly well developed and hardly at all, or not at all, hidden by interœcial secondary tissue; the intraterminal front-wall is well arched, and consists of about fourteen costæ lying fairly close together, with no lateral fusions, and each bearing a single pelma lying close to the median area of fusion, which is imperforate; apertural bar very stout, but otherwise not differentiated; there are four small apertural spines; the aperture is slightly super-normal, and with a tendency to acquire a thin encircling rim of secondary tissue. Aviculœcia numerous and somewhat irregularly distributed, but with a strong tendency to a circum-apertural grouping in a proximal-lateral pair and a distal-lateral pair; small, tubular, and with blunt or slightly pointed apertures, which are directed obliquely upwards and borne at the summit of considerably elongated tubular pedestals.

Distribution.—Senonian, zone of *M. coranguinum*. Southern England.

Type-specimen.—**D. 21200.** Wooburn Green, S.W. of Beaconsfield, Bucks. L. Treacher Collection. 1911.

Remarks.—*Pelmatopora crepidaria* may have been derived directly from *P. calceata*, and differs from that species chiefly in the aviculœcia, which are more-or-less definitely placed—namely, at the proximal-lateral and distal-lateral corners of the orthœcial apertures; they are also elongated into tubular structures, so that the apertures are carried up on long pedestals; while the rostra have become more-or-less pointed. The definite position of the aviculœcia suggests a connection with *Ichnopora*, which, however, has but one pair of apertural aviculœcia, and these larger than those of *Pelmatopora*; whereas the aviculœcia of *P. crepidaria* remain small, as in the other species of the genus.

Figures.—Text-fig. 75. An orthœcium with four circum-apertural aviculœcia.

Plate V, fig. 7. Part of the type-specimen, showing four complete orthœcia, parts of others, and numerous aviculœcia. × about 27 diameters.

LIST OF SPECIMENS.

D. 21200. The type-specimen. Senonian, zone of *M. coranguinum*. Wooburn Green, S.W. of Beaconsfield, Bucks. L. Treacher Collection. 1911.

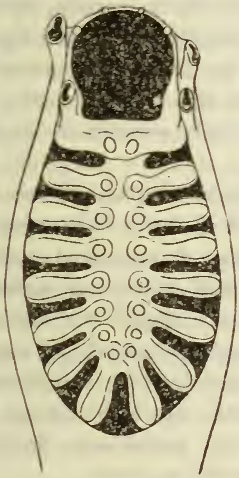
D. 4110. Paratype. A worn asty, probably of this species. Lower Senonian, Chatham, Kent. W. Gamble Collection. 1898.

3. Pelmatopora solearis, Lang.

Pelmatopora solearis, sp. n.; Lang, 1916, pp. 102, 103; *M. coranguinum*-zone; Hurley Bottom, Berks.

Pelmatopora solearis, Lang; Lang, 1919[4], pp. 210–11, 213, 218, 223–5, fig. 50 on p. 211.

Diagnosis.—*Pelmatopora* in which secondary aviculœcia do not replace the distal apertural spines; the median area of fusion is imperforate and there are no well-developed secondary pelmata; the intraterminal front-wall is well arched; there is a fair amount of interœcial secondary tissue.



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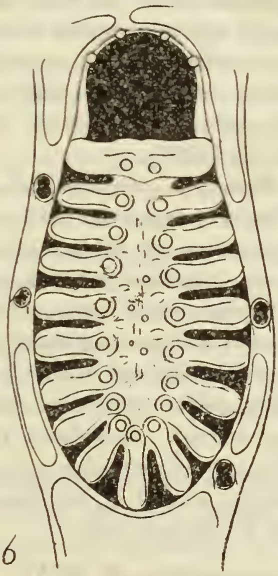

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Fig. 75.—*Pelmatopora crepidaria*. Diagram of an orthœcium with four apertural aviculœcia, from above. × about 75 diameters.

Fig. 76.—*Pelmatopora solearis*. Diagram of an orthœcium and four aviculœcia, from above. × about 75 diameters.

Description.—Asty incrusting, unilaminar; œcia dimorphic.

(a) *Ephebœcia*.—Orthœcia about ·85 mm. long and ·45 mm. wide, elliptical, and somewhat parallel-sided; extraterminal front-wall of fair extent, but considerably hidden by interœcial secondary tissue, which consists of contour-like ridges on the extraterminal front-wall near the termen; the intraterminal front-wall is well arched, though flat on the top, and consists of about sixteen or seventeen costæ lying fairly close together, with no lateral fusions, each bearing a pelma distally, and firmly united in a wide median band of fusion; the pelmata often are not so close to the median band of fusion as in the former two species—in other words, the apparent proximal migration of the primary pelmata along the costa has begun; moreover, although the median band of fusion is yet imperforate, in some orthœcia median pelmatidia are clearly to be seen (**D. 19510, D. 28267**), and are doubtless rudimentary secondary pelmata, which are thus on their way to appear; apertural bar stout; apertural spines four in number and small; aperture normal to cribriline with a tendency to a secondary outer rim. Aviculœcia numerous, sporadic, with somewhat elongate constricted apertures, generally blunt, but sometimes decidedly pointed (**D. 28267**).

(b) *Neanœcia.*—Orthœcia about ·5 mm. long and ·3 mm. wide, oval-elliptical; extraterminal front-wall of fairly wide extent, but little concealed by contour-like ridges of intercœcial secondary tissue; the intraterminal front-wall is well arched and consists of about thirteen stout costæ, rather closely placed, with no lateral fusions, and each bearing distally a single pelma, which lies close to the middle line, and seldom is followed by even a rudimentary secondary pelma; apertural bar stout; apertural spines four; aperture normal. Aviculœcia small and sporadically distributed with blunt, nearly circular, and constricted apertures.

Senonian, zone of *M. cortestudinarium* and [lower part of the] zone of *M. coranguinum.*

Type-specimen.—**D. 21211.**

Remarks.—*Pelmatopora solearis* may have been directly derived from *P. calceata* by a flattening of the lateral curve of the orthœcium; by an increase in size and number of costæ; by a slight shifting of the primary pelmata proximally along the costa, correlated with a flattening of the intraterminal front-wall above, and a more frequent appearance of rudimentary (pelmatidial) secondary pelmata in the middle line; and by an increase of intercœcial secondary tissue. The neanœcia of *P. solearis* bear out this derivation, for they differ from the ephebœcia in being smaller, and in having the sides more bowed, fewer costæ, pelmata close to the median line, a well-arched intraterminal front-wall, rare traces of secondary pelmata, and less interœcial secondary tissue. In a word, they resemble the ephebœcia of the supposed ancestor, *P. calceata*, except in having actually rather fewer costæ, a lower aperture, and little interœcial secondary tissue, which last *P. calceata* almost entirely lacks.

Included in the list of specimens of *P. solearis* is a number of somewhat diverse forms, all of which, however, come under the specific diagnosis, but of which some may not closely correspond with the specific description, which is drawn up mainly from the type-specimen. It is highly probable that among these specimens there are some early terms of other lineages derived, like *P. solearis*, from a form near *P. calceata*, and therefore improperly included in the species under consideration. In this period in the evolution of *Pelmatopora*, when the genus was undergoing its first outburst of evolutionary activity, when variation was frequent, manifold, and almost continuous—in other words, when the forms were extremely unstable,—the early stages of the various lineages overlapped in outward appearance to such an extent that the present unravelling of the apparent tangle is a highly complex and uncertain undertaking. The forms are therefore left under *P. solearis* until, with more material and further knowledge, it is possible to reconstruct with some certainty, and to focus into clarity, the proximal lineage-ends as yet so nebulous.

FIGURES.—Text-fig. 76. An orthœcium and four aviculœcia.

Plate V, fig. 8. Part of the type-specimen, showing three complete orthœcia, parts of others, and ten aviculœcia. × about 27 diameters.

LIST OF SPECIMENS.

D. 21211. Type-specimen. Incrusting an Echinoid. Senonian, zone of *M. coranguinum* Hurley Bottom, Berks, S.E. of Henley, Oxon. Collected by L. Treacher, Esq., F.G.S. 1911.

D. 28267. Paratype. Senonian, zone of *M. coranguinum*, *Trochiliopora* Bed of Gaster, about 20 ft. from the base of the zone. Hindover, N.E. of Seaford, Sussex. Collected by C. T. A. Gaster, Esq., and presented by him. 1915.

D. 28268. Paratype. Horizon, collection, and donation as last. Cliff End, east side of Cuckmere Haven, Sussex.

D. 28265–6. Horizon, collection, and donation as last. Summit of the Downs, Mount Harry, near Lewes, Sussex.

D. 24542. Paratype. Senonian, zone of *M. coranguinum*. Gillingham, N.E. of Chatham, Kent. W. Gamble collection. 1911.

D. 27042–6. Paratype. Senonian, zone of *M. cortestudinarium*. Lower Pit, Sline's Oak, Worms Heath, Warlingham, Surrey. F. Möckler collection. 1912.

D. 19510. Paratype. Senonian, zone of *M. cortestudinarium*. Seaford, Sussex. F. Möckler collection. 1910.

D. 28269. Paratype. Senonian, zone of *M. cortestudinarium*. Between Hope Gap and Cuckmere Haven, Sussex. Collected by C. T. A. Gaster, Esq., and presented by him. 1915.

D. 2763. D. 2813. D. 2817. D. 27980. Paratypes. Senonian [base of the zone of *M. coranguinum* or top of the zone of *M. cortestudinarium*]. Chatham, Kent. G. R. Vine collection. 1893.

D. 4026. D. 4971. D. 4978. Paratypes. From same horizon and locality as the last. W. Gamble collection. 1898.

D. 4030. D. 4271. D. 4965. Poorly-preserved asties from the same horizon, locality, and collection as the last.

4. Pelmatopora larva, new species.

Pelmatopora interrupta (d'Orbigny); Lang, 1916, pp. 102, 103; Senonian; Saintes, France.

Non *Semiescharipora interrupta*, d'Orb., 1851; d'Orbigny, 1852, pl. 719, figs. 5–8; 1853, p. 487; 1854, p. 1098; Senonien; environs de Saintes (Charente Inférieure). See under *Pelmatopora interrupta* (d'Orbigny).

Pelmatopora interrupta (d'Orbigny); Lang, 1914 [4], pp. 211–3, 223, fig. 42 on p. 211.

Diagnosis.—*Pelmatopora* in which secondary aviculœcia do not replace the apertural spines; the median area of fusion is imperforate, and there are no well-developed secondary pelmata; the intraterminal front-wall is flattish; and the asty is erect and unilaminar.

Description.—Asty erect, unilaminar; œcia dimorphic. Orthœcia about ·9 mm. long and about ·45 mm. wide, elliptical; extraterminal front-wall obscured by interœcial secondary tissue, which fills the interœcial valleys and has elongate lacunæ; the intraterminal front-wall is flattish, and consists of about seventeen rather widely separated costæ with no lateral fusions, and each bearing distally a single pelma and united medianly in a rather narrow, imperforate band of fusion; apertural bar stout and flat; apertural spines four in number, small and tending to be swamped by secondary tissue growing up round the primary apertural rim; aperture rather large, and normal. Aviculœcia sporadically distributed, fairly numerous, decidedly larger than those of *Pelmatopora calceata*, distally directed, and with the aperture divided by a constriction into a sub-circular proximal portion and a pointed triangular rostrum.

Distribution.—Senonian, Coniacian; La Ribochère, Loir-et-Cher, E. of La Chartre-sur-le-Loir, Sarthe, France.

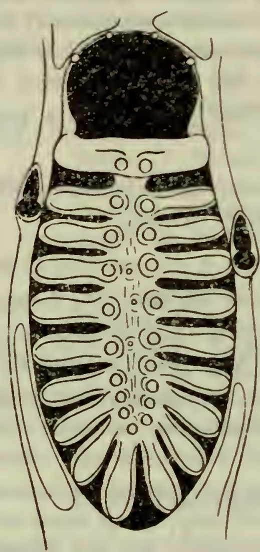
Type-specimen.—D. 28440.

Remarks.—*Pelmatopora larva* lies at the base of a lineage, of which the succeeding terms are *P. chrysalis* and *P. striata*. The lineage is characterised mainly by the large apertures and the flat intraterminal front-walls of the forms composing it; but also by their rather large size, abundance of interœcial secondary tissue, and large (for *Pelmatopora*) pointed aviculœcia—all advanced characters,—accompanying a very lowly-developed intraterminal front-wall. This has primary pelmata only, lying close to the median line, and leaving little or no room for the secondary pelmata even in their earliest pelmatidial stages. In this respect the *P. larva–P. chrysalis* lineage has an even more primitive front-wall than *P. calceata*, in which the pelmata do not lie so close to the mid-line, and secondary pelmatidial beginnings are sometimes seen; and so to derive this lineage it is necessary in strict fairness to go back further than *P. calceata*.

At the time of writing the synopsis of the Cribrimorph Polyzoa (Lang, 1916, pp. 102, 103), the type-specimen of *P. larva* was considered as *Semiescharipora interrupta*, d'Orbigny, from its specific identity with a specimen in Mr. Canu's collection, labelled by him "*Cribrilina interrupta* d'O." A re-examination, however, of d'Orbigny's figure has convinced me that the dots in the median area of fusion represent perforations, and not pelmata, and that, therefore, d'Orbigny's species comes nearer to the group in which lie the lineages of *P. suffulta* and *P. repleta*, to be considered later. Canu's specimen, therefore, is *P. larva*: a photograph of this specimen is in the Collection.

Figures.—Text-fig. 77. Orthœcium and two aviculœcia.

Plate V, fig. 9. Part of the type-specimen, showing four orthœcia and eight aviculœcia. × about 27 diameters.



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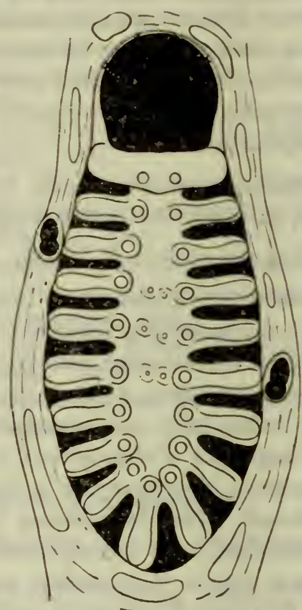

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Fig. 77.—*Pelmatopora larva.* Diagram of an orthœcium and two aviculœcia, from above. × about 75 diameters.

Fig. 78.—*Pelmatopora chrysalis.* Diagram of an orthœcium and two aviculœcia, from above. × about 75 diameters.

LIST OF SPECIMENS.

D. 28440. The type-specimen. Senonian, Coniacian. La Ribochère, Loir-et-Cher, E. of La Chartre-sur-le-Loir, Sarthe, France. In exchange with F. Canu. 1914.

D. 28443. Paratype. A much-worn example. From the same horizon and locality as D. 28440. In exchange with F. Canu. 1914.

A photograph of a specimen in Mr. Canu's collection. Senonian, Coniacian. Tours, Indre-et-Loire, France.

5. Pelmatopora chrysalis (d'Orbigny).

Escharipora chrysalis, d'Orb., 1851; d'Orbigny, 1851, pl. 686, figs. 6–8; 1852, p. 228; 1854, p. 1097; Sénonien; Fief-Neuf, Pons (Charente-Inférieure).
Escharipora chrisalis; d'Orbigny, 1851, legend on pl. 686, figs. 6–8.
Escharipora chrysalis, d'Orb.; Coquand, 1860, p. 121; Angoumien; Pons.
Escharipora chrysalis d'Orb.; Canu, 1900 [2], p. 449; Sénonien; =*Semieschari-pora interrupta*, d'Orbigny.
Non=*Semiescharipora interrupta*; d'Orbigny, 1852, pl. 719, figs. 5–8, 1853, p. 487 as stated by Canu, 1900, p. 449 [*Pelmatopora interrupta*].
Pelmatopora chrysalis (d'Orbigny); Lang, 1916, pp. 102, 104; Senonien; Fief-Neuf and Pons, France.
Pelmatopora chrysalis (d'Orbigny); Lang, 1919 [4], pp. 212–3, 223.

Diagnosis.—*Pelmatopora* in which secondary aviculœcia do not replace the apertural spines; the median area of fusion is imperforate, and there are no well-developed secondary pelmata; the intraterminal front-wall is flattish; the asty is erect and bilaminar; and there are about 17 costæ.

Description.—Asty erect, bilaminar; œcia dimorphic. Orthœcia about 1 mm. long and ·5 mm. wide, elliptical; extraterminal front-wall obscured by an abundant deposit of secondary tissue, which fills the interœcial valleys to overflowing, and has comparatively small sub-circular or elongate lacunæ; intraterminal front-wall flattish and composed of about seventeen rather widely-spaced costæ, each of which bears a distal pelma (which does not, however, lie as close to the middle line as those of *P. larva*) and has no lateral fusions with its neighbours, but is firmly united with the other costæ in an imperforate area of fusion; traces of secondary pelmata in the pelmatidial stage are visible in the median area of fusion; apertural bar stout and flat; apertural spines presumably four, but almost obliterated by an apertural ring of secondary tissue; aperture large and normal. Aviculœcia larger than those of *P. calceata*, sporadically distributed, distally directed, and with the aperture divided by a constriction into a sub-circular proximal portion and a pointed triangular rostrum.

Distribution.—Senonian, France.

Remarks.—Although Canu considers that d'Orbigny's *Escharipora chrysalis* and *Semiescharipora interrupta* are synonymous, the strong row of perforations in the median line of fusion shown in d'Orbigny's figure of the latter species is so distinct, and so noticeably absent from his figure of the former species and from the specimen **D. 28438**, which has a remarkable general resemblance to d'Orbigny's figure, that the species probably are different. Moreover, in Mr. Canu's collection is a slide labelled "*Escharipora striata*, d'Orb.," containing three specimens, of which the two outside specimens differ from the middle one in having many more costæ. The middle specimen closely resembles d'Orbigny's figure of *Escharipora chrysalis* and is specifically identical with specimen **D. 28438**. The difference between the two forms on Mr. Canu's slide is so striking that I have no hesitation in considering *Escharipora chrysalis* as a distinct species, differing from *Semiescharipora interrupta*, on the one hand, in having an imperforate area of fusion and from *Escharipora striata*, on the other hand, in its fewer costæ. A photograph of Mr. Canu's specimen is in the Collection.

Thus interpreted, *Pelmatopora chrysalis* is a further development of *P. larva*, both in the form of the asty, as well as in its greater size and greater abundance of interœcial secondary tissue. Its intraterminal front-wall, too, shows a slight advance on that of *P. larva*, since the pelmata are not so near the mid-line and traces of rudimentary secondary pelmata are to be seen here and there.

Figures.—Text-fig. 78. Orthœcium and two aviculœcia.

LIST OF SPECIMENS.

D. 28438. Senonian, Coniacian. La Ribochère, Loir-et-Cher, E. of La Chartre-sur-le-Loir, Sarthe, France. In exchange with F. Canu. 1914.

D. 28439. A fragment, probably of this species. From the same horizon and locality as D. 28438. In exchange with F. Canu. 1914.

A photograph of the middle of three specimens on a slide in Mr. Canu's collection, labelled "*Escharipora striata*, d'Orb. Coniacian. Villedieu."

6. Pelmatopora striata (d'Orbigny).

Escharipora striata, d'Orb., 1851; d'Orbigny, 1851, pl. 686, figs. 9–12; 1852, p. 229; 1854, p. 1097; Sénonien; Sainte-Colombe (Manche).

Escharipora Mumia, d'Orb., 1851; d'Orbigny, 1851, pl. 687, figs. 4–6; 1852, p. 233; 1854, p. 1097; Sénonien; Sainte-Colombe (Manche); [*fide* Canu].

? *Escharipora elegans*, d'Orb., 1851 ; d'Orbigny, 1851, pl. 684, figs. 13–15; 1852, p. 222 ; 1854, p. 1097 ; Sénonien ; Vendôme (Loir-et-Cher).
Cribrilina (*Decurtaria*) *striata* d'Orb. ; Canu, 1900 [2], p. 450 ; Sénonien ; =*Escharipora mumia*, d'Orbigny (*fide* Canu).
? *Escharipora elegans* ; Canu, 1900 [2], p. 457 ; "Restauration idéale."
Pelmatopora striata (d'Orbigny) ; Lang, 1916, pp. 102, 104 ; Senonian ; Sainte-Colombe ; =*Escharipora mumia*, d'Orbigny (*fide* Canu).
Pelmatopora striata (d'Orbigny) ; Lang, 1919 [4], pp. 212–3, 222.

Diagnosis.—*Pelmatopora* in which secondary aviculœcia do not replace the apertural spines ; the median area of fusion is imperforate and there are no well-developed secondary pelmata ; the intraterminal front-wall is flattish, the asty is erect and bilaminar, and there are more than 25 costæ.

Distribution.—Senonian, France.

Type-specimen.—That figured by d'Orbigny, 1851, pl. 686, fig. 10, is hereby selected. An MS. note in Mr. Canu's collection states that the type is from Néhou, S. of Valognes, and E. of Ste. Colombe, Manche, France.

Remarks.—In the absence of any indications of pelmata in d'Orbigny's figure of this species, and in those of the species considered by Canu to be synonymous with it, it is only tentatively that *Escharipora striata* can be included in the genus *Pelmatopora*. But in Mr. Canu's collection is a slide containing three specimens, labelled "*Escharipora striata*, d'Orb.," the outer two of which agree generally with d'Orbigny's figures, and are certainly *Pelmatopora*. The middle specimen has already been discussed under *P. chrysalis*. A photograph of one of these outer specimens is in the British Museum Collection. Being, then, a species of *Pelmatopora*, *P. striata* appears to be a further term in the lineage *P. larva*–*P. chrysalis*, with many more costæ than the latter form. The apertures, however, are comparatively smaller than those of *P. larva* and *P. chrysalis* ; and, since a large aperture is characteristic of these forms, the smaller aperture of *P. striata* makes its position at the end of this lineage somewhat doubtful.

Specimens.—Only a photograph of an outer specimen of three on a slide in Mr. Canu's collection, labelled "*Escharipora striata*, d'Orb." Senonian, Coniacian. Villedieu, Loir-et-Cher, E. of La Chartre-sur-le-Loir, Sarthe, France.

7. Pelmatopora d'orbignyi, Lang.

Pelmatopora d'orbignyi, sp. n.; Lang, 1916, pp. 102, 104; Coniacian; St. Avertin.

Pelmatopora d'orbignyi, Lang; Lang, 1919 [4], pp. 211–13, 222, 225, fig. 48 on p. 211.

Diagnosis.—*Pelmatopora* in which secondary aviculœcia do not replace the distal apertural spines; the median area of fusion has a double row of perforations, and secondary pelmata are present, if only in a pelmatidial stage; a pair of aviculœcia is placed laterally with regard to each orthœcial aperture; there is much interœcial secondary tissue.

Description.—Asty erect, bilaminar; œcia dimorphic. Orthœcia about ·8 mm. long and ·4 mm. wide, elliptical and somewhat wider distally; extraterminal front-wall entirely concealed beneath a thick deposit of interœcial secondary tissue, which fills the interœcial valleys to overflowing, and has narrow, slot-like, median lacunæ; intraterminal front-wall flattish, tending to sink beneath the level of the interœcial tissue, composed of about eighteen to twenty fairly closely-placed costæ; each costa bears one, and sometimes two, pelmata distally, and, at least, the proximal costæ are united laterally at the level of the primary pelmata, so that there is a row of intercostal perforations on each side of and close to the middle line; apertural bar wide but low; apertural spines obliterated by an apertural rim of secondary tissue; apertures rather small, normal to super-normal. Aviculœcia, a pair placed laterally with regard to the aperture of each orthœcium, raised proximally, and directed obliquely upwards and obliquely towards the distal end of the aperture they accompany; with rather elongate and rather pointed, but apparently unconstricted apertures, whose rims are much thickened distally.

Distribution.—Senonian, Coniacian. St. Avertin, S.E. of Tours, Indre-et-Loire, France.

Type-specimen.—D. 28453. In exchange with F. Canu. 1914.

Remarks.—In the characters of its aviculœcia, *Pelmatopora d'orbignyi* approaches the genus *Ichnopora*, and, in fact, might reasonably be included in that genus as far as mere diagnosis is concerned. In some respects, however, *Pelmatopora d'orbignyi* is rather specialised, notably in the great development of interœcial secondary tissue; so that it is not at all a probable ancestor of the genus *Ichnopora*, and the bilateral arrangement of its aviculœcia probably was acquired independently and may be compared with the arrangement in *Pelmatopora suffulta* and *P. interrupta*. Moreover, the aviculœcia of *Ichnopora* are enlarged even in the more primitive species, and attain a great size as evolution proceeds, so that their size, as well as their peculiar position, distinguish *Ichnopora* from *Pelmatopora*. Now the aviculœcia of *P. d'orbignyi*, though larger than those of *P. calceata*, are no bigger than the aviculœcia of some other species of *Pelmatopora*, e. g. *P. larva*. On the other hand, though it is improbable that *Ichnopora* arose from *Pelmatopora d'orbignyi*, it is possible that both arose from such a form as *P. crepidaria*, in which the tendency of the aviculœcia to take up a circumapertural position is well marked.

Figures.—Text-fig. 79. Orthœcium and two accompanying aviculœcia.

Plate V, fig. 10. Part of the type-specimen, showing three complete orthœcia, parts of others, and eight aviculœcia. × about 27 diameters.

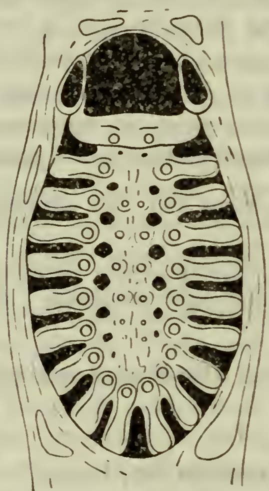
Specimens.—The type-specimen. Distribution and collection as above.

8. Pelmatopora pauciclavia, Lang.

Pelmatopora pauciclavia, sp. n.; Lang, 1916, pp. 102, 104; base of *M. coranguinum*-zone; E. of Cuckmere Haven, Sussex.
Pelmatopora pauciclavia, Lang; Lang, 1919[4], pp. 211–13, fig. 41 on p. 211.

Diagnosis.—*Pelmatopora* in which secondary aviculœcia do not replace the distal apertural spines; the median area of fusion has a double row of perforations, and secondary (often pelmatidial) pelmata are present; the aviculœcia are sporadically distributed; the intraterminal front-wall is distinctly arched, and consists of about 11 costæ; the apertures are comparatively large.

Description.—Asty ?erect, unilaminar; œcia dimorphic. Orthœcia about ·75 mm. long and ·45 mm. wide, oval-elliptical; extraterminal front-wall more-or-less hidden beneath interœcial secondary tissue, which, however, is not very abundant but is mainly confined to contour-like ridges lying on the extraterminal front-wall near the termen; where it is most abundant there are large median lacunæ; intraterminal front-wall well arched, though flat on the top, and consisting of about eleven widely-spaced costæ, each bearing a pelma towards its distal end and often a secondary pelma near the mid-line; at each primary pelma neighbouring costæ are united by lateral fusions, so that there is a line of intercostal perforations in the median area of fusion on each side of the middle line; apertural bar very stout; apertural spines four, much



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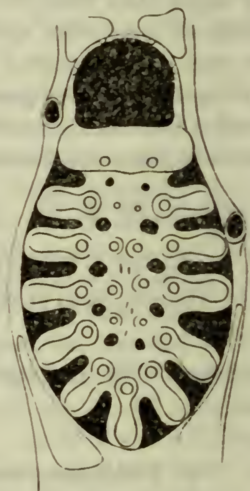

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Fig. 79.—*Pelmatopora d'orbignyi.* Diagram of an orthœcium and its pair of apertural aviculœcia, from above. × about 75 diameters.

Fig. 80.—*Pelmatopora pauciclavia.* Diagram of an orthœcium and two aviculœcia, from above. × about 75 diameters.

obscured by an apertural rim of secondary tissue; aperture large, normal. Aviculœcia numerous, sporadically distributed, small, with blunt or slightly pointed apertures.

Distribution.—Senonian, zone of *M. coranguinum*, *Trochiliopora* Bed of Gaster, about 20 ft. from the base of the zone. East side of Cuckmere Haven, Sussex.

Type-specimen.—D. 28273. Collected by C. T. A. Gaster, Esq., and presented by him, 16th January, 1916.

Remarks.—*Pelmatopora pauciclaria*, if, as is likely, derived from *P. calceata*, is catagenetic in the number of its costæ. It is probably allied to, if not the direct ancestor of, *P. fragilis* (*Semiescharipora fragilis*, d'Orbigny, as here interpreted), and these two, then, form a lineage characterised by catagenetically few costæ.

Figures.—Text-fig. 80. Orthœcium and two aviculœcia.

Plate V, fig. 11. Part of the type-specimen, showing four complete orthœcia, parts of others, and nine aviculœcia. × about 27 diameters.

Specimens.—The type-specimen. Distribution and collection as above.

9. Pelmatopora fragilis (d'Orbigny).

Semiescharipora fragilis, d'Orb., 1851; d'Orbigny, 1852, pl. 717, figs. 8–11: 1853, p. 480; 1854, p. 1097; Sénonien; environs de Fécamp (Seine-Inférieure).

Semiescharipora fragilis. D'Orb.; Vine, 1885, pp. 116, 156.

Cribrilina fragilis, d'Orbigny: Pergens, 1893, pp. 202, 216; Sénonien; Sainte-Paterne.

? *Cribrilina fragilis*, d'Orb.; Vine, 1893, pp. 316, 323, 336; Chalk: Chatham and Aldenborough [near Salisbury].

Cribrilina (Cribrilina) fragilis d'Orb.: Canu, 1900 [2], pp. 448, 458; Sénonien.

? *Cribrilina fragilis*, d'Orb.: Jukes-Browne, 1904, p. 490: zone of *M. cortestudinarium*: Charlton, Kent.

Pelmatopora fragilis (d'Orbigny): Lang, 1916, pp. 102, 104; Senonian [Coniacian]: Fécamp.

Pelmatopora fragilis (d'Orbigny): Lang, 1919 [4], pp. 212–3, 222.

Diagnosis.—*Pelmatopora* in which secondary aviculœcia do not replace the distal apertural spines: the median area of fusion has a double row of perforations, and secondary pelmata are present; [the aviculœcia are sporadically distributed:] the intraterminal front-wall is flattish: and the costæ about 15 in number.

Distribution.—Senonian, Emscherian, Coniacian. Fécamp, N.E. of Le Havre, Seine Inférieure, France.

Type-specimen.—That figured by d'Orbigny, 1852, pl. 717, fig. 9, is hereby selected.

REMARKS.—The interpretation here given of *Pelmatopora fragilis* follows that by Canu of a specimen in his collection from Fécamp (the locality where d'Orbigny's specimen was found), and labelled "*Cribrilina* [*Semiescharipora*] *fragilis*, d'O." There are three specimens on Canu's slide, and the one nearest the label differs from the other two, and has become the type of *Pelmatopora filliozati*. The other two differ from d'Orbigny's figure of *Semiescharipora fragilis* in having the aviculœcia sporadically distributed (whereas in d'Orbigny's figure there is a pair at the proximal-lateral corners of every orthœcial aperture), in having rather fewer costæ and more interœcial secondary tissue. The accuracy of d'Orbigny's figures, however, on Canu's testimony (Canu, 1900 [2], pp. 335, 340), is not such as necessarily to invalidate Canu's interpretation of this species, and *Pelmatopora fragilis* is therefore here interpreted accordingly.

Thus defined, *P. fragilis* may have been derived from *P. pauciclavia* by a slight increase in the number of costæ. If that is so, the presumed catagenesis of this character has ceased and anagenesis has again set in. A photograph of the two specimens on Canu's slide is in the Collection.

LIST OF SPECIMENS.

D. 28441–2. Two fragmentary asties. Senonian, Coniacian. La Ribochère, Loir-et-Cher, E. of La Chartre-sur-le-Loir, Sarthe, France. In exchange with M. Canu. 1914.

D. 28452. A specimen resembling this species, but with incrusting asty. Horizon and collection as above. St. Avertin, S.E. of Tours, Indre-et-Loire, France.

A photograph of one of three specimens on a slide in Mr. Canu's collection, labelled "*Cribrilina* [*Semiescharipora*] *fragilis*, d'O." Senonian, Emscherian. Fécamp, Seine Inférieure, France.

10. Pelmatopora quadrata, Lang.

Pelmatopora quadrata, sp. n.; Lang, 1916, pp. 102, 104; base of *M. coranguinum*-zone; E. of Cuckmere Haven, Sussex.

Pelmatopora quadrata, Lang; Lang, 1919 [4], pp. 197, 211–13, 222, fig. 40 on p. 211.

DIAGNOSIS.—*Pelmatopora* in which secondary aviculœcia do not replace the distal apertural spines; the median area of fusion has a paired row of perforations, and secondary pelmata are present;

the aviculœcia are sporadically distributed, with a tendency to arrangement in pairs at the proximal-lateral corners of each orthœcial aperture; the intraterminal front-wall is well arched; there are about 15 costæ.

Description.—Asty erect, unilaminar; œcia dimorphic. Orthœcia about ·7 mm. long and ·35 mm. wide, elliptical; extraterminal front-wall a good deal hidden by interœcial secondary tissue, which, however, is not very abundant; intraterminal front-wall well arched, consisting of about fifteen rather widely-spaced costæ, each of which bears a primary pelma towards its distal end, often accompanied by a secondary pelma close to the mid-line; lateral costal fusions occur at the primary pelmata, and there is consequently a row of perforations in the median area of fusion on each side of the mid-line; apertural bar not very wide; apertural spines four in number, but much obscured by an apertural ring formed of secondary tissue; aperture sub-normal to sub-circular, except when an ovicell is present, and then somewhat quadrangular and considerably wider than long. Aviculœcia sporadically distributed, with a tendency to a paired arrangement at the proximal-lateral corners of the orthœcial apertures, small, distally directed, with elongate sharply-pointed apertures.

Distribution.—Senonian, zone of *M. coranguinum*, *Trochiliopora* Bed of Gaster, about 20 ft. from the base of the zone. East side of Cuckmere Haven, Sussex.

Type-specimen.—**D. 28271.**

Remarks.—*Pelmatopora quadrata* and *P. filliozati* form a lineage characterised by the small size of the orthœcia, which does not appreciably advance on that of *P. calceata*. *P. filliozati*, though probably the more advanced form, since the costæ are decidedly more numerous, is yet somewhat smaller than *P. quadrata*. The aviculœcia of *P. quadrata* are as small as those of *P. calceata*, but with sharply-pointed apertures; while those of *P. filliozati* are somewhat larger. In the forms hitherto considered, ovicells have not been evident; but in *P. quadrata* endozoœcial ovicells are well developed, and give the characteristic quadrate appearance to the apertures of those orthœcia that bear them (fig. 81 *b*).

Figures.—Text-fig. 81 *a*. Orthœcium with no ovicell and two aviculœcia. 81 *b*. Distal end of orthœcium with ovicell.

LIST OF SPECIMENS.

D. 28271. D. 28272. Type-specimen and paratype. Senonian, zone of *M. cor-anguinum*, *Trochiliopora* Bed of Gaster, about 20 ft. from the base of the zone. East side of Cuckmere Haven, Sussex. Collected by C. T. A. Gaster, Esq., and presented by him, 16th January, 1915.

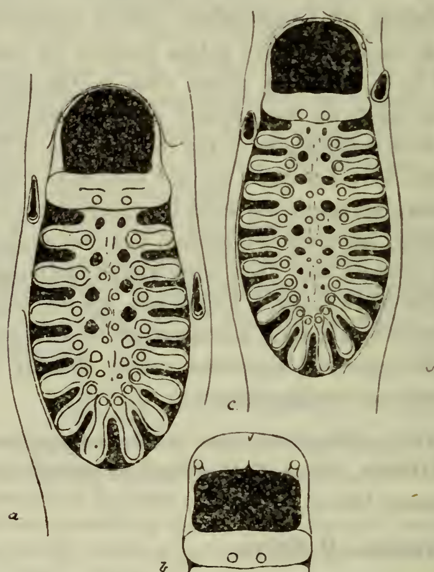


Fig. 81 *a*.—*Pelmatopora quadrata*. Diagram of an orthœcium bearing no ovicell and two aviculœcia, from above. × about 75 diameters.

Fig. 81 *b*.—*Pelmatopora quadrata*. Diagram of the distal end of an orthœcium bearing an ovicell, from above. × about 75 diameters.

Fig. 81 *c*.—*Pelmatopora filliozati*. Diagram of an orthœcium and two aviculœcia, from above. × about 75 diameters.

11. Pelmatopora filliozati, Lang.

Pelmatopora filliozati, sp. n.; Lang, 1916, pp. 102, 105; Emscherian; Fécamp, France.

Pelmatopora filliozati, Lang; Lang, 1919 [1], pp. 197, 212–3, 222.

Diagnosis.—*Pelmatopora* in which secondary aviculœcia do not replace the apertural spines; the median area of fusion has a paired row of perforations, and secondary pelmata are present; the aviculœcia are sporadically distributed; the intraterminal front-wall is well arched; there are about 20 costæ.

Description.—Asty unilaminar, erect; œcia dimorphic. Orthœcia about ·65 mm. long and about ·3 mm. wide, elliptical; extra-terminal front-wall almost entirely concealed beneath interœcial secondary tissue, which, however, is not present in great abundance; intraterminal front-wall well arched, and consisting of twenty fairly closely-set costæ, each of which bears a primary pelma towards its distal end, often accompanied by a secondary pelma close to the mid-line; lateral costal fusions occur at the primary pelmata and there is, consequently, a row of perforations in the median area of fusion on each side of the mid-line; apertural bar not very wide; apertural spines much obscured by an apertural rim of secondary tissue, but, presumably, four in number; apertures sub-normal to sub-circular. Aviculœcia sporadically distributed, rather small, distally directed, with pointed apertures.

Distribution.—Senonian, Emscherian, Fécamp, N.E. of Le Havre, Seine Inférieure, France.

Type-specimen.—In the collection of Mr. F. Canu, of Versailles. A photograph of this specimen is in the Collection.

Remarks.—In Mr. Canu's collection is a slide bearing the label "*Cribrilina* [*Semiescharipora*] *fragilis*, d'O.," and on it are three specimens, two of which have been used to interpret d'Orbigny's species (see under *Pelmatopora fragilis*). The third specimen, that nearest the label, is a different form, and has been made the type of *P. filliozati*. Its affinities have been discussed under the species *P. quadrata*.

Figures.—Text-fig. 81 *c*. Orthœcium and two aviculœcia.

Specimens.—Only a photograph of the type-specimen.

12. Pelmatopora insignis (Canu).

Cribrilina insignis, nov. sp.; Canu, 1911, pp. 252, 280, 282, 286, pl. vi, figs. 7–10; Rocanéen; Roca.

Pelmatopora insignis (Canu); Lang, 1916, pp. 102, 104; Rocanéan; Roca, Argentine, S. America.

Pelmatopora insignis (Canu); Lang, 1919 [1], pp. 211, 213, 222, 224–5, fig. 39 on p. 211.

Diagnosis.—*Pelmatopora* in which secondary aviculœcia do not replace the distal apertural spines; the median area of fusion carries a paired row of perforations, and secondary pelmata are present; the aviculœcia are sporadically distributed; there are more than 16 costæ; the orthœcia are 1 mm. or more in length; there is little or no interœcial secondary tissue; apertures subnormal to normal.

Distribution.—Rocanean (see Remarks). Roca, on the Río Negro, just E. of its confluence with the Río Limay and the Río Neuquen, Argentine, S. America.

Type-specimen.—That figured by Canu, 1911, pl. vi, fig. 9, is hereby selected. In the Museum of Natural History at Buenos Aires.

Remarks.—*Pelmatopora insignis* stands aloof from the mass of more lowly-organised *Pelmatopora*, in virtue of its great size and somewhat complex intraterminal front-wall, combined with an almost total absence of interœcial secondary tissue, which causes the somewhat extensive extraterminal front-wall to become a prominent feature. Thus the general aspect of *P. insignis* is primitive; and this is enhanced by the four apertural spines, unencumbered by secondary apertural tissue, that are so clearly seen in specimen **50466**, though they are hardly visible in Canu's figures.

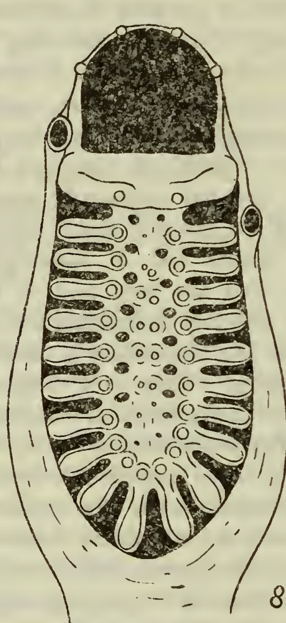
It cannot be doubted that specimen **50466** is very closely allied to, if not identical with, this species. Its differences when compared with the figures of Canu's species are its size, being about 1·2 mm. long, while Canu gives the length of *Cribrilina insignis* as variable and from ·92 mm.–1·02 mm.; its rather smaller aviculœcia; its fewer costæ; and, as already mentioned, its prominent apertural spines. With regard to the last character, however, Canu's figures do not show any marked secondary tissue in connection with the aperture, and since it is almost certain that, as in all other species of *Pelmatopora*, four apertural spines existed, their inconspicuousness in the figures is probably due to their having been worn in the figured specimens.

It is probable, then, that specimen 50466 is either this species or hardly specifically distinct. It is unfortunate that the horizon and locality of this specimen are unknown. But its source (Prof. John Morris' collection) makes it all but certain that it is North European, and probably Southern English. In either case its similarity to, if not identity with, a South American species is remarkable.

Though standing somewhat apart among more lowly-organised *Pelmatopora*, *P. insignis* is linked with a group of forms which, though allied, are by no means easy to arrange according to exact relationship. This group includes, besides *P. insignis*, *P. suffulta*, *P. gasteri*, *P. interrupta*, *P. repleta*, *P. coryli*, *P. simplex*, and, as an outlier, *P. fecampensis*. It resembles, in the distribution of its members, a 'circulus' of Gregory; but whereas the members of a circulus are not necessarily closely related, these forms most emphatically are, not only closely related, but possibly, in the case of *P. repleta* and *P. interrupta*, synonymous. The lack of attention that has been paid to the position of the aviculœcia causes the difficulty in deciding the last point, and hinders a lucid exposition of the relationship in terms of lineages rather than of centred grouping. Thus, in d'Orbigny's figure of *Semiescharipora interrupta*, the aviculœcia are distinctly figured as an apertural pair, while Brydone's *Cribrilina repleta* apparently differs from this figure only in the sporadic distribution of the aviculœcia, and possibly in the colonial habit. In Brydone's figure of *C. suffulta*, on the other hand, the aviculœcia distinctly form apertural pairs; yet, in his description, Brydone says that they have a disposition corresponding with those of *C. gregoryi*, which are sporadically distributed. In such a detailed character too much reliance cannot be placed upon d'Orbigny's figures. Yet, that this character may be important, though detailed, is shown by its being the first step in the evolution of the genus *Ichnopora* (see p. 236). A possible phylogeny of this group of species is shown in the table on p. 249, but it must be remembered in reading this phylogeny (and the others in this volume) that it is but tentative and provisional and, in this group of species especially, expresses in lineages what we are as yet, perhaps, only justified in expressing in groups.

Pelmatopora insignis also brings into discussion the age of the

Rocanean. There can be no question as to the propriety of placing this species in *Pelmatopora*. All other known *Pelmatopora* are Lower Senonian in age, and those with the general build of *P. insignis* are almost confined to the lowest part of the Senonian. It is nearly certain that *Pelmatopora* arose as low as the top of the Turonian, but extremely unlikely that it goes back as far as the Cenomanian, since no known Cenomanian form shows even a distant relationship to it. Now the Rocanean Beds are considered to



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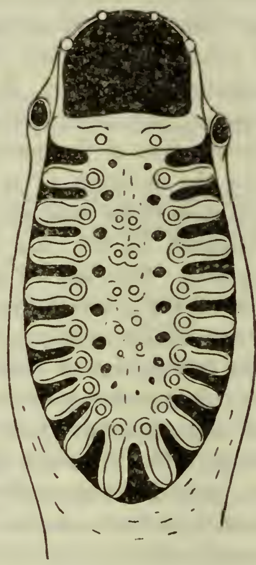

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Fig. 82.—*Pelmatopora insignis*. Diagram of an orthœcium and two aviculœcia, from above. × about 75 diameters.

Fig. 83.—*Pelmatopora suffulta*. Diagram of an orthœcium and two aviculœcia, from above. × about 75 diameters.

be rather low in the Cenomanian (*fide* Ameghino, 1906, Mus. Nac. Buenos Aires, vol. xv [series 3, vol. viii], p. 498). But the presence of *Pelmatopora* suggests that they range upwards to at least the Turonian, and probably above the lower beds of this stage. The other Cribrimorph described and figured from the Rocanean is doubtfully referred to *Tricephalopora*. If this generic determination is right, it is additional evidence that some at least of the Rocanean is higher than Turonian, since *Tricephalopora* does not range below the Senonian.

Figures.—Text-fig. 82. Orthœcium and two aviculœcia.

LIST OF SPECIMENS.

50466. A fragmentary asty, probably of this species, incrusting an Echinoid. Locality and horizon unknown, but probably from the Senonian of the South of England. Prof. Morris collection. 1863.

13. Pelmatopora suffulta (Brydone).

Cribrilina suffulta, sp. nov.; Brydone, 1913, pp. 436–8, pl. xiv, fig. 4; zone of *M. coranguinum*; Gravesend.

Non *Cribrilina suffulta*, sp. nov.; Brydone, 1913, pp. 436–8, pl. xiv, fig. 5; zones of *M. coranguinum* and *Uintacrinus*, and occasionally subzone of *O. pillula*; Gravesend [and, presumably, other localities. The form depicted in fig. 5 is Brydone's type of *Cribrilina repleta*, see *Pelmatopora repleta*].

Pelmatopora suffulta (Brydone); Lang, 1916, pp. 102, 104; *M. coranguinum*-zone; Gravesend, Kent.

Cribrilina suffulta; Brydone, 1917, p. 495.

Pelmatopora suffulta (Brydone); Lang, 1919[4], pp. 198, 211–3, 218, 222, 226, fig. 45 on p. 211.

Diagnosis.—*Pelmatopora* in which secondary aviculœcia do not replace the distal apertural spines; the median area of fusion has a paired row of perforations; there is a tendency for a pair of aviculœcia to be placed at the lateral-proximal corners of the rather large normal to sub-normal apertures; there is little or no interœcial secondary tissue; the orthœcial length is just less than 1 mm., and the aperture is not pointed.

Distribution.—Senonian, zone of *M. coranguinum*. Essex, Kent, and Sussex.

Type-specimen.—That figured by Brydone, 1913, pl. xiv, fig. 4, is hereby selected.

Remarks.—*Pelmatopora suffulta* belongs to the group whose general affinities are discussed under the remarks on *Pelmatopora insignis*. It differs from *P. gasteri* and *P. repleta* in generally having regularly placed aviculœcia and less pointed apertures, and probably, therefore, lies on a lineage of its own, derived more-or-less directly from *P. calceata*; yet, possibly, from an intervening form from which the other members of the above-mentioned group are also derived.

Figures.—Text-fig. 83. Orthœcium and two aviculœcia.

Specimen.—D. 29907. Idiotype, incrusting an Echinoid. Senonian, Santonian, zone of *M. coranguinum*. Grays, E. of Tilbury, Essex. Collected by G. E. Dibley, Esq., F.G.S., and presented by him, 1919.

14. Pelmatopora gasteri, Lang.

Pelmatopora gasteri, sp. n.; Lang, 1916, pp. 102, 105; low in *M. coranguinum*-zone; Cuckmere Haven, Sussex.

Pelmatopora gasteri, Lang; Lang, 1919[4], pp. 211–13, 218, 222, 226, fig. 44 on p. 211.

Diagnosis.—*Pelmatopora* in which secondary aviculœcia do not replace the distal apertural spines; the median area of fusion has a paired row of perforations and secondary pelmata are present; the aviculœcia are sporadically distributed; there are about 16 costæ; the orthœcial length is not much more than ·5 mm.; the apertures are small and cribriline.

Description.—Asty erect, unilaminar; œcia dimorphic. Orthœcia about ·66 mm. long and ·35 mm. wide, elliptical; extraterminal front-wall completely hidden by interœcial secondary tissue, which, while filling the interœcial valleys and having but occasional and narrow median lacunæ, is not greatly developed—that is, does not rise above the interœcial valleys and tend to overflow the intraterminal front-wall; the intraterminal front-wall is well arched laterally, but flat at the median area of fusion, and consists of about sixteen costæ, each bearing a pelma towards its distal end, and in most cases a secondary pelma close to the middle line; lateral costal fusions occur at the primary pelmata, so that there is a row of perforations in the median area of fusion on each side of, and close to, the mid-line; apertural bar very wide; apertural spines four, tending to be obliterated by an apertural rim of secondary tissue; apertures small, cribriline, and with a slight tendency to distal narrowing. Aviculœcia sporadically distributed, distally directed, as small as those of *P. calceata*, and with blunt or slightly pointed apertures.

DISTRIBUTION.—Senonian, zone of *M. coranguinum*, *Trochiliopora* Bed of Gaster, about 20 ft. from the base of the zone. East side of Cuckmere Haven, Sussex.

TYPE-SPECIMEN.—**D. 28274.** Collected by C. T. A. Gaster, Esq., and presented by him, 1915.

REMARKS.—*Pelmatopora gasteri* may have been derived from *P. calceata* by a slight increase of size and number of costæ, a

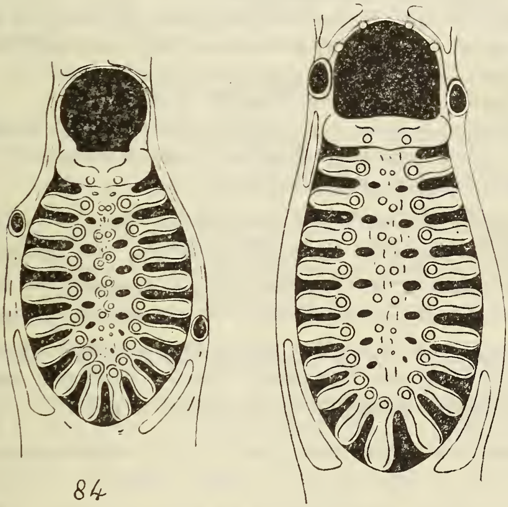

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Fig. 84.—*Pelmatopora gasteri.* Diagram of an orthœcium and two aviculœcia, from above. × about 75 diameters.

Fig. 85.—*Pelmatopora interrupta.* Diagram of an orthœcium and its two apertural aviculœcia, from above. × about 75 diameters.

greater complication of the intraterminal front-wall, the development of interœcial secondary tissue, and a decrease in the relative size of the aperture; it leads on to *P. repleta* and, finally, to *P. simplex* on the one hand and *P. coryli* on the other; it also has close affinities with *P. interrupta*; and approaches, though not so closely, *P. insignis*, *P. suffulta*, and *P. fecampensis.* Further remarks on this group are given under *P. insignis*.

Figures.—Text-fig. 84. Orthœcium and two aviculœcia.

Plate V, fig. 12. Part of the type-specimen, showing three complete orthœcia, parts of others, and six aviculœcia. × about 27 diameters.

Specimens.—The type-specimen. Distribution and collection as above.

15. Pelmatopora repleta (Brydone).

Cribrilina suffulta, sp. nov.; Brydone, 1913, pp. 436–8, pl. xiv, fig. 5; zone of *M. coranguinum*; Gravesend, Kent.

Non *Cribrilina suffulta*, sp. nov.; Brydone, 1913, pp. 436–8, pl. xiv, fig. 4; zones of *M. coranguinum*, *Uintacrinus*, and, occasionally, subzone of *O. pillula*; Gravesend [and, presumably, other localities].

Cribrilina repleta, nom. nov.; Brydone, 1917, p. 495.

Non *Cribrilina repleta*, nom. nov.; Brydone, 1917, pp. 495–6, pl. xxxii, fig. 9; zone of *M. coranguinum*; Soberton, Hants. [This figure appears to represent *Pelmatopora quadrivolucris.*]

Diagnosis.—*Pelmatopora* in which secondary aviculœcia do not replace the distal pair of apertural spines; the median area of fusion has a paired row of perforations (occasionally the beginnings of a second paired row are visible); the aviculœcia are sporadically distributed; about 17 costæ; length just less than 1 mm.; a fair amount of interœcial secondary tissue; apertures small, subnormal to normal, and somewhat narrowed distally.

Distribution.—Senonian, zone of *M. coranguinum*; Kent and Sussex.

Type-specimen.—That figured by Brydone, 1913, pl. xiv, fig. 5, is hereby selected.

Remarks.—*Pelmatopora repleta* is founded upon the form described and figured by Brydone in 1913 as a "coarse form" of *Cribrilina suffulta*. The form figured by him in 1917 as *C. repleta* agrees with *Pelmatopora quadrivolucris* if, as appears, the "tubercles" are secondary aviculœcia and not apertural spines.

It is possible, considering the frequent inaccuracy of d'Orbigny's figures, that his *Semiescharipora interrupta* is the same as Brydone's *Cribrilina repleta*, since the differences are in matters of detail, which (though important) d'Orbigny might easily have failed to appreciate. These differences are the regular distribution of the aviculœcia of *Semiescharipora interrupta*, the scantiness of the interœcial secondary tissue, and the absence of any sign of a second paired row of perforations in its median area of fusion, such as are occasionally to be seen in Brydone's figure of *C. repleta*. In the light of these differences it is advisable to keep the species distinct, but the possibility of their identity is mentioned in case an examination of d'Orbigny's type should show that their apparent difference is due to inaccuracies in d'Orbigny's figures.

Pelmatopora repleta probably was derived directly from *P. gasteri* mainly by an increase of size, but the occasional appearance, in the median area of fusion, of a few perforations of a second paired row point also to its more advanced condition.

LIST OF SPECIMENS.

D. 28275-7. D. 28290. Senonian, Santonian, zone of *M. coranguinum*, *Trochiliopora* Bed of Gaster, about 20 ft. from the base of the zone. Cliff end, east side of Cuckmere Haven, Sussex. Collected by C. T. A. Gaster, Esq., and presented by him, 1915.

D. 29857. Senonian, Santonian, zone of *M. coranguinum*. Pit in Houndean Bottom, W. of Lewes, Sussex. Collected by C. T. A. Gaster, Esq., and presented by him, 1919.

16. Pelmatopora interrupta (d'Orbigny).

Semiescharipora interrupta, d'Orb., 1851; d'Orbigny, 1852, pl. 719, figs. 5–8; 1853, p. 487; 1854, p. 1098; Sénonien; environs de Saintes (Charente Inférieure).

Semiescharipora interrupta, d'Orb.; Coquand, 1860, p. 150; Santonien; Saintes.

Cribrilina interrupta, d'Orb.; Canu, 1900, p. 409; Sénonien; Tours.

Cribrilina (*Cribrilina*) *interrupta* (d'Orb.); Canu, 1900[2], p. 449; Sénonien; =*Escharipora chrysalis*, d'Orbigny, 1851–2, p. 228, pl. 686, figs. 6–8; [Here considered as *Pelmatopora chrysalis*].

Non *Pelmatopora interrupta* (d'Orbigny); Lang, 1916, pp. 102, 103; Senonian; Saintes, France [=*Pelmatopora larva*, q. v. p. 260].

Semiescharipora interrupta, D'Orb.; Brydone, 1917, p. 495.

Non *Pelmatopora interrupta* (d'Orbigny); Lang, 1919[4], pp. 211–3, 223, fig. 42 on p. 211 [=*P. larva*, q. v. p. 260].

Diagnosis.—*Pelmatopora* in which secondary aviculœcia do not replace the distal pair of apertural spines; there is a paired row of perforations near the mid-line in the median area of fusion; a pair of aviculœcia is placed laterally and proximally with regard to each orthœcial aperture; there is comparatively little interœcial secondary tissue; and the apertures are somewhat narrowed distally.

DISTRIBUTION.—Senonian, near Saintes, Charente-Inférieure, France.

TYPE-SPECIMEN.—That figured by d'Orbigny, 1852, pl. 719, fig. 6, is hereby selected.

REMARKS.—*Pelmatopora interrupta* is evidently a close ally of *P. repleta*, and the relation between them has been discussed under that species. Canu considers d'Orbigny's *Escharipora chrysalis* to be the same as *Semiescharipora interrupta*, d'Orbigny; but in my remarks under the former species (p. 264), I have already given reasons for regarding *Pelmatopora chrysalis* and *P. interrupta* as distinct. *P. interrupta* probably was derived from *P. gasteri*, and, in turn, led on to *P. simplex*.

FIGURES.—Text-fig. 85. Orthœcium and two aviculœcia.

SPECIMENS.—None in the Collection.

17. Pelmatopora simplex, Lang.

Pelmatopora simplex, sp. n.; Lang, 1916, pp. 102, 105; *A. quadratus*-zone; Newhaven, Sussex.

Pelmatopora simplex, Lang; Lang, 1919[4], pp. 210–13, 218, 221, 224, 226, fig. 46 on p. 211.

DIAGNOSIS.—*Pelmatopora* in which secondary aviculœcia do not replace the distal pair of apertural spines; a second paired row of perforations is present in the median area of fusion, and tertiary pelmata appear; the orthœcial length is just less than 1 mm.; and there are about 16 costæ; the apertural spines are almost entirely obliterated by secondary tissue; the aviculœcia are more-or-less regularly distributed in pairs, one at each proximal-lateral corner of the orthœcial aperture.

DESCRIPTION.—Asty incrusting, uniserial; œcia dimorphic.

(a) *Ephebœcia.*—Orthœcia about ·8–·9 mm. long and ·45–·5 mm. wide, elliptical; extraterminal front-wall only visible at the bottom of the spacious median lacunæ of the interœcial secondary tissue, which, in spite of these long and wide lacunæ, is abundant and fills the interœcial valleys so as to tend to overflow the intraterminal front-wall; the intraterminal front-wall rather flat, and consisting of about sixteen costæ, each of which bears primary, secondary, and tertiary pelmata, with lateral fusions at the primary and secondary pelmata, while the tertiary pelmata lie close to the middle line; so that the whole intraterminal front-wall resembles a lattice-work, with pelmata at the nodes; apertural bar wide, with poorly-developed pelmata and a low median ridge; apertural spines four, but much obscured by a high apertural ring of secondary tissue; apertures sub-normal to normal. Aviculœcia more-or-less regularly disposed in pairs, one at the proximal-lateral corners of each orthœcial aperture; distally directed, larger than those of *P. calceata*, and with blunt apertures; there is a slight irregularity in the disposition of the aviculœcia in the early neanastic stages.

(b) *Ancestrœcium.*—About ·5 mm. long and ·25 mm. wide, elliptical; extraterminal front-wall more-or-less obscured by interœcial secondary tissue, which chiefly consists of high, thin, ridges running contour-wise round the front-wall at about the level of the termen, and occasionally traversing the interœcial valleys; intraterminal front-wall fairly well arched and consisting of about ten rather widely-spaced costæ, each bearing a primary pelma at about half-way, a secondary pelma towards the distal end, and lateral fusions with its neighbours at the levels of these pelmata (though those at the level of the primary pelmata are obscure and not easy to certify); there are, consequently, perforations in the median area of fusion, which is narrow, so that what is really a double row of perforations appears to be a single row owing to the coalescence of nearly opposite pairs of perforations; apertural bar thin, with clearly-defined pelmata; apertural spines four, much obscured by secondary tissue; aperture rather large, sub-normal.

Distribution.—Senonian, zone of *A. quadratus*, sub-zones of *E. depressa* and *O. pillula*. Sussex.

Type-specimen.—D. 28281.

Remarks.—*Pelmatopora simplex* is probably descended from *P. interrupta*, and may have been derived from it by a further complication of the intraterminal front-wall and a greater development of interœcial secondary tissue. It is remarkable for being, with *P. coryli*, one of the two species of *Pelmatopora* occurring above the *M. coranguinum*-zone with the distal pair of apertural spines visible and not replaced by secondary aviculœcia.

Figures.—Text-fig. 86. Orthœcium and two aviculœcia.

Plate VI, fig. 1. Part of the type-specimen, showing four complete orthœcia and eleven aviculœcia. × about 27 diameters.

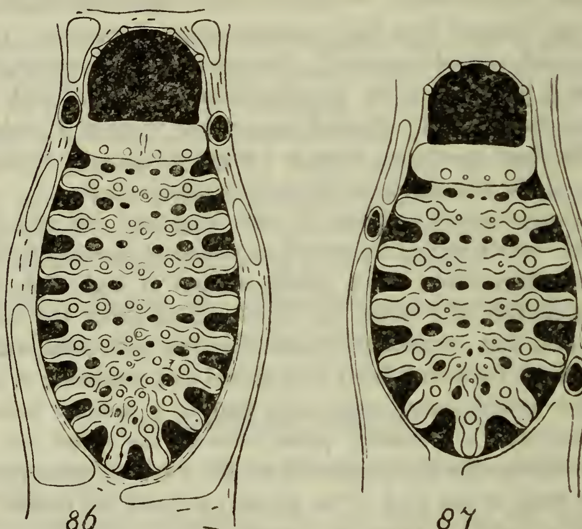

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Fig. 86.—*Pelmatopora simplex.* Diagram of an orthœcium and two aviculœcia, from above. × about 75 diameters.

Fig. 87.—*Pelmatopora coryli.* Diagram of an orthœcium and two aviculœcia, from above. × about 75 diameters.

LIST OF SPECIMENS.

D. 28281. Type-specimen. Senonian, Campanian, zone of *A. quadratus*, E. side of Old Nore Point, W. of Newhaven, Sussex. Collected by C. T. A. Gaster, Esq., and presented by him, 1915.

D. 29860. Senonian, Campanian, zone of *A. quadratus*, subzone of *E. scutata*, var. *depressa*. Pit 4 of Gaster, W. of Boundstone Lane, S. of Lancing Ring, N.E. of Worthing, Sussex. Collected by C. T. A. Gaster, Esq., and presented by him, 1919.

D. 29859. Senonian, Campanian, zone of *A. quadratus*, subzone of *O. pillula*. Chalk-pit on East Hill, Rottingdean, E. of Brighton, Sussex. Collected by C. T. A. Gaster, Esq., and presented by him, 1919.

18. Pelmatopora coryli (Lang).

Carydiopora coryli, sp. n.; Lang, 1916, p. 94; *A. quadratus*-zone, *O. pillula*-subzone; North Lancing, Sussex.

Diagnosis.—*Pelmatopora* in which the secondary pelmata have not entirely passed out of the pelmatidial stage, even when they follow the primary pelmata proximally along the costa; secondary aviculœcia do not replace the distal apertural spines.

Description.—Asty incrusting, unilaminar; œcia dimorphic. Orthœcia about ·7 mm. long and ·5 mm. wide; oval-elliptical; extraterminal front-wall of small extent, and but little obscured by the interœcial secondary tissue, which chiefly consists of contour-like ridges on the front-wall at about the level of the termen; the intraterminal front-wall is flattish, and consists of about eleven rather widely-spaced costæ which bear a pelma at about the middle of their length, and a pelmatidium more distally, and are united at these points by lateral fusions with their neighbours; occasionally a second pelmatidium is present close to the mid-line. The secondary pelmata, still in the pelmatidial stage, are often to be seen at some distance from the mid-line; apertural bar wide, with well-developed pelmata and pelmatidia; apertural spines four, the distal pair sometimes thickened, but not, apparently, replaced by secondary aviculœcia; apertures rather small, sub-normal. Aviculœcia sporadic, with a tendency to segregate into pairs, one of each pair being situated at the proximal-lateral corner of each orthœcial aperture; they are distally directed, rather small, with somewhat elongate apertures.

Distribution.—Senonian, zone of *Marsupites*, and zone of *A. quadratus*, subzone of *E. scutata*, var. *depressa*.

Type-specimen.—D. 28998.

Remarks.—It is conceivable that *Pelmatopora coryli* was derived from a form near *P. gasteri*, by a further elaboration of the intraterminal front-wall along the usual lines; but the development of the pelmatidia into pelmata was retarded or inhibited. This form suggests how the derivatives of *Pelmatopora* in the Upper Senonian, namely, *Decurtaria* and possibly also *Batrachopora* and *Pachydera*, may have arisen, though, owing to the position of their aviculœcia, the last two genera may have been derived from *Ichnopora*; but, even so, the same method of evolution of the intraterminal front-wall may have been repeated in them. In these high-zonal genera the primary pelmata are large, and the others smaller and not easily distinguished from pelmatidia.

FIGURES.—Text-fig. 87. Orthœcium and two aviculœcia.

Plate VI, fig. 2. Part of the type-specimen, showing four complete orthœcia, the distal end of a fifth, and two aviculœcia. × about 27 diameters.

LIST OF SPECIMENS.

D. 28998. Type-specimen. Senonian, zone of *A. quadratus*, subzone of *E. scutata*, var. *depressa*. Pit 2 of Gaster; by reservoir near Hill Barn, North Lancing, N.E. of Worthing, Sussex. Collected by C. T. A. Gaster, Esq., and presented by him, 1916.

D. 28997. Paratype. Senonian, zone of *A. quadratus*, subzone of *E. scutata*, var. *depressa*. Cliffs between the last groyne East of Rottingdean Gap and Saltdean, E. of Brighton, Sussex. Collection and donation as above.

D. 28896. Paratype. Horizon, collection, and donation as D. 28997. Pit 4 of Gaster, W. of Boundstone Lane and S. ot Lancing Ring, N.E. of Worthing, Sussex.

D. 28899. Paratype. Senonian, zone of *Marsupites*. Brighton Cliffs, Sussex. Collection and donation as above.

19. Pelmatopora fecampensis, Lang.

Pelmatopora fecampensis, sp. n.; Lang, 1916, pp. 102, 105; Senonian, Coniacian; Fécamp, France.

Pelmatopora fecampensis, Lang; Lang, 1919 [4], pp. 211–13, 222, fig. 43 on p. 211.

DIAGNOSIS.—*Pelmatopora* in which secondary aviculœcia do not replace the apertural spines; the median area of fusion has a paired row of perforations, and secondary pelmata are present; the aviculœcia are sporadically distributed; there are about 18 costæ; interœcial secondary tissue is well developed; the apertures are not small, as in *P. gasteri*, and are rounded, not narrowed distally.

DESCRIPTION.—Asty [erect], unilaminar; œcia dimorphic. Orthœcia about ·8 mm. long and ·5 mm. wide, elliptical; extraterminal front-wall entirely concealed by interœcial secondary tissue, which fills the lower parts of the interœcial valleys, but does not over-brim them, and seldom has lacunæ; when, however, lacunæ are present they are shallow median slits or slight triangular depressions; intraterminal front-wall slightly arched laterally, flat above, and consisting of about eighteen rather closely-placed costæ, each of which bears a primary pelma distally and often a secondary pelma close to the mid-line; there are lateral costal fusions at the level of the primary pelmata; and consequently a line of perforations on each side of the mid-line; apertural bar hardly wider than the normal costæ and but slightly differentiated; apertural spines four in number and somewhat hidden by circum-apertural secondary tissue; apertures normal. Aviculœcia numerous, sporadically distributed, distally directed, small, with long-drawn-out, sharply pointed apertures.

Type-specimen.—D. 28473.

Remarks.—Of the group represented by *P. insignis*, *P. suffulta*, and *P. gasteri* and its derivatives, *Pelmatopora fecampensis* is the last species to be considered. It stands rather on the outside of the group, having a great development of interœcial secondary tissue compared with *P. insignis*, sporadically distributed aviculœcia as contrasted with *P. suffulta*, and a somewhat large aperture, not narrowed distally as in *P. gasteri* and *P. repleta*. As remarked above, the lineal relationship of this group cannot, at present, be determined with certainty, and the species rather form a nucleus in the developmental flux that ensued upon the general outburst of evolutionary activity in the genus *Pelmatopora* in Coniacian and Lower Santonian times; while other lineages stream outwards, gradually becoming defined as narrow strings or lines.

Figures.—Text-fig. 88. Orthœcium and two aviculœcia.

Plate VI, fig. 3. Part of the type-specimen, showing three complete orthœcia and eight aviculœcia. × about 27 diameters.

LIST OF SPECIMENS.

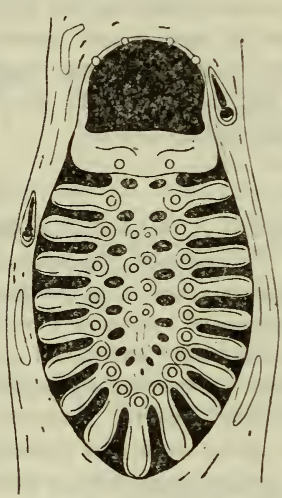
D. 28473. D. 28472. D. 28474–7. Type-specimen and five paratypes. Senonian, Coniacian. Fécamp, N.E. of Le Havre, Seine Inférieure, France. In exchange with Mr. F. Canu. 1914.

20. Pelmatopora plantaris, Lang.

Pelmatopora plantaris, sp. n.; Lang, 1916, pp. 102, 105; *M. coranguinum*-zone; Alton, Hants.

Pelmatopora plantaris, Lang; Lang, 1919[4], pp. 199, 210–11, 213, 216, 218, 222, 224–5, figs. 6–8 on p. 199, fig. 51 on p. 211.

Diagnosis.—*Pelmatopora* in which secondary aviculœcia do not replace the distal pair of apertural spines; a second paired row of perforations is present in the median area of fusion, and tertiary



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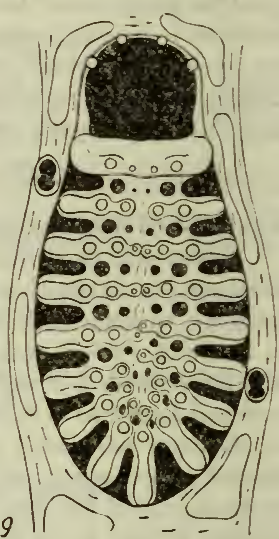

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Fig. 88.—*Pelmatopora fecampensis.* Diagram of an orthœcium and two aviculœcia, from above. × about 75 diameters.

Fig. 89.—*Pelmatopora plantaris.* Diagram of an orthœcium and two aviculœcia, from above. × about 75 diameters.

pelmata occasionally appear; the asty is incrusting; the orthœcial length is less than 1 mm.; there are about 14 costæ; the apertural spines are slightly, if at all, obscured by secondary tissue; and the aviculœcia are sporadically distributed.

Description.—Asty incrusting, unilaminar; œcia dimorphic.

(a) *Ephebœcia.*—Orthœcia about ·8 mm. long and ·5 mm. wide, elliptical with somewhat parallel sides; extraterminal front-wall entirely concealed by abundant interœcial secondary tissue, which has deep and rather narrow median lacunæ; the intraterminal front-wall flattish, and consisting of about fourteen or fifteen rather widely-spaced costæ, each of which bears primary and secondary pelmata, and occasionally, near the mid-line, a tertiary pelma; lateral costal fusions occur at the level of the primary and secondary pelmata, and, consequently, there are two rows of perforations on each side of the middle line; apertural bar low and rather wide; apertural spines four in number, thick, and, though partially surrounded by interœcial secondary tissue, they stand out boldly from it and are by no means obliterated; apertures normal. Aviculœcia sporadic, rather large, with blunt, more-or-less elongate apertures.

(b) *Neanœcia.*—Orthœcia about ·5 mm. long and ·25 mm. wide in the earliest, and larger in the later, stages, elliptical; extraterminal front-wall of fair extent proximally, and hardly, or not at all, obscured by interœcial secondary tissue; intraterminal front-wall well arched and consisting of eleven or twelve rather widely-spaced costæ, each of which bears a primary pelma and often a secondary pelma (generally in the pelmatidial stage) near the mid-line; there is thus a paired row of perforations in the median area of fusion; apertural bar of about the same thickness and appearance as the normal costæ; apertural spines four in number; apertures rather small and decidedly longer than wide. Aviculœcia sporadic, rather small, and with blunt and hardly elongate apertures.

Distribution.—Senonian, zone of *M. coranguinum.*

Type-specimen.—D. 19620.

Remarks.—With *Pelmatopora plantaris* a return is made to the 'main lineage' of *Pelmatopora*, which, starting with *P. calceata*, passes through *P. solearis* and *P. plantaris* to *P. pero* and *P. brydonei*, and so on to the high-zonal forms characterised by the obliteration of the apertural spines and the replacement of the distal pair by 'secondary aviculœcia.' *P. plantaris*, then, was probably derived directly from *P. solearis* by the greater complication of the intraterminal front-wall, a greater development of interœcial secondary tissue, and slightly larger aviculœcia. But the orthœcia are shorter compared with their width, and the costæ, if anything, fewer; and this may mean that the species is slightly off the main line of evolution. In the present state of our knowledge, however, it is convenient, for simplicity's sake, to disregard these deviations to the extent of placing *P. plantaris* between *P. solearis* and *P. pero*; on the other hand, to bear them in mind in order to replace the species in its truer position when reconstruction is advisable. And, it may be remarked incidentally, that this general principle should be applied to all the diagrammatic representations of phylogenies in this work, which, in the nature of things, are bound to be but tentative, and, in fact, profess to be no more than approximations.

The earlier neanastic stages of *Pelmatopora plantaris* are the morphic representatives of the ephebœcia of *P. calceata*, and the later neanastic stages are morphic representatives of *P. solearis*.

Figures.—Text-fig. 89. Orthœcium and two aviculœcia.

Plate VI, fig. 4. Part of the type-specimen, showing four complete orthœcia and seven aviculœcia. × about 27 diameters.

LIST OF SPECIMENS.

D. 19620. Type-specimen. Senonian, zone of *M. coranguinum*. Wivelrod, W. of Alton, Hants. Collected by H. O. White, Esq., F.G.S., and presented by him, 5th Dec., 1910.

D. 28288–9. Paratypes. Senonian, zone of *M. coranguinum*, *Trochiliopora* Bed of Gaster, about 20 ft. from the base of the zone. East side of Cuckmere Haven, Sussex. Collected by C. T. A. Gaster, Esq., and presented by him, 1915.

D. 28291. An asty, probably of this species. Senonian, zone of *M. coranguinum*. Western-most of Seven Sisters, E. of Cuckmere Haven, Sussex. Collected by C. T. A. Gaster, Esq., and presented by him, 1915.

21. Pelmatopora pero, Lang.

Pelmatopora pero, sp. n.; Lang, 1916, pp. 102, 105; top of *M. coranguinum*-zone; Epsom, Surrey.

Pelmatopora pero; Lang, 1919[3], p. 107.

Pelmatopora pero, Lang; Lang, 1919[4], pp. 210–211, 213, 216, 218, 220, 222, fig. 52 on p. 211.

Diagnosis.—*Pelmatopora* in which secondary aviculœcia do not replace the distal pair of apertural spines; a second (occasionally) paired row of perforations is present in the median area of fusion; secondary pelmata are present and tertiary pelmata sometimes appear; the asty is erect and unilaminar; and the orthœcial length more than 1 mm.

DESCRIPTION.—Asty erect, unilaminar; œcia dimorphic. Orthœcia more than 1 mm. long and about ·57 mm. wide, elliptical; extraterminal front-wall entirely hidden by interœcial secondary

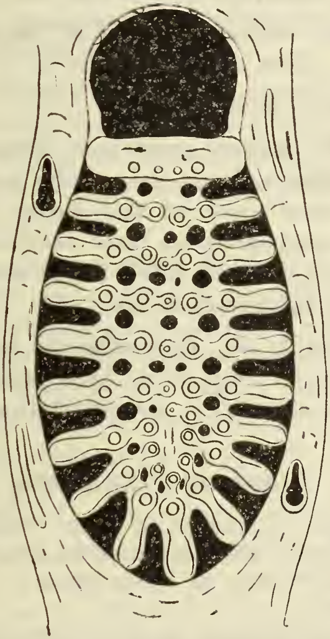


Fig. 90.—*Pelmatopora pero.* Diagram of an orthœcium and two aviculœcia, from above. × about 75 diameters.

tissue, which fills the interœcial valleys and has but occasional, very shallow lacunæ; intraterminal front-wall flattish, and consisting of about sixteen to nineteen rather widely-spaced costæ, each bearing a primary pelma at about half-way down its length, a secondary pelma towards its distal end, and occasionally a tertiary pelma (in the pelmatidial stage) close to the mid-line; lateral costal fusions occur at the levels of the pelmata, consequently there is a paired row of perforations in the median area of fusion, and often a second, medianly placed row, which really is a double row, but, lying so close to the middle, the alternating perforations of the two rows appear to lie approximately in a line; apertural bar wide; apertural spines four in number, but tending to be obliterated by circum-apertural secondary tissue; apertures normal. Aviculœcia sporadically distributed, comparatively large, distally directed, and with elongate apertures, which are rounded proximally and produced into a fine point distally.

Distribution.—Senonian, zone of *M. coranguinum*, extreme top of the zone. Kent, Surrey, and Sussex.

Type-specimen.—D. 23405.

Remarks.—*Pelmatopora pero* is more advanced than *P. plantaris*, having larger orthœcia, more costæ, and better-developed interœcial secondary tissue, so that median lacunæ are hardly present and the apertural spines much obscured. It leads on to *P. brydonei*, from which it differs in the absence of secondary aviculœcia on the distal apertural rim.

Figures.—Text-fig. 90. Orthœcium and two aviculœcia.

Plate VI, fig. 5. Part of the type-specimen, showing four orthœcia and ten aviculœcia. × about 27 diameters.

LIST OF SPECIMENS.

D. 23405. D. 23402–4. D. 23406–16. D. 23428. Type-specimen and fifteen paratypes. Senonian, extreme top of zone of *M. coranguinum*. Medical College Pit, Epsom, Surrey. F. Möckler collection. 1912.

D. 29861. A specimen with only one pair of perforated rows in the median area of fusion. Senonian, Santonian, high in the zone of *M. coranguinum*. Coomb's Pit (264 of Young), West Horsley, N.E. of Guildford, Surrey. Collected by C. T. A. Gaster, Esq., and presented by him, 1919.

D. 29908. Senonian, Santonian, zone of *M. coranguinum*. Meopham, S. of Gravesend, Kent. Collected by G. E. Dibley, Esq., F.G.S., and presented by him, 1919.

D. 29858. A similar specimen to the last. Senonian, Santonian, zone of *M. coranguinum*. Pit between Cliff End and Exceat Farm, near Seaford, Sussex. Collected by C. T. A. Gaster, Esq., and presented by him 1919.

22. Pelmatopora brydonei, Lang.

Pelmatopora brydonei, sp. n.; Lang, 1916, pp. 103, 105; top of *M. coranguinum*-zone. Epsom, Surrey.

? *Cribrilina Gregoryi*, mihi, early, coarse form; Brydone, 1913, pp. 436–8, pl. xiv, fig. 3, upper part of *M. coranguinum*-zone; Basingstoke, Hants.

Non *Cribrilina Gregoryi*, mihi; Brydone, 1913, pp. 436–8, pl. xiv, figs. 1–2; *A. quadratus*-subzone; Upham, Hants.

Non *Cribrilina Gregoryi*, sp. nov.; Brydone, 1906, pp. 300, 290, text-fig. 13 on p. 300.

? *Cribrilina galanthis*, nom. nov.; Brydone, 1917, p. 495.

Pelmatopora brydonei, Lang; Lang, 1919 [4], pp. 199, 210, 213–4, 220, 222, 225, figs. 9–11 on p. 199, figs. 53–4 on p. 214.

Diagnosis.—*Pelmatopora* in which secondary aviculœcia are present on the distal apertural rim at the level of the distal pair of apertural spines; the apertural spines are not always obliterated by secondary tissue, but the proximal pair is often, and the distal pair sometimes, visible.

Description.—Asty incrusting, unilaminar; œcia dimorphic. Orthœcia about 1·25 mm. long and ·57 mm. wide, elliptical; extra-terminal front-wall entirely concealed beneath interœcial secondary tissue, which entirely fills the interœcial valleys and either has no median lacunæ or these are very slightly developed; the intra-terminal front-wall is much flattened, and consists of about eighteen somewhat widely-spaced costæ, each of which bears a primary pelma at about half-way down its length, a secondary pelma near its distal end, and sometimes a tertiary pelma (often in the pelmatidial stage) close to the mid-line; intercostal fusions occur at the levels of the primary and secondary pelmata; there is therefore a paired row of perforations in the median area of fusion between the levels of the primary and secondary pelmata, and a variously developed second paired row close to the mid-line; apertural bar wide and flat, with the pelmata rather obscure; apertural spines often entirely concealed by apertural secondary tissue, but often one or both of the proximal pair, and occasionally one of the distal pair, are visible; on the secondary apertural rim at the level of the distal pair of apertural spines arises a pair of peg-like structures resembling aviculœcia; they are somewhat pointed distally, and their outer face is hollowed like the upper side of an aviculœcium. Though it is possible that they are developments of the distal pair of apertural spines (see p. 244), they are here called 'secondary aviculœcia'; apertures normal. Primary aviculœcia are sporadic, comparatively large, distally directed, and with an elongate aperture.

Distribution.—Senonian, zone of *M. coranguinum*, extreme top of the zone. Medical College Pit, Epsom, Surrey.

Type-specimen.—**D. 23396.**

Remarks.—Of the species of *Pelmatopora* with visible apertural spines, *Pelmatopora brydonei* alone remains to be considered. In the ephebœcia of all the following species apertural spines are obliterated by secondary circum-apertural tissue, and replaced by secondary aviculœcia. *P. brydonei* is also the first species with secondary aviculœcia. In the possession of these it differs from *P. pero*, which otherwise it closely resembles, and from which it is almost certainly descended. The secondary aviculœcia are small and peg-like, affording no suggestion of their further developmental history or of their future importance as evolutionary indices. They replace the apertural spines, and, in specimen **D. 23397**, both the right distal apertural spine and the right secondary aviculœcium are present, the latter lying outside the former. But the primary apertural rim in this specimen is so distinct as to suggest that the whole aperture has been renewed. If this has happened, this specimen cannot be used to demonstrate that the secondary aviculœcium is a new structure, and not a development of the distal apertural spine, as has been assumed hitherto (p. 11; Vol. III, p. xxxiv; Lang, 1919 [4], p. 218) and shown in fig. 91. If the secondary aviculœcia are rightly regarded as developments of no pre-existing structures, the species *P. brydonei* must be considered as arising from a saltation, *i. e.*, 'mutation' in de Vries' (not in Waagen's) meaning of the term. Hence the interest and importance of these structures, which, having now appeared, are present throughout the remaining evolutionary history of the genus, and themselves afford, in their various developments, the most important evolutionary index to its main lineages.

Figures.—Text-fig. 91. Orthœcium with two primary and two secondary aviculœcia. Text-fig. 73 *a* on p. 248. A secondary aviculœcium.

LIST OF SPECIMENS.

D. 23396. D. 23397–401. D. 23429–31. Type-specimen and eight paratypes. Senonian, extreme top of the zone of *M. coranguinum.* Medical College Pit, Epsom, Surrey. F. Möckler collection. 1912.

D. 23325. Same horizon, collection, and locality as the last.

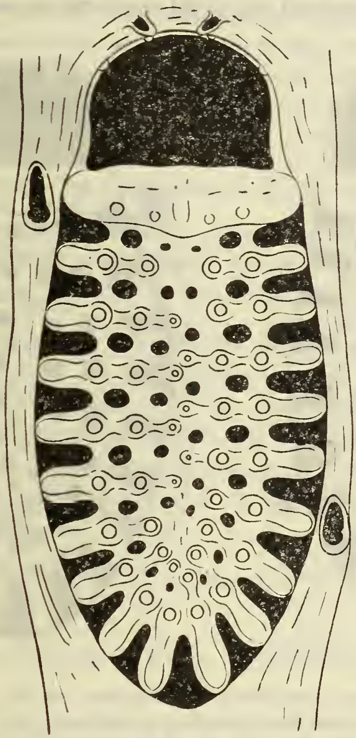


Fig. 91.—*Pelmatopora brydonei.* Diagram, from above, of an orthœcium with two primary and two secondary aviculœcia. The distal apertural spines are represented as being structures distinct from the secondary aviculœcia; though it is possible that the so-called secondary aviculœcia are really modifications of these spines.

23. Pelmatopora quadrivolucris, Lang.

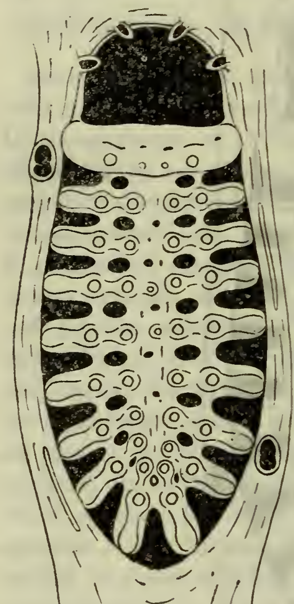
Pelmatopora quadrivolucris, sp. n.; Lang, 1916, pp. 102, 105; *M. coranguinum*-zone; West Horsley, Surrey.

Cribrilina repleta, nom. nov.; Brydone, 1917, pp. 495, 496, pl. xxxii, fig. 9; zone of *M. coranguinum*; Soberton, Hants.

Non *Cribrilina repleta*, nom. nov.; Brydone, 1917, p. 495; =*Cribrilina suffulta*, sp. nov., coarse form; Brydone, 1913, p. 436, pl. xiv, fig. 5 (non fig. 4).

Pelmatopora quadrivolucris, Lang; Lang, 1919[4], pp. 200, 213, 216, 222.

Diagnosis.—*Pelmatopora* in which secondary aviculœcia replace both the proximal and distal apertural spines.



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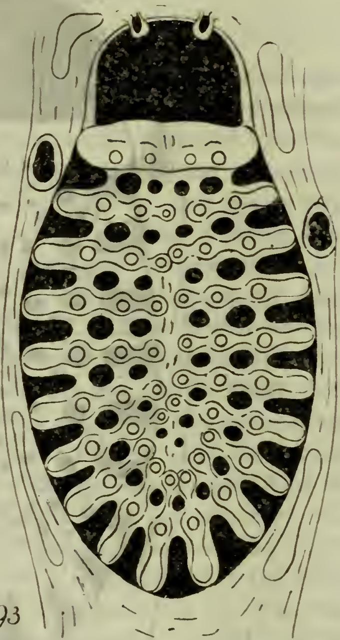

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Fig. 92.—*Pelmatopora quadrivolucris.* Diagram of an orthœcium, two normal, and four secondary aviculœcia, from above. × about 75 diameters.

Fig. 93.—*Pelmatopora marsupitum.* Diagram of an orthœcium, two normal, and two secondary aviculœcia, from above. × about 75 diameters.

Distribution.—Asty incrusting, unilaminar; œcia dimorphic. Orthœcia about 1 mm. long and ·57 mm. wide, elliptical; extra-terminal front-wall entirely concealed by interœcial secondary tissue, in which lacunæ are but feebly developed; the intraterminal front-wall is flattened, and consists of about sixteen somewhat widely-spaced costæ, each of which bears a primary pelma at about its mid-length, and a secondary pelma distally; occasionally there are signs of a tertiary pelma close to the mid-line; but, as a rule, there is only one row of perforations on each side of the mid-line consequent upon the occurrence of lateral costal fusions at the level of the primary pelmata; apertural bar wide and low, bearing large primary pelmata; apertural spines obliterated by secondary circum-apertural tissue, and replaced by peg-like secondary aviculœcia; apertures sub-normal to normal. Primary aviculœcia numerous, sporadic, comparatively large, and with slightly elongate apertures.

Distribution.—Senonian, zone of *M. coranguinum.*

Type-specimen.—**D. 28907.** Coombs Pit (264 of Young), West Horsley, N.E. of Guildford, Surrey. Collected by C. T. A. Gaster, Esq., and presented by him, 1916.

Remarks.—Though with slightly smaller orthœcia than *Pelmatopora brydonei*, *P. quadrivolucris* may be considered as a descendant of that form or of some immediate common ancestor of very similar structure. Not only do secondary aviculœcia appear in *P. quadrivolucris* approximately in the position of the distal pair of apertural spines of *P. brydonei*, but they replace the proximal pair also.

Figures.—Text-fig. 92. Orthœcium, two primary, and four secondary aviculœcia.

Specimen.—The type-specimen. Distribution and collection as above.

24. Pelmatopora marsupitum, Lang.

Pelmatopora marsupitorum, sp. n.; Lang, 1916, pp. 103, 105; *Marsupites*-zone; Brighton, Sussex.

Pelmatopora marsupitum, Lang; Lang, 1919 [4], pp. 214–16, 222, figs. 55–6 on p. 214.

Diagnosis.—*Pelmatopora* in which secondary aviculœcia replace the distal pair of apertural spines, and the latter are invisible in the ephebastic stages; the secondary aviculœcia are short and peg-like; there are 15–18 costæ; and the asty is incrusting and unilaminar.

Description.—Asty incrusting, unilaminar; œcia dimorphic.

(a) *Ephebœcia.*—Orthœcia about 1 mm. to 1·2 mm. long and about ·57 mm. wide, elliptical; extraterminal front-wall entirely concealed by the abundant interœcial secondary tissue, which has long, slot-shaped, median lacunæ; the intraterminal front-wall is flattish, and consists of about eighteen rather widely-spaced costæ, each of which bears a primary pelma towards its proximal end, a secondary pelma towards its distal end, and a tertiary pelma close to the mid-line; there are lateral costal fusions at the pelmata, and at least two paired rows of perforations in the original median area of fusion, which now comprises the greater part of the intraterminal front-wall; apertural bar low and broad, with the pelmata somewhat obscure; apertures sub-normal: apertural spines completely concealed by secondary circum-apertural tissue. Secondary aviculœcia short and peg-like, sometimes rather broad, and even tending to bifurcate distally. Primary aviculœcia sporadic, or tending to be arranged in pairs proximal to each orthœcial aperture; comparatively large, with but slightly elongate and blunt apertures.

(b) *Neanœcia.*—Orthœcia about ·66 mm. long and about ·28 mm. wide, elliptical; extraterminal front-wall of but small extent, and but little concealed by the scanty interœcial secondary tissue, which consists of a contour-like ridge at about the level of the termen, with an occasional spur crossing the interœcial valley; the intraterminal front-wall is more-or-less arched laterally, though flattish above, and consists of about fourteen rather widely-spaced costæ, each of which bears a primary pelma at about half-way, and a secondary pelma (generally in a pelmatidial developmental stage) at its distal end and near the mid-line; there are lateral costal fusions at the primary pelmata and, consequently, a row of perforations on each side of the mid-line. Apertural bar narrow, each half differing but little from the normal costæ; apertural spines four, with circum-apertural secondary tissue enveloping their proximal ends on the outside; aperture normal to sub-normal, *i. e.*, rather higher than the aperture of the ephebœcia.

Distribution.—Senonian, Santonian, zone of *Marsupites*; occasionally also Campanian, zone of *A. quadratus*, subzone of *E. scutata*, var. *depressa*. Sussex.

Type-specimen.—D. 28867.

Remarks.—*Pelmatopora marsupitum* is to be distinguished from *P. brydonei*, from which it was probably derived, mainly by its more complex intraterminal front-wall, its larger secondary aviculœcia, which are also broader distally and sometimes show a tendency to bifurcation, and the complete disappearance of the apertural spines under the secondary apertural ring. The spines are visible, however, in the neanœcia, and in these (except the latest) there are no secondary aviculœcia. From *P. brydonei* two main lineages appear to have diverged. In the one, in which *P. marsupitum* is the next term, the secondary aviculœcia are characterised by their distal expansion; in the other by their great elongation. In both they increase in size and, finally, bifurcate.

Figures.—Text-fig. 93. Orthœcium, two primary, and two secondary aviculœcia. Text-fig. 73 *b* on p. 248. A secondary aviculœcium.

Plate VI, fig. 6. Part of the type-specimen, showing three complete orthœcia, each with its distal pair of secondary aviculœcia, and seven primary aviculœcia. × about 27 diameters.

LIST OF SPECIMENS.

D. 28867. D. 28866. Type-specimen and paratype. Senonian, zone of *Marsupites*. Brighton, Sussex. Collected by C. T. A. Gaster, Esq., and presented by him, 1915.

D. 28282. D. 28287. D. 28869–70. Four asties, probably of this species. Horizon, locality, and donation as above.

D. 29867. Senonian, zone of *A. quadratus*, subzone of *E. scutata*, var. *depressa*, lower part, Pit 1 of Gaster, S. of College Farm, North Lancing, Sussex. Collected by C. T. A. Gaster, Esq., and presented by him, 1919.

D. 29866. Senonian, zone of *A. quadratus*, subzone of *E. scutata*, var. *depressa* Cliffs between the last groyne on the east side of Rottingdean Gap and Saltdean, Sussex. Collected by C. T. A. Gaster, Esq., and presented by him, 1919.

D. 28283. An asty, probably of this species. From same horizon, locality, and collection as **D. 29866.** Presented by the collector, 1915.

25. Pelmatopora roedeanensis, Lang.

Pelmatopora roedeanensis, sp. n.; Lang, 1916, pp. 103, 105; *Marsupites*-zone; Brighton, Sussex.

Pelmatopora roedeanensis, Lang; Lang, 1919[4], pp. 215–6, 222.

Diagnosis.—*Pelmatopora* in which short and peg-like secondary aviculœcia replace the distal pair of apertural spines, and the latter are invisible in the ephebastic stages; there are 15–18 costæ; and the asty is erect and unilaminar.

DESCRIPTION.—Asty erect, unilaminar, Otherwise as *Pelmatopora marsupitum.*

DISTRIBUTION.—Senonian, Santonian, zone of *Marsupites,* and Campanian, zone of *A. quadratus,* subzone of *E. scutata,* var. *depressa.*

TYPE-SPECIMEN. **D. 28868.**

REMARKS.—*Pelmatopora roedeanensis* differs only in colonial habit from *P. marsupitum,* and has been directly derived from that form.

LIST OF SPECIMENS.

D. 28868. The type-specimen. Senonian, zone of *Marsupites.* Brighton, Sussex. Collected by C. T. A. Gaster, Esq., and presented by him, 1915.

D. 29870. Senonian, zone of *A. quadratus,* subzone of *E. scutata,* var. *depressa,* lower part. Pit 1 of Gaster, S. of College Farm, North Lancing, Sussex. Collected by C. T. A. Gaster, Esq., and presented by him, 1919.

D. 29868–9. Senonian, zone of *A. quadratus,* subzone of *E. scutata,* var. *depressa.* Cliffs E. of Chimney shaft, Roedean, E. of Brighton, Sussex. Collected by C. T. A. Gaster, Esq., and presented by him, 1919.

26. Pelmatopora somptingensis, Lang.

Pelmatopora somptingensis, sp. n.; Lang, 1916, pp. 103, 106; *A. quadratus*-zone, *A. quadratus*-subzone; Sompting, Sussex.

Pelmatopora somptingensis, Lang; Lang, 1919[4], pp. 214–16, 221, 224–6, figs. 57–8 on p. 214.

DIAGNOSIS.—*Pelmatopora* in which secondary aviculœcia replace the distal pair of apertural spines; the secondary aviculœcia are flattened and expanded distally, and tend to bifurcate.

DESCRIPTION.—Asty unilaminar, erect; œcia dimorphic.

(a) *Ephebœcia.*—Orthœcia about 1 mm. to 1·25 mm. long and about ·5 mm. wide, elliptical, with more-or-less parallel sides; extraterminal front-wall entirely concealed by interœcial secondary tissue, which is well developed, though not very abundant, and has but shallow and inconspicuous median lacunæ; intraterminal front-wall flat above, very slightly arched laterally, and consisting of about sixteen or seventeen rather widely-spaced costæ, bearing primary, secondary, and, near the mid-line, tertiary pelmata, and with lateral fusions at the level of the primary and secondary pelmata, so that there are two paired rows of perforations in the original median area of fusion (now comprising the greater part of the intraterminal front-wall); apertural bar low and wide, with obscure pelmata; apertures sub-normal to normal. Secondary aviculœcia large and flattened, wider distally, tending to bifurcate, and in many cases with the outer horn actually somewhat produced. Primary aviculœcia more-or-less regularly arranged, one being situated in the interœcial tissue on each side of, and proximal to, every orthœcial aperture; comparatively large, distally directed, with elongate and sharply pointed apertures. Ovicells endozoœcial, producing a distal shield in the œcia that bear them, by filling in the space between the secondary aviculœcia with secondary tissue.

(b) *Neanœcia* (see specimen D. 28747).—Orthœcia about ·66 mm. long and ·33 mm. wide, oval to elliptical, with bowed sides; extraterminal front-wall of small extent, and but little obscured by interœcial secondary tissue; the intraterminal front-wall is but slightly arched, and consists of about twelve rather widely-spaced costæ, each bearing primary and secondary pelmata, and occasionally a tertiary pelma, the last often in a pelmatidial stage; there are lateral costal fusions at the primary and tertiary pelmata, so that two paired rows of perforations occur in the median area of fusion; aperture comparatively large, sub-normal; apertural spines invisible. Secondary aviculœcia peg-like, though flattened distally, and resembling those of the ephebœcia of *Pelmatopora marsupitum*. Primary aviculœcia comparatively smaller than those of the ephebastic stages.

(c) *Ancestrœcium* (see specimen D. 28747).—About ·55 mm. long and about ·25 mm. wide, with less bowed sides than the neanœcia; extraterminal front-wall of but small extent, and but little obscured by interœcial secondary tissue; the intraterminal front-wall is well arched, and consists of about eight or nine rather widely-spaced costæ, each bearing a primary pelma and sometimes close to the mid-line a secondary pelma in the pelmatidial stage; there is an imperfectly paired line of perforations in the median area of fusion, caused by lateral costal fusions occurring at the level of the primary pelmata; apertural bar very wide; apertures very large and sub-circular; apertural spines invisible. Secondary aviculœcia peg-like, but somewhat widened distally, resembling those of *Pelmatopora marsupitum*, and about the same comparative size as those of the neanœcia. Primary aviculœcia similar to those of the neanastic stage.

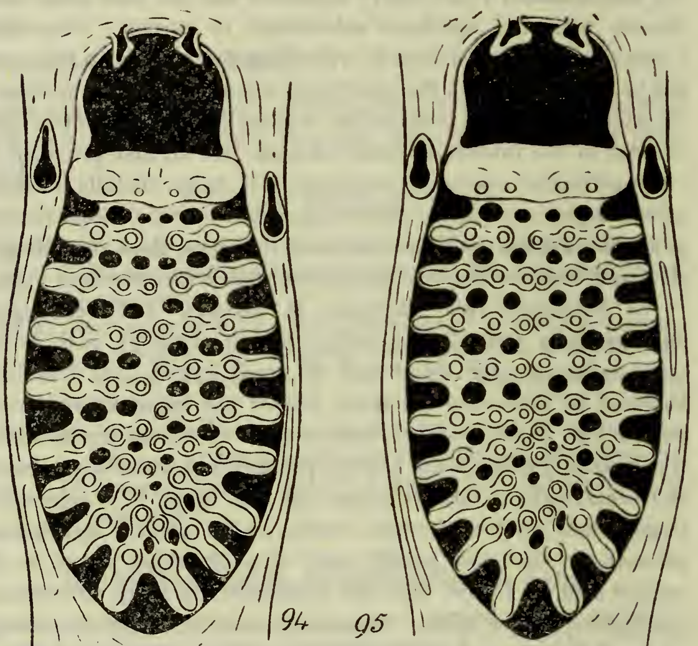


Fig. 94.—*Pelmatopora somptingensis.* Diagram of an orthœcium, two normal aviculœcia, and a distal pair of secondary aviculœcia, from above. × about 75 diameters.

Fig. 95.—*Pelmatopora palmata.* Diagram of an orthœcium, two normal aviculœcia, and a distal pair of secondary aviculœcia, from above. × about 75 diameters.

Distribution.—Senonian, zone of *A. quadratus*, chiefly in the subzone of *A. quadratus*. Sompting district, Sussex.

Type-specimen.—D. 28762.

Remarks.—*Pelmatopora somptingensis* may have been derived from *P. marsupitum* by an increase in size and a distal expansion of the secondary aviculœcia. These structures, in the ancestrœcium and neanastic stages, are in the condition of those of the ephebastic stages of *P. marsupitum*. Thus the early stages of *P. somptingensis* represent the ephebœcia of *P. marsupitum* in respect of the secondary aviculœcia. In most other respects, especially in the degree of development of the intraterminal front-wall, the neanœcia of *P. somptingensis* correspond to the ephebœcia of *P. plantaris* and the ancestrœcium to the ephebœcia of *P. solearis*. Thus the phylogeny of nearly the whole lineage from *P. calceata* through *P. solearis*, *P. plantaris*, *P. pero*, *P. brydonei*, *P. marsupitum*, *P. somptingensis* is represented in the astogeny of this species.

FIGURES.—Text-fig. 94. Orthœcium, two primary, and two secondary aviculœcia. Text-fig. 73 *c* on p. 248. A secondary aviculœcium.

LIST OF SPECIMENS.

D. 28762. D. 28101–9. D. 28747–61. D. 28763–75. The type-specimen and thirty-seven paratypes. **D. 28747** shows the ancestrœcium, but poorly preserved; **D. 28768**, a remarkably deformed orthœcium; **D. 28771**, exceptionally well-preserved secondary aviculœcia; and **D. 28101**, **D. 28103**, **D. 28106**, **D. 28108**, **D. 28761**, and **D. 28770**, ovicells. Senonian, zone of *A. quadratus*, subzone of *A. quadratus*. Pit 7 of Gaster, Upton Lane (or Lambley's Lane), N.W. of Sompting, Sussex. Collected by T. H. Withers, Esq., F.G.S., and presented by him, 1914, 1915.

D. 28776–86. D. 28788–94. D. 28797. Nineteen paratypes. Senonian, zone of *A. quadratus*, subzone of *A. quadratus*. Pit 9 of Gaster, eastern pit, lane on eastern side of Charman Dean, N. of Broadwater, Sussex. Collector and donor as the last.

D. 28979–85. Six paratypes, showing well-preserved secondary aviculœcia, especially **D. 28981**. Ovicells are present in **D. 28983**. From the same horizon and locality as the last. Collected by C. T. A. Gaster, Esq., and presented by him, 1916.

D. 28798–801. Four paratypes, of which **D. 28800** shows ovicells. From the same horizon as the last. Pit 10 of Gaster, western pit, lane on eastern side of Charman Dean. Collected by T. H. Withers, Esq., F.G.S., and presented by him, 1915.

D. 28988–92. Five paratypes showing well-preserved secondary aviculœcia, and ovicells in **D. 28988**. From the same horizon and locality as the last. Collected by C. T. A. Gaster, Esq., and presented by him, 1916.

D. 29056–8. Specimens with secondary aviculœcia more expanded distally than is usual in *P. somptingensis*. Senonian, zone of *A. quadratus*, subzone of *A. quadratus*. Pit 8 of Gaster, about half-way between Upton Lane (Lambley's Lane), Sompting, and lane east of Charman Dean. Collector and donor as the last.

D. 29876. Senonian, zone of *A. quadratus*, subzone of *O. pillula*. Pit by roadside between Burpham and Arundel, and W.N.W. of Warning-camp Hill, Sussex. Collector and donor as the last. 1919.

D. 29877–8. Senonian, zone of *A. quadratus*, subzone of *E. depressa*, upper part. Pit 2 of Gaster, by reservoir, near Hill Barn, North Lancing, Sussex. Collector and donor as **D. 29876.**

D. 4338. D. 29062. Two specimens, probably of this species, but **D. 4338** with very worn secondary aviculœcia. Senonian, zone of *A. quadratus*. East Harnham, S. of Salisbury. W. Gamble collection. 1898.

27. Pelmatopora gregoryi (Brydone).

Cribrilina—a special undescribed form [partim]; Rowe, 1900, p. 341; zone of *A. quadratus*; Sussex.

Cribrilina Gregoryi, sp. nov.; Brydone, 1906, pp. 300, 290, text-fig. 13 on p. 300; zone of *B. quadrata*. [Type-specimen is from the subzone of *A. quadratus*, Upham, Hants, see Brydone, 1913, p. 438.]

Non *Cribrilina Gregoryi*, sp. nov.; Brydone, 1916, *loc. cit.*; zones of *M. cortestudinarium–Marsupites*. [These are presumably other species of *Pelmatopora*.]

Cribrilina Gregoryi [partim]; Brydone, 1910, p. 77.

Cribrilina—an unnamed species, the zoœcium somewhat resembles the sole of a hob-nailed boot; White, 1910, p. 56; zone of *A. quadratus*; Alresford district, Hants.

Non *Cribrilina Gregoryi* (free, unilaminate); Brydone & Griffith, 1911, p. 4; zone of *A. quadratus*, subzone of *E. scutatus* var. *depressus*; Hants. [Probably *P. roedeanensis* or an allied form.]

Non *Cribrilina Gregoryi* (free); Brydone, 1912, pp. 20, 53, 62, 70, 89–95; zone of *M. coranguinum*; Basingstoke, Medsted, and Soberton; zone of *A. quadratus*, subzone of *E. scutatus* var. *depressus*; many localities in Hants, viz., Avington, Brown Candover, Cheriton, Chilton Candover, East Meon, Goodworth, Clatford, Hinton Ampner, Kilmeston, Lower Wield, Tichborne, Warnford, and Woodmancott.

Cribrilina gregoryi Brydone; White, 1912, pp. 35, 43; zone of *A. quadratus*, subzone of *A. quadratus*; Winchester district, Hants.

Cribrilina Gregoryi, mihi; Brydone, 1913, pp. 436–8, pl. xiv, figs. 1–2; zone (restricted) of *A. quadratus*; Upham, Hants.

Non *Cribrilina Gregoryi*, mihi; Brydone, 1913, pp. 436–8, pl. xiv, fig. 3; upper part of zone of *M. coranguinum*; Basingstoke. [Probably *P. brydonei.*]

Non *Cribrilina gregoryi* Brydone (free unilaminate specimens); White, 1913, p. 24; zone of *A. quadratus*, subzone of *E. scutatus* var. *depressus*; Fareham and Havant districts, Hants.

? *Cribrilina gregoryi* [partim] Brydone; White, 1913, pp. 27, 30, 32, 38; zones of *M. coranguinum* and *A. quadratus*; Fareham and Havant district, Hants.

Cribrilina gregoryi Brydone; Lang, 1913, p. 171; zone of *A. quadratus.*

Non *Cribrilina gregoryi*, Brydone; Lang, 1913, p. 171; zone of *M. coranguinum* [probably *P. brydonei*]; and zone of *A. quadratus*, Dankton Lane, N.W. of Sompting Church, B.M. specimen D. 23963 [*P. danktonensis*].

Pelmatopora gregoryi (Brydone); Lang, 1916, pp. 103, 106; zone of *A. quadratus*, subzone of *A. quadratus*; Upham, Hants.

Cribrilina Gregoryi [partim]; Brydone, 1917, pp. 50, 52, 495.

Cribrilina gregoryi, Brydone [partim]; Lang, 1919 [4], p. 213.

Pelmatopora gregoryi (Brydone); Lang, 1919 [4], pp. 215, 216, 221.

Diagnosis.—*Pelmatopora* in which secondary aviculœcia replace the distal pair of apertural spines; the secondary aviculœcia are very much flattened distally and distinctly bi-lobed; the asty is incrusting and unilaminar.

Description.—Asty incrusting, unilaminar; œcia dimorphic. Orthœcia about 1 mm. to 1·25 mm. long and ·5 mm. wide, elliptical with nearly parallel sides; extraterminal front-wall entirely concealed by interœcial secondary tissue, which fills the interœcial valleys, and has no median lacunæ or these but very feebly developed; the intraterminal front-wall is much flattened, and consists of about eighteen rather widely-spaced costæ, each of which bears primary, secondary, and generally tertiary pelmata and lateral fusions at the levels of these, so that two rows of perforations occur on each side of the mid-line; the rows of the midmost pair, however, are often so close to the mid-line that they may appear as a single row; apertural bar broad and low; apertural spines entirely concealed by secondary circum-apertural tissue; apertures sub-normal to normal. Secondary aviculœcia very much flattened and expanded distally into two horns, of which the outer is the longer and the inner but slightly developed. Primary aviculœcia generally arranged in pairs, one proximal to, or at, each proximal-lateral corner of every orthœcial aperture; comparatively large.

Distribution.—Senonian, zone of *A. quadratus*, subzone of *A. quadratus*, and, probably, lower. Hampshire and Sussex.

Type-specimen.—That figured by Brydone, 1913, pl. xiv, figs. 1–2 (see Brydone, 1913, pp. 436, 438).

Remarks.—*Pelmatopora gregoryi* appears to be a direct development of *P. somptingensis* by a further increase in size, flattening, and bifurcation of the secondary aviculœcia, and a somewhat greater development of interœcial secondary tissue. It occurs, with the two next species, in the highest subzone of the *A. quadratus*-zone, and these three forms constitute the highest development of *Pelmatopora* along the main lineage, as well as occurring at a higher stratigraphical horizon than any other *Pelmatopora*. They have specialised in expansion of the secondary aviculœcia, which suggest in general shape the palmate antlers of certain deer.

LIST OF SPECIMENS.

D. 19564. A specimen presented in 1910 by H. O. White, Esq., F.G.S., and said to be identical with that described by him as *Cribrilina* resembling the sole of a hob-nailed boot (1910, p. 56). Senonian, zone of *A. quadratus*, subzone of *A. quadratus*. Southampton Waterworks pit, Otterbourne. S. of Winchester, Hants.

D. 8009. Idiotype. Senonian, middle of zone of *A. quadratus*. Sussex Coast. Collected by R. M. Brydone, Esq., F.G.S., and presented by him, 27th March, 1907.

D. 21169. A specimen from the same horizon and locality as **D. 19464.** Collection of L. Treacher, Esq., F.G.S. 1911.

D. 28537. An asty in three fragments. Senonian, S. of England. F. H. Butler. 1885.

D. 9425. A fragmentary asty, possibly of this species. Senonian, zone of *A. quadratus*. Caroline Birley bequest. 1907.

28. Pelmatopora palmata, Lang.

Pelmatopora palmata, sp. n.; Lang, 1916, pp. 103, 107; *A. quadratus*-zone, *A. quadratus*-subzone; Winchester, Hants.

Pelmatopora palmata, Lang; Lang, 1919 [4], pp. 199, 214–216, 221, figs. 12–14 on p. 199, figs. 59, 60 on p. 214.

Diagnosis.—*Pelmatopora* in which secondary aviculœcia replace the distal pair of apertural spines; the secondary aviculœcia are very much flattened and expanded distally, and distinctly bi-lobed; the asty is erect and unilaminar.

DISTRIBUTION.—Senonian, zone of *A. quadratus*, subzone of *A. quadratus*, and, possibly, subzone of *O. pillula*. Hampshire and Sussex.

TYPE-SPECIMEN.—D. 8010.

REMARKS.—*Pelmatopora palmata* apparently differs from *P. gregoryi* only in its colonial habit, which is free and unilaminar, instead of incrusting. The advisability of taking this difference into consideration is considered under the next species, *P. damicornis*.

FIGURES.—Text-fig. 96. Orthœcium, two primary, and two secondary aviculœcia. Text-fig. 73 *d* on p. 248. A secondary aviculœcium.

Plate VI, fig. 7. Part of the type-specimen, showing three complete orthœcia each with its distal pair of secondary aviculœcia, parts of others, and ten primary aviculœcia. × about 27 diameters.

LIST OF SPECIMENS.

D. 8010. Type-specimen of *Pelmatopora palmata* and idiotype of *Cribrilina gregoryi*, Brydone. Senonian, zone of *A. quadratus*, subzone of *A. quadratus*. Winchester, Hants. Collected by R. M. Brydone, Esq., and presented by him, 1907.

D. 28971. Paratype. Senonian, zone of *A. quadratus*, subzone of *A. quadratus*. Pit 8 of Gaster, between Upton Lane (or Lambley's Lane), Sompting, and lane east of Charman Dean, N. of Broadwater, Worthing, Sussex. Collected by C. T. A. Gaster, Esq., and presented by him, 1916.

D. 28865. A fragment, possibly of this species. Senonian, zone of *A. quadratus*, subzone of *O. pillula*. Pit on East Hill, Rottingdean, E. of Brighton, Sussex. Collected by C. T. A. Gaster, Esq., and presented by him, 1915.

29. Pelmatopora damicornis, Lang.

Pelmatopora damicornis, sp. n.; Lang, 1916, pp. 103, 107; *A. quadratus*-zone; Seaford, Sussex.

Pelmatopora damicornis, Lang; Lang, 1919 [4], pp. 215–6, 221.

DIAGNOSIS.—*Pelmatopora* in which secondary aviculœcia replace the distal pair of apertural spines; the secondary aviculœcia are very much flattened distally, and probably bilobed; the asty is erect and bilaminar.

Distribution.—Senonian, zone of *A. quadratus*. Seaford, Sussex.

Type-specimen.—D. 20204.

Remarks.—*Pelmatopora damicornis* differs from *P. gregoryi* and *P. palmata* in its colonial habit, which is bilaminar. The three species thus form a progressive series with regard to colonial habit and condition, culminating in the erect bilaminar *P. damicornis*. In treating of the general question of colonial habit and condition, it has already been observed that it is not always possible certainly to distinguish an incrusting unilaminar form, which originally grew upon a perishable object, from an erect unilaminar form; and Brydone's remarks on this subject (Brydone, 1906, pp. 289, 290) have been referred to (Lang, 1919[4], p. 196). Brydone also throws doubt upon the validity of *P. damicornis* (1917, p. 52):—"I shall also be much surprised if there should prove to be a bilaminar race of *Cribrilina gregoryi*, that is, something more than an isolated freak or a unilaminar zoarium which has happened to incrust rather neatly the reverse side of a free unilaminar zoarium, at the horizon with which of all the Chalk horizons I am perhaps most familiar." The exact systematic value of most, if not all, described "species" of organisms, both Recent and fossil, must always be liable to readjustment under the advance of knowledge; and the reasons for distinguishing the three terms of this series under separate names (namely, *P. gregoryi*, *P. palmata*, *P. damicornis*) are (1) to have a name for each term, in order to avoid the necessity of describing it at each mention of it, and (2) to call attention to the series and its progressive nature, since, if this is recognised, some stratigraphical results might accrue. Could these terms be definitely proved not only to form a series but, as is here theoretically assumed, to compose a genetic lineage, a still stronger reason would be present for naming them as species. For what are the species of a given lineage, but the terms in a progressive series? Brydone's possible explanation then may be borne in mind, without rendering it advisable to do away with *P. damicornis*. A general rule for the palæontologist, who finds himself in a welter of undescribed forms of varying and doubtful values, is not to give a name until it is needed—that is, not until a form can be fitted into some constructive scheme, and so requires a name for reference; and then to name it in spite of criticism.

30. Pelmatopora danktonensis, Lang.

Pelmatopora danktonensis, sp. n.; Lang, 1916, pp. 103, 106; *A. quadratus*-zone, *E. depressa*-subzone; Sompting, Sussex.

Cribrilina gregoryi, Brydone; Lang, 1913, p. 171; zone of *A. quadratus*; Dankton Lane, N.E. of Sompting Church.

Pelmatopora danktonensis, Lang; Lang, 1919[4], pp. 215–7, 221.

Diagnosis.—*Pelmatopora* in which secondary aviculœcia replace the distal pair of apertural spines; the secondary aviculœcia are small and somewhat lengthened distally, with a tendency to bifurcation; the asty is incrusting and unilaminar.

Description.—Asty incrusting, unilaminar; œcia dimorphic. Orthœcia about 1 mm. long and ·5 mm., or rather less, in width, elliptical with somewhat parallel sides; extraterminal front-wall entirely concealed beneath interœcial secondary tissue, which is abundant and has shallow median lacunæ; the intraterminal front-wall is much flattened, and consists of about sixteen rather widely-separated costæ, each of which bears primary, secondary, and tertiary pelmata, and has lateral fusions at these points, so that there are two paired rows of perforations in the original median area of fusion; apertural bar very wide and low; apertures large, sub-normal to normal. Secondary aviculœcia small, but lengthened, and tending to bifurcation. Primary aviculœcia more-or-less sporadic, but with a strong tendency towards a paired arrangement, one of each pair being placed near the distal and proximal corners of the apertures of each orthœcium; with the aperture divided by a constriction into a more-or-less circular proximal portion and a triangular, somewhat elongate, and sharply-pointed rostrum.

Distribution.—Senonian, zone of *A. quadratus*, subzones of *O. pillula* and *E. scutata* var. *depressa*. Sussex.

Type-specimen.—D. 23963.

Remarks.—The lineage of *Pelmatopora marsupitum–P. somptingensis–P. gregoryi–P. palmata–P. damicornis*, whose members have just been considered, is characterised by a development of the secondary aviculœcia involving an enlargement, a widening, and a bifurcation of these structures; and it was based upon *P. brydonei* in which the secondary aviculœcia are small, peg-like, and not at all distally expanded. From *P. brydonei* there arose a second line of development, in which the secondary aviculœcia, while again increasing in size and tending to bifurcate, never became very broad distally, but, on the contrary, tended to become much elongated. *P. danktonensis* is the next term in this

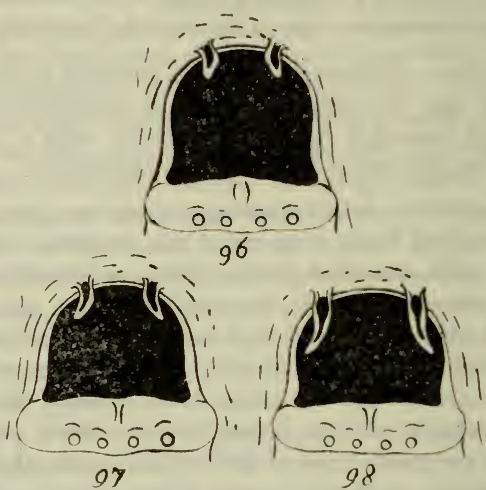


Fig. 96.—*Pelmatopora danktonensis*; fig. 97, *P. bidens*; fig. 98, *P. lancingensis*. Diagrams of the distal ends of orthœcia, each with its distal pair of secondary aviculœcia.

series, and has secondary aviculœcia, which are but little larger than those of *P. brydonei*, but decidedly longer, somewhat flattened, though narrow distally, and with a tendency to bifurcation; moreover, they vary a good deal in their development, apparently irregularly, some being much longer than others—a feature more noticeable in the next species, *P. bidens*. *P. danktonensis* corresponds to *P. marsupitum* in the other lineage, and the secondary aviculœcia of *P. danktonensis* may be distinguished from those of *P. marsupitum* in being less expanded distally compared with their length.

Figures.—Text-fig. 96. Aperture of an orthœcium with its pair of secondary aviculœcia. Text-fig. 73*e* on p. 248. A secondary aviculœcium.

LIST OF SPECIMENS.

D. 23963. Type-specimen. Senonian, Campanian, zone of *A. quadratus*, subzone of *E. scutata*, var. *depressa*. Pit 5 of Gaster, Dankton Lane, N. of Sompting Church, N.E. of Worthing, Sussex. Collected by the author and presented by him, 1912.

D. 29863. From the upper part of the same subzone as **D. 23963.** Pit 4 of Gaster, West of Boundstone Lane, S. of Lancing Ring, N.E. of Worthing, Sussex. Collected by C. T. A. Gaster, Esq., and presented by him, 1919.

D. 29864. From the upper part of the same subzone as **D. 23963.** Pit 2 of Gaster, by reservoir near Hill Barn, North Lancing, Sussex. Collection and donation as **D. 29863.**

D. 29862. Senonian, Campanian, zone of *A. quadratus*, subzone of *O. pillula*. Cliffs W. of Breakwater and Castle Hill, Newhaven, Sussex. Collection and donation as **D. 29863.**

31. Pelmatopora bidens, Lang.

Pelmatopora bidens, sp. n.; Lang, 1916, pp. 103, 105; *A. quadratus*-zone, *O. pillula*-subzone; North Lancing, Sussex.

Cribrilina simplex (d'Orb.); White, 1910, p. 55; *A. quadratus*-zone; Alresford district.

Non *Semiescharipora simplex*, d'Orb., 1851; d'Orbigny, 1852, pl. 718, figs. 1–4; 1853, p. 481; 1854, p. 1097; Sénonien; environs de Fécamp.

Pelmatopora bidens, Lang; Lang, 1919 [4], pp. 214–16, 221, figs. 61–2 on p. 214.

Diagnosis.—*Pelmatopora* in which secondary aviculœcia replace the distal pair of apertural spines; the secondary aviculœcia vary greatly in size, but are never very large, and are elongate with a tendency to bifurcation; in those in which the latter character is most developed, the inner horn is suppressed, but the outer horn developed, so as to add to the general elongation of the structure; the asty is erect and unilaminar.

Description.—Asty erect, unilaminar; œcia dimorphic. Orthœcia about 1 mm. long and ·5 mm. wide, elliptical with somewhat parallel sides; extraterminal front-wall entirely concealed by interœcial secondary tissue, which is abundant, and in which lacunæ are but poorly developed; the intraterminal front-wall is much flattened, and consists of about sixteen somewhat widely-spaced costæ, each of which bears primary, secondary, and tertiary pelmata, and has lateral fusions at these points, so that there are two paired rows of perforations in the original median area of fusion; apertural bar wide and low; apertures sub-normal to normal. Secondary aviculœcia varying much and, apparently, irregularly, in individual development, those on some of the orthœcia being very small and peg-like, and on others large and fully developed; in their fullest development they are large, narrow, and elongate, with a tendency to bifurcation; but the inner horn of the bifurcation is not developed, while the outer horn is long and pointed, adding to the general elongation of the structure. Primary aviculœcia somewhat irregularly arranged, but generally in pairs, one of each pair near the proximal-lateral corners of the apertures of every orthœcium; the apertures are divided by a constriction into a proximal more-or-less circular portion and a rostrum, which is more-or-less triangular, sometimes rather blunt, and sometimes rather acutely pointed; ovicells endozoœcial, producing on the apertures of the orthœcia that bear them a strong distal shield, by filling the gaps between the secondary aviculœcia.

Distribution.—Senonian, zone of *A. quadratus*, chiefly in the subzones of *E. scutata* var. *depressa* and of *O. pillula*. S. of England.

Type-specimen.—D. 28934.

Remarks.—*Pelmatopora danktonensis* is the first term of the main lineage in which the secondary aviculœcia developed in the direction of greater extension rather than expansion. From this point two lineages again diverged, the one—*P. danktonensis*–*P. bidens*–*P. lancingensis*—marked by this extension of the secondary aviculœcia, and the other, though likewise to some extent extending these structures, characterised rather by a catagenetic development of orthœcial length and of the number of costæ.

P. bidens is thus seen to be intermediate between *P. danktonensis* and *P. lancingensis*, having secondary aviculœcia more extended than those of the former, but not as a rule nearly so extended as those of the latter. And this character—namely, the extent of development of secondary aviculœcia—is remarkably and irregularly variable in *P. bidens*. That is to say, in some orthœcia the secondary aviculœcia are small and peg-like, and in others large, somewhat flattened distally, and tending to bifurcate, but with the inner horn of the bifurcation suppressed, and the outer horn extended in a line with the rest of the aviculœcium; and the distribution of these orthœcia with diverse secondary aviculœcia is irregular, bearing, for instance, no apparent relation to astogeny. In *P. lancingensis*, the focus of whose stratigraphical distribution is probably at a somewhat higher level than that of *P. bidens*, this irregularity in the amount of development of the secondary aviculœcia is far less marked, and the better-developed secondary aviculœcia are very much extended by the long, pointed, backwardly-curving outer horn of the suppressed bifurcation at their distal ends.

FIGURES.—Text-fig. 97. Aperture of an orthœcium with its pair of secondary aviculœcia. Text-fig. 73 *f* on p. 248. A secondary aviculœcium.

Plate VI, fig. 8. Part of the type-specimen, showing three complete orthœcia, each with its pair of secondary aviculœcia, parts of others, and nine primary aviculœcia. × about 27 diameters.

LIST OF SPECIMENS.

D. 7315. An asty, probably of this species. Senonian, [zone of *A. quadratus*]. Arreton Down, S. of Newport, I. of Wight. Presented by Miss Mary Salter, 1903.

D. 29097. Three pieces of one asty, probably of this species. Senonian, zone of *A. quadratus*. Portsdown, Hants. Presented by W. Gamble, Esq., 1900.

D. 23992–4001. Pieces of ten asties. Senonian, zone of *A. quadratus*. Newhaven, Sussex. F. Möckler collection. 1912.

D. 29865. Senonian, zone of *A. quadratus*, subzone of *E. scutata* var. *depressa*. Large pit on Warningcamp Hill, N.E. of Arundel, Sussex. Collected by C. T. A. Gaster, Esq., and presented by him, 1919.

D. 21168. Paratype. Horizon as the last. N.W. of Chilton Candover, W. of Alton, Hants. Recorded as *Cribrilina simplex* (d'Orb.); White, 1910, p. 55. L. Treacher collection. 1911.

D. 28953–58. Six paratypes. Horizon as the last. Pit 4 of Gaster, W. of Boundstone Lane, S. of Lancing Ring, N.E. of Worthing, Sussex. Collected by C. T. A. Gaster, Esq., and presented by him, 1916.

D. 28963–4. Two paratypes. Horizon, collector, and donor as the last. Pit 5 of Gaster, Dankton Lane, N.E. of Sompting Church, N.E. of Worthing, Sussex.

D. 28934. D. 28828–35. D. 28933. Type-specimen and nine paratypes. The type-specimen—D. 28934—shows an ovicell. Senonian, zone of *A. quadratus*, subzone of *E. scutata* var. *depressa*, upper part. Pit 2 of Gaster, pit by reservoir, near Hill Barn, North Lancing, N.E. of Worthing, Sussex. Collected by C. T. A. Gaster, Esq., and presented by him, 1915 and 1916.

D. 28804–5. Two paratypes. Senonian, zone of *A. quadratus*, subzone of *O. pillula*. Pit on East Hill, Rottingdean, E. of Brighton, Sussex. Collected by C. T. A. Gaster, Esq., and presented by him, 1915.

D. 28968–70. Three paratypes. Senonian, zone of *A. quadratus*, subzone of *A. quadratus*. Pit 7 of Gaster, pit in Upton Lane (or Lambley's Lane), Sompting, N.E. of Worthing, Sussex. Collected by C. T. A. Gaster, Esq., and presented by him, 1916.

D. 28796. Paratype, from same horizon as the last. Pit 9 of Gaster, eastern pit, lane E. of Charman Dean, N. of Worthing, Sussex. Collected by T. H. Withers, Esq., F.G.S., and presented by him, 1915.

D. 28973–78. Six paratypes, from the same horizon and locality as the last. Collected by C. T. A. Gaster, Esq., and presented by him, 1916.

D. 28987. A paratype, from the same horizon as D. 28768–70. Pit 10 of Gaster, western pit, lane E. of Charman Dean, N. of Worthing, Sussex. Collector and donor as the last.

32. Pelmatopora lancingensis, Lang.

Pelmatopora lancingensis, sp. n.; Lang, 1916, pp. 103, 106; *A. quadratus*-zone, *E. depressa*-subzone; North Lancing, Sussex.
Pelmatopora lancingensis; Lang, 1919 [1], pp. 214–6, 221, figs. 63–4 on p. 214.

Diagnosis.—*Pelmatopora* in which secondary aviculœcia replace the distal pair of apertural spines; the secondary aviculœcia, though varying somewhat in amount of development, are generally large, elongate, somewhat flattened distally with a tendency to bifurcate; the inner horn of the bifurcation, however, is suppressed, but the outer horn is considerably elongated, pointed, curving backwards and slightly outwards, and greatly extends the generally elongate structure; the asty is erect and unilaminar.

Description.—Asty erect, unilaminar; œcia dimorphic. Orthœcia about 1 mm. long and ·5 mm. wide, elliptical, with sides tending to be parallel; extraterminal front-wall entirely concealed by interœcial secondary tissue, which is very abundant, and in which lacunæ are but poorly developed; the intraterminal front-wall is much flattened, and consists of from fifteen to twenty somewhat widely-spaced costæ, each of which bears primary, secondary, and tertiary pelmata, with lateral fusions at the level of the primary and secondary pelmata, so that there are two paired rows of perforations in the original median area of fusion; apertural bar wide and low; apertural spines invisible; apertures subnormal to normal. Secondary aviculœcia varying somewhat and, apparently, irregularly in amount of development, but generally large, elongate, and somewhat flattened distally with a tendency to bifurcation, but the inner horn of this bifurcation is not developed, while the outer horn carries on the general outline of the aviculœcium, and is elongate, pointed, and curved backwards and slightly outwards. Primary aviculœcia arranged somewhat irregularly in pairs, one near the proximal-lateral corners of each orthœcial aperture; rather small, and with somewhat blunt apertures; ovicells endozoœcial; those orthœcia that bear them have a distal apertural shield formed by the infilling of the space between the secondary aviculœcia.

Distribution.—Senonian, zone of *A. quadratus*, chiefly in the subzone of *E. scutata* var. *depressa*. S. of England.

Type-specimen.—D. 28947.

Remarks.—*Pelmatopora lancingensis* may have been directly derived from *P. bidens* by a further development of the secondary aviculœcia, which, on the whole, are larger and much longer than those of *P. bidens*.

Figures.—Text-fig. 98. Aperture of orthœcium with its pair of secondary aviculœcia. Text-fig. 73 *g* on p. 248. A secondary aviculœcium.

Plate VI, fig. 9. Part of the type-specimen, showing three complete orthœcia and the distal end of a fourth, each with its distal pair of secondary aviculœcia and ten primary aviculœcia. × about 27 diameters.

LIST OF SPECIMENS.

D. 4337. A fragmentary asty, probably of this species. Senonian, zone of *A. quadratus*. East Harnham, S. of Salisbury, Wilts. W. Gamble collection. 1898.

All the following were collected by C. T. A. Gaster, Esq., from the Senonian, zone of *A. quadratus*, in Sussex, and presented by him in the years mentioned:—

D. 28285–6. Two paratypes. Subzone of *E. scutata* var. *depressa*. Cliffs east side of Rottingdean Gap, near and above the last groyne, E. of Brighton. 1915.

D. 28962. A paratype. Subzone of *E. scutata* var. *depressa*. Pit 5 of Gaster, Dankton Lane, N.E. of Sompting Church, N.E. of Worthing. 1916.

D. 28947. D. 28946. D. 28948–50. The type-specimen and four paratypes. Subzone of *E. scutata* var. *depressa*, upper part. Pit 3 of Gaster, E. of Boundstone Lane, S. of Lancing Ring, N.E. of Worthing. 1916.

D. 29871–3. Three asties, of which D. 29872 shows many ovicells and excellently-developed secondary aviculœcia. From the same horizon and locality as the type. 1919.

D. 29874–5. Two asties from the same horizon as the type. Pit 4 of Gaster, W. of Boundstone Lane, S. of Lancing Ring, N.E. of Worthing. 1916.

D. 28808–D. 28819. D. 28923–D. 28929. Nineteen paratypes, high in the same subzone as the type. Pit 2 of Gaster, by reservoir, near Hill Barn, North Lancing, N.E. of Worthing. 1915.

D. 29055. An asty, probably of this species, showing several ovicells. Senonian, zone of *A. quadratus*, subzone of *A. quadratus*. Pit 9 of Gaster, eastern pit, lane east of Charman Dean, N. of Broadwater, Worthing. 1916.

33. Pelmatopora saltdeanensis, Lang.

Pelmatopora saltdeanensis, sp. n.; Lang, 1916, pp. 103, 106; *A. quadratus*-zone, *E. depressa*-subzone; E. of Brighton, Sussex.

Pelmatopora saltdeanensis; Lang, 1919[4], pp. 214–7, 221, 224, 226, figs. 65–6 on p. 214.

Diagnosis.—*Pelmatopora* in which secondary aviculœcia replace the distal pair of apertural spines; the secondary aviculœcia are large, but slender and somewhat lengthened; there are 15–17 costæ; the orthœcial length is less than 1 mm.; the primary intercostal spaces are still slot-like, though hardly so long as in *P. lancingensis*; the asty is incrusting and unilaminar, and, though interœcial secondary tissue is well developed and plentiful, there is less than in *P. collium*.

Description.—Asty incrusting, unilaminar; œcia dimorphic.

(a) *Ephebœcia*. Orthœcia rather less than 1 mm. long, and rather less than ·5 mm. wide, elliptical with a slight tendency to parallelism of the sides ; extraterminal front-wall entirely concealed beneath interœcial secondary tissue, which is abundant and has more-or-less well-defined median lacunæ ; the intraterminal front-wall is much flattened, and consists of about fifteen to seventeen fairly well-spaced costæ, each of which bears primary, secondary, and tertiary pelmata and lateral fusions at the levels of the primary and secondary pelmata ; consequently there are two paired rows of perforations in the original median area of fusion ; the original intercostal spaces outside these are very short, but still slot-like and not circular ; the apertural bar is wide and low ; the apertural spines are invisible ; the apertures are sub-normal to normal. Secondary aviculœcia apparently are lengthened but hardly further developed than those of *P. danktonensis*. Primary aviculœcia on the whole sporadically distributed, but tending to a paired arrangement with one situated near each proximal-lateral corner of the orthœcial apertures.

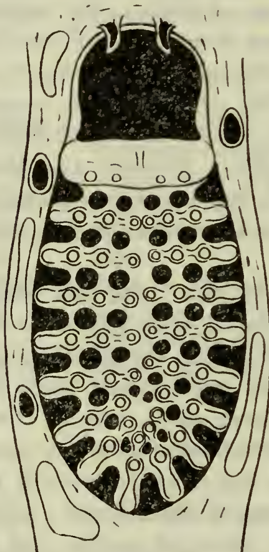
(b) *Neanœcia*. Orthœcia about ·66 mm. long and rather less than ·5 mm. wide, oval ; extraterminal front-wall somewhat obscured by interœcial secondary tissue, which, though abundant, has large irregularly-shaped lacunæ ; the intraterminal front-wall is rather flat and consists of about eleven costæ, each of which bears a primary pelma at about its middle, and a secondary pelma close to the mid-line ; there are lateral fusions at the levels of the primary pelmata, so that the median area of fusion bears a paired row of perforations ; a more-or-less developed median row of perforations shows that the tertiary pelmata have begun to develop in the mid-line, but these latter are not easily distinguished ; apertural spines four, more-or-less concealed by secondary circum-apertural tissue ; apertures normal. Aviculœcia sporadically distributed.

(c) *Ancestrœcium*. Differs from the neanœcia chiefly in having less interœcial secondary tissue, fewer costæ (ten), and a more arched intraterminal front-wall.

Distribution.—Senonian, zone of *A. quadratus*, subzone of *E. scutata* var. *depressa*. Sussex.

Type-specimen.—D. 28842.

Remarks.—It was remarked, under *Pelmatopora bidens*, that, after *P. brydonei*, the main lineage split into two developments, one in which the secondary aviculœcia were characterised by expansion and the other by extension; and that the latter development again split after *P. danktonensis* into a lineage represented by *P. bidens*–*P. lancingensis*, in which extension of the secondary aviculœcia was carried far, and one in which the secondary aviculœcia were not much extended, but in which catagenesis of the orthœcial



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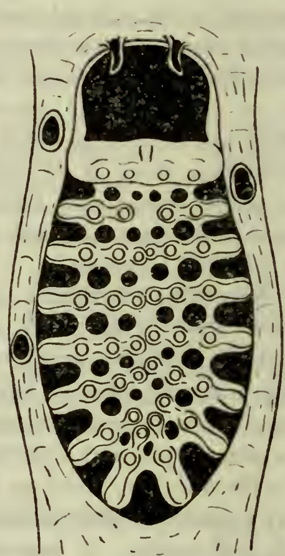

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Fig. 99.—*Pelmatopora saltdeanensis.* Diagram of an orthœcium, three primary, and a distal pair of secondary aviculœcia, from above. × about 75 diameters.

Fig. 100.—*Pelmatopora collium.* Diagram of an orthœcium, three primary, and a distal pair of secondary aviculœcia, from above. × about 75 diameters.

length and of the number of costæ appeared. *P. saltdeanensis* is the first term in this last lineage, and gives rise on the one hand to *P. promontoriorum*, which is unilaminar and erect, and to *P. collium*, in which the interœcial secondary tissue is still more abundant; and, in the line of increased catagenesis, to *P. ranunculoides* with its further developments, *P. lacuum* and *P. gyrinoides*.

It is noticeable in *P. saltdeanensis* how long the apertural spines persist, and how the distal pair seems to merge into the secondary aviculœcia, suggesting, in spite of the evidence of *P. brydonei*, that these structures are developments of the distal apertural spines.

FIGURES.—Text-fig. 99. Orthœcium with its secondary aviculœcia and three primary aviculœcia.

LIST OF SPECIMENS.

D. 28842. D. 28841. D. 28843–4. Type-specimen and three paratypes. Senonian, zone of *A. quadratus*, subzone of *E. scutata* var. *depressa*. Cliffs between the last groyne E. of Rottingdean Gap and Saltdean, E. of Brighton, Sussex. Collected by C. T. A. Gaster, Esq., and presented by him, 1915.

D. 28538. A paratype showing the ancestrœcium, and the neanastic and ephebastic stages. Senonian, [zone of *A. quadratus*]. S. of England. F. H. Butler. 1885.

D. 21171. An asty, probably of this species. Senonian, zone of *A. quadratus*. Compton, S.W. of Winchester, Hants. L. Treacher Collection. 1911.

34. Pelmatopora collium, Lang.

Pelmatopora collium, sp. n.; Lang, 1916, pp. 103, 106. *A. quadratus*-zone, [*O. pillula*-subzone]; North Lancing, Sussex.
Pelmatopora collium; Lang, 1919 [4], pp. 214–6, 221, figs. 68 on p. 214.

DIAGNOSIS.—*Pelmatopora* in which secondary aviculœcia replace the distal pair of apertural spines; the secondary aviculœcia are large, but slender and somewhat lengthened; there are about 15 costæ; the orthœcial length is less than 1 mm.; the primary intercostal spaces are still slot-like, though hardly as long as in *P. lancingensis*; the asty is incrusting and unilaminar, and interœcial secondary tissue is very abundant, has very slightly-developed lacunæ, or none, and stands out as a ridge considerably above the level of the very flat intraterminal front-wall.

DESCRIPTION.—The structure resembles that of *Pelmatopora saltdeanensis*, but the interœcial secondary tissue is more abundant, the costæ rather fewer, and the secondary aviculœcia appear at an earlier astogenetic stage than in *P. saltdeanensis*.

Distribution.—Senonian, zone of *A. quadratus*, subzone of *E. scutata* var. *depressa*. Sussex.

Type-specimen.—**D. 28824.**

Remarks.—See remarks under *Pelmatopora saltdeanensis.*

Figures.—Text-fig. 100. Orthœcium with its secondary aviculœcia and three primary aviculœcia.

LIST OF SPECIMENS.

D. 28824. D. 28825–7. Type-specimen and three paratypes. Senonian, zone of *A. quadratus*, subzone of *E. scutata* var. *depressa*. Pit 2 of Gaster, by the reservoir, near Hill Barn, North Lancing, N.E. of Worthing, Sussex. Collected by C. T. A. Gaster, Esq., and presented by him, 1915.

D. 28823. A paratype. Horizon, collection, and donation as the last. Cliffs between the last groyne E. of Rottingdean Gap and Saltdean, E. of Brighton, Sussex.

D. 28284. An asty, probably of this species. Horizon, locality, collection, and donation as the last.

35. Pelmatopora promontoriorum, Lang.

Pelmatopora promontoriorum, sp. n.; Lang, 1916, pp. 103, 106; *A. quadratus*-zone, [*O. pillula*-subzone]; North Lancing, Sussex.

Pelmatopora promontoriorum; Lang, 1919 [1], pp. 214–6, 221, fig. 67 on p. 214.

Diagnosis.—*Pelmatopora* in which secondary aviculœcia replace the distal pair of apertural spines; the secondary aviculœcia are large, but slender and very long, though not generally so elongated as in *P. lancingensis*; there are about 16 costæ; the orthœcial length is generally just less than 1 mm.; the primary intercostal spaces are still slot-like, though hardly as long as in *P. lancingensis*; the asty is erect and unilaminar, and the interœcial secondary tissue is well developed and plentiful, though there is less than in *P. collium.*

Description.—The structure resembles that of *Pelmatopora saltdeanensis*, but the asty is erect instead of incrusting.

Distribution.—Senonian, zone of *A. quadratus*, especially in the subzone of *O. pillula* and just below it. Sussex.

Type-specimen.—**D. 28930.**

Remarks.—See under *Pelmatopora saltdeanensis.*

Figures.—Plate VI, fig. 10. Part of the type-specimen, showing two complete orthœcia and the distal end of a third, each with its distal pair of secondary aviculœcia, and six primary aviculœcia. × about 27 diameters.

LIST OF SPECIMENS.

All collected by C. T. A. Gaster, Esq., from the Senonian, zone of *A. quadratus* in Sussex, and presented by him in the years mentioned.

D. 28806–7. D. 28874. D. 28877. Four paratypes. Subzone of *E. scutata* var. *depressa*. Cliffs between the last groyne E. of Rottingdean Gap and Saltdean, E. of Brighton. 1915.

D. 28951–2. Two paratypes. Subzone of *E. scutata* var. *depressa.* Pit 3 of Gaster, E. of Boundstone Lane, S. of Lancing Ring, N.E. of Worthing. 1916.

D. 28959–61. Three paratypes, from the same horizon as the last. Pit 4 of Gaster, W. of Boundstone Lane, S. of Lancing Ring, N.E. of Worthing. 1916.

D. 28930. D. 28836–40. D. 28849–52. D. 28871–3. D. 28931–2. Type-specimen and fourteen paratypes. Subzone of *E. scututa* var. *depressa*, upper part. Pit 2 of Gaster, near the reservoir by Hill Barn, North Lancing, N.E. of Worthing. 1915–16.

D. 28820–2. Three paratypes. Subzone of *O. pillula.* Cliffs E. of Old Nore point, W. of Newhaven. 1915.

D. 28876. Paratype, from the same horizon as the last. E. side of Telscombe cliff-staircase, E. of Brighton. 1915.

D. 28972. Paratype. Subzone of *A. quadratus.* Pit 8 of Gaster, between Upton Lane (Lambley's Lane) and lane E. of Charman Dean, N. of Broadwater, Worthing. 1916.

D. 28967. Paratype. Horizon, donation, and collection as last. Pit 7 of Gaster, Upton Lane (Lambley's Lane), Sompting, N.E. of Worthing. 1916.

36. Pelmatopora ranunculoides, Lang.

Pelmatopora ranunculoides, sp. n.; Lang, 1916, pp. 103, 106; *A. quadratus*-zone, *E. depressa*-subzone; E. of Brighton, Sussex.

Pelmatopora ranunculoides; Lang, 1919[4], pp. 214–7, 221, figs. 60–70 on p. 214.

Diagnosis.—*Pelmatopora* with secondary aviculœcia replacing the distal pair of apertural spines; secondary aviculœcia large and elongate; costæ 12–15; original intercostal spaces circular rather than slot-like; orthœcial length about ·8 mm; asty incrusting.

Description.—Asty unilaminar, incrusting; œcia dimorphic. Orthœcia rather more than ·8 mm. long and about ·4 mm. wide, oval to elliptical; extraterminal front-wall entirely concealed by interœcial secondary tissue, which is abundant and in which the lacunæ are shallow; the intraterminal front-wall is flat and formed of about thirteen somewhat widely-placed costæ, each of which bears primary, secondary, and, near the mid-line, tertiary pelmata, and lateral fusions at the levels of the primary and secondary pelmata; consequently there are two paired rows of perforations on each side of the middle line; the original intercostal spaces are

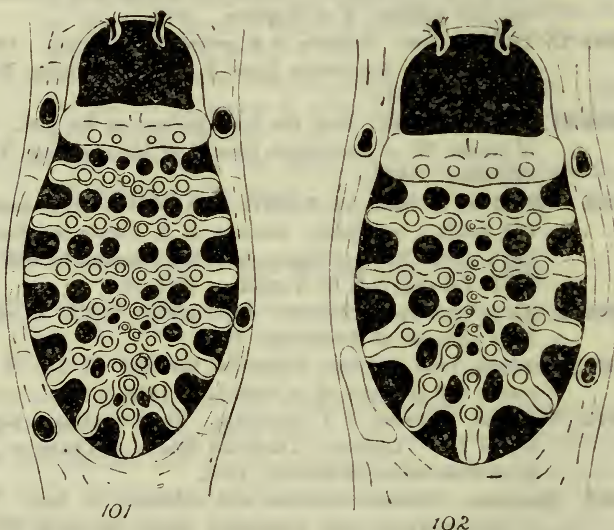


Fig. 101.—*Pelmatopora ranunculoides.* Diagram of an orthœcium, four primary and a distal pair of secondary aviculœcia, from above. × about 75 diameters.

Fig. 102.—*Pelmatopora gyrinoides.* Diagram of an orthœcium, three primary and a distal pair of secondary aviculœcia. from above. × about 75 diameters.

circular rather than slot-like, and so appear as a third paired row of perforations lying outside the other two rows; apertural bar wide and low; apertural spines invisible; apertures sub-normal to normal. Secondary aviculœcia rather large and elongate. Primary aviculœcia generally arranged in pairs, one at each proximal-lateral corner of the orthœcial apertures, and occasionally a few extra ones sporadically distributed in the interœcial secondary tissue; rather large with blunt (probably from wear) somewhat elongate apertures.

Distribution.—Senonian, zone of *A. quadratus,* subzones of *E. scutata* var. *depressa* and *O. pillula*; occasionally in the zone of *Marsupites.*

Type-specimen.—**D. 28856.**

Remarks.—*Pelmatopora ranunculoides* continues the line of evolution of *P. saltdeanensis*, in which there is a catagenesis in orthœcial length and in the number of costæ; it is followed by *P. gyrinoides* in which this tendency is carried still further. Thus, *P. saltdeanenis–P. ranunculoides–P. gyrinoides* are consecutive terms in a lineage, having orthœcial lengths of rather less than 1 mm., rather more than ·8 mm., and rather less than ·8 mm., respectively, and 15–17, 12–15, and 10 costæ, respectively. *P. lacuum* is an erect unilaminate from of *P. ranunculoides.*

Figures.—Text-fig. 101. Orthœcium with its secondary aviculœcia and four primary aviculœcia.

Plate VI, fig. 11. Part of the type-specimen, showing two complete orthœcia, each with its distal pair of secondary aviculœcia, and eight primary aviculœcia. × about 27 diameters.

LIST OF SPECIMENS.

D. 28861. Paratype. Senonian, zone of *Marsupites.* Brighton, Sussex. Collected by C. T. A. Gaster, Esq., and presented by him, 1915.

D. 10995. Two fragments of an asty. Senonian, zone of *A. quadratus.* Rottingdean, E. of Brighton. Presented by H. D. Schloss, Esq., 1908.

The following were all collected by C. T. A. Gaster, Esq., from the Senonian, zone of *A. quadratus*, in Sussex, and presented by him in the year mentioned:—

D. 28280. Saltdean, E. of Brighton. 1915.

D. 28279. Between Rottingdean and Saltdean, E. of Brighton. 1915.

D. 28875. Subzone of *E. scutata* var. *depressa.* Cliffs west side of Saltdean bottom, E. of Brighton. 1915.

D. 28845–48. Four specimens from the same horizon as the last. Cliffs between the last groyne E. of Rottingdean Gap and Saltdean, E. of Brighton. 1915.

D. 28856. D. 28857–9. Type-specimen and three paratypes from the same horizon as the last. 1915.

D. 28864. Paratype. Subzone of *E. scutata* var. *depressa*, upper part. Pit 2 of Gaster, near reservoir by Hill Barn, North Lancing, N.E. of Worthing. 1915.

D. 28860. Paratype. Subzone of *O. pillula*. Pit on East Hill, Rottingdean. E. of Brighton. 1915.

37. Pelmatopora lacuum, Lang.

Pelmatopora lacuum, sp. n.; Lang, 1916, pp. 103, 106; *A. quadratus*-zone [*O. pillula*-subzone]; North Lancing, Sussex.

Pelmatopora lacuum; Lang, 1919[4], pp. 214–6, 221, fig. 71 on p. 214.

Diagnosis.—*Pelmatopora* with secondary aviculœcia replacing the distal pair of apertural spines; secondary aviculœcia large and elongate; costæ 12–15; original intercostal spaces circular rather than slot-like; orthœcial length about ·8 mm.; asty erect and unilaminar.

Description.—As *Pelmatopora ranunculoides*, but with an erect unilaminar asty.

Distribution.—Senonian, zone of *A. quadratus*, subzone of *E. scutata* var. *depressa*. Sussex.

Type-specimen.—**D. 28862.**

Remarks.—See remarks under *Pelmatopora ranunculoides*.

LIST OF SPECIMENS.

D. 28862–63. D. 28838–43. Type-specimen and seven paratypes, of which **D. 28938** and **D. 28942** show ovicells. Senonian, zone of *A. quadratus*, subzone of *E. scutata* var. *depressa*. Pit 2 of Gaster, near reservoir by Hill Barn, North Lancing, N.E. of Worthing, Sussex. Collected by C. T. A. Gaster, Esq., and presented by him, 1915 and 1916.

D. 28935–7. D. 28853–5. Six specimens from the same horizon, locality, and collection as the type. 1915, 1916.

38. Pelmatopora gyrinoides, Lang.

Pelmatopora gyrinoides, sp. n.; Lang, 1916, pp. 103, 106; *A. quadratus*-zone; E. of Brighton, Sussex.

Pelmatopora gyrinoides; Lang, 1919[4], pp. 214–6, fig. 72 of p. 214.

Diagnosis.—*Pelmatopora* with secondary aviculœcia replacing the distal pair of apertural spines; secondary aviculœcia large [and long]; costæ about 9.

Description.—Asty incrusting, unilaminar; œcia dimorphic. Orthœcia about ·8 mm. long and a little less than ·5 mm. wide, oval; extraterminal front-wall entirely hidden by interœcial secondary tissue, which, however, is not very abundant and has median lacunæ; the intraterminal front-wall is flattened and consists of about nine rather widely-spaced costæ, each of which bears at least primary and secondary pelmata and lateral fusions at the levels of these, so that there are two paired rows of perforations in the original median area of fusion; the original intercostal spaces are reduced to a third paired row of perforations lying outside the other rows; apertural bar wide and low; apertural spines invisible; apertures very large, sub-normal in shape. Secondary aviculœcia large. Primary aviculœcia sporadically distributed with a tendency to a paired arrangement, with one near each proximal-lateral corner of the orthœcial apertures.

Distribution.—Senonian, zone of *A. quadratus*. Saltdean, W. of Newhaven, Sussex.

Type-specimen.—D. 28270. Collected by C. T. A. Gaster, Esq., and presented by him, January 1915.

Remarks.—In *Pelmatopora gyrinoides*, the catagenesis exhibited by the lineage *P. danktonensis*–*P. saltdeanensis*–*P. ranunculoides* is carried to an extreme; the number of costæ has sunk from about sixteen to nine; and the orthœcial length from about 1 mm. to ·8 mm., without a proportional decrease in breadth, so that the orthœcial shape has passed from an ellipse with somewhat parallel sides to an oval. *P. gyrinoides* differs from *P. ranunculoides* mainly in its fewer costæ, and was probably derived directly from that form, though otherwise its intraterminal front-wall does not appear to be quite so advanced.

Figures.—Text-fig. 102. Orthœcium with its pair of secondary aviculœcia and three primary aviculœcia.

Plate VI, fig. 12. Part of the type-specimen, showing a complete orthœcium with its much worn pair of secondary aviculœcia, and five primary aviculœcia. × about 27 diameters.

Specimens.—The type-specimen. Distribution and collection as above.

II. SANDALOPORA, Lang, 1916.

Sandalopora, gen. nov.; Lang, 1916, pp. 101, 107–8.
Sandalopora; Lang, 1919[4], pp. 192, 197, 199, 201, 204, 208–9, 218, 220, 222–4, 226.

Diagnosis.—Pelmatoporinæ in which the secondary aperture is represented only by an imperfect proximal shield formed by a median projection of the apertural bar; probably this median projection ultimately fused with the proximal pair of apertural spines.

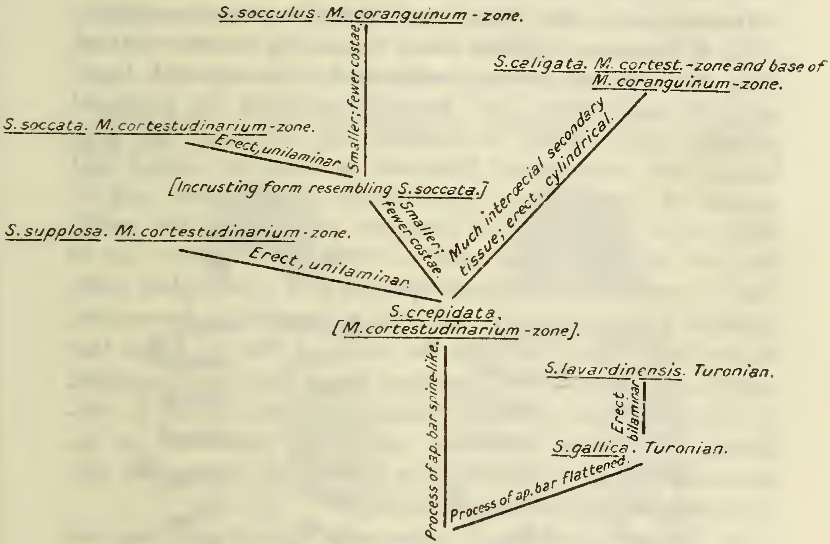
Distribution.—Turonian; and Senonian (Coniacian and Lower Santonian).

Genotype.—*Sandalopora soccata*, Lang.

Remarks.—Though *Pelmatopora* has not yet been found below the Senonian, it is reasonable to suppose that it must have lived in Turonian times and given rise to *Sandalopora*, two species of which are found in the Turonian, while the rest occur in the lowest Senonian beds. *Sandalopora* resembles the more primitive forms of *Pelmatopora*, but has a median projection on the apertural bar. Such a projection is known in other genera of the Pelmatoporidæ as well as in other families, and is generally, if not always, fused to the proximal pair of apertural spines, forming a tripod-shaped proximal shield of a secondary aperture. It is probable, then, that the same fusion took place in *Sandalopora*, but specimens thus perfectly preserved have not yet been found.

The species of *Sandalopora* readily fall into two groups, according as the median process of the apertural bar is flattened or spine-like. The former group comprises *S. gallica* and its bilaminar derivative *S. lavardinensis*, both from the French Turonian. The other species are found in the lowest Senonian of England, and may have been derived from *S. crepidata*. If for the moment the colonial habit be disregarded, three of the remaining species—namely, *S. supplosa–S. soccata–S. socculus*—may be held to form a lineage catagenetic in orthœcial length and in the number of costæ. In all cases the pelmata remain close to the mid-line, as in the most primitive forms of *Pelmatopora*. To establish this lineage, however, it is necessary to suppose an incrusting unilaminar form corresponding to *S. soccata*. The table below should make this clear. *S. caligata* remains to be considered. This species retains the primitive orthœcial length and number of costæ, assumes an erect cylindrical colonial habit, and develops much interœcial secondary tissue. It forms, therefore, a separate lineage derived from *S. crepidata.*

Table showing supposed phylogeny of *Sandalopora.*



Key to the Species of *Sandalopora.*

A. Median process of the apertural bar flattened into a proximal shield.
- I. Incrusting, unilaminar (fig. 103) .... 1. *S. gallica.*
- II. Erect, bilaminar.. 2. *S. lavardinensis.*

B. Median process of the apertural bar spiniform.
- I. Little or no interœcial secondary tissue.
  - *a.* Orthœcial length about ·8 mm; costæ 15–17.
    - 1. Asty incrusting, unilaminar .... 3. *S. crepidata.*
    - 2. Asty erect, unilaminar (fig. 104) .... 4. *S. supplosa.*
  - *b.* Orthœcial length about ·66 mm.; costæ about 14; erect, unilaminar .... 5. *S. soccata.*
  - *c.* Orthœcial length about ·5 mm.; costæ about 10; incrusting, unilaminar (fig. 105) .... 6. *S. socculus.*
- II. A considerable amount of interœcial secondary tissue; erect, cylindrical (fig. 106) .... 7. *S. caligata.*

1. Sandalopora gallica, Lang.

Sandalopora gallica, sp. n.; Lang, 1916, p. 108; Turonian; Lavardin, France.
Sandalopora gallica, Lang; Lang, 1919[4], pp. 201, 208–9, 218, 220, 223–4, 226.

DIAGNOSIS.—*Sandalopora* with the median process of the apertural bar much flattened and forming a wide proximal shield; asty incrusting and unilaminar.

DESCRIPTION.—Asty incrusting, unilaminar; œcia dimorphic.

(a) *Ephebœcia.*—Orthœcia about ·8 mm. long and about ·4 mm. wide, elliptical and rather parallel-sided; extraterminal front-wall of small extent and generally concealed by interœcial secondary tissue, which is abundant, but sometimes has large lacunæ; the intraterminal front-wall is somewhat arched, and consists of about fifteen rather widely-spaced costæ, each of which bears a pelma at its distal end and close to the middle line, and is firmly united with its fellows in a median line of fusion; apertural bar produced upwards as a wide median shelf, flattened proximo-distally, and with a more-or-less pronounced median seam, which indicates the fusion of the two costæ that compose the apertural bar; apertural spines four, much concealed by circum-apertural secondary tissue; apertures normal to sub-circular. Aviculœcia numerous, sporadically distributed in the interœcial secondary tissue, varying considerably in size, and with somewhat elongate and pointed apertures.

(b) *Neanœcia.*—Orthœcia rather more than ·5 mm. long and about ·25 mm. wide, oval; extraterminal front-wall of small extent and little, if at all, concealed by interœcial secondary tissue; the intraterminal front-wall is well arched and consists of about nine to eleven costæ, each of which bears a very small pelma (it might be considered a pelmatidium) at its distal end, and is united with its fellows in a median line of fusion; apertural bar produced vertically in as wide a proximal shield as that of the ephebœcia; apertural spines four; apertures sub-normal to normal. Aviculœcia fairly numerous, sporadically distributed, and small.

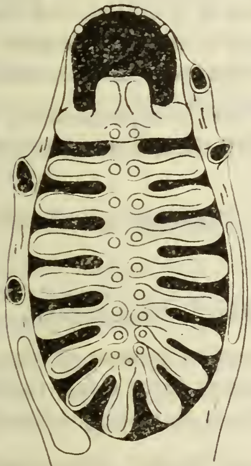
DISTRIBUTION.—Turonian. Lavardin, S.E. of Montoire, Loir-et-Cher, France.

TYPE-SPECIMEN.—D. 28422. In exchange with Mr. F. Canu. 1914.

FIGURES.—Text-fig. 103. Orthœcium and four aviculœcia.

Remarks.—*Sandalopora gallica* and its bilaminar erect derivative, *S. lavardinensis* are sharply distinguished from the other species of the genus by the median process of the apertural bar being flat and wide, instead of narrow and spiniform. This character is firmly established in the early stages of *S. gallica*, and nothing intermediate between it and the spiniform process is observable. Unfortunately, the ancestrœcium, though present in the type-specimen of *S. gallica*, is not well enough preserved for the detailed characters to be clearly determined, and the shape of the process of its apertural bar is not evident.

Specimens.—The type-specimen. Distribution and collection as above.



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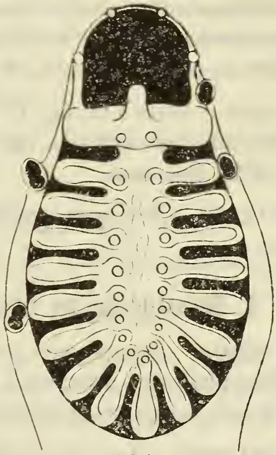

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Fig. 103.—*Sandalopora gallica.* Diagram of an orthœcium and four aviculœcia, from above. × about 75 diameters.

Fig. 104.—*Sandalopora supplosa.* Diagram of an orthœcium and four aviculœcia, from above. × about 75 diameters.

2. Sandalopora lavardinensis, Lang.

Sandalopora lavardinensis, sp. n.; Lang, 1916, p. 108; Turonian; Lavardin, France.

Sandalopora lavardinensis, Lang; Lang, 1919[4], pp. 201, 208–9, 220, 223, figs. 21–3 on p. 201.

Diagnosis.—*Sandalopora* in which the median process of the apertural bar is much flattened and forms a wide proximal shield; asty erect and bilaminar.

Description.—As *Sandalopora gallica*, but with a bilaminar erect asty and slightly smaller orthœcia (about ·7 mm. long).

Distribution.—Turonian. Lavardin, S.E. of Montoire, Loir-et-Cher, France.

Type-specimen.—**D. 28421.** In exchange with Mr. F. Canu. 1914.

Remarks.—*Sandalopora lavardinensis* appears to be a direct descendant of *S. gallica*, being more advanced in respect of colonial habit. It is interesting that the orthœcia of *S. lavardinensis* are somewhat shorter than those of *S. gallica*, and thus the lineage shows a tendency to catagenesis in orthœcial length. The lineage *S. supplosa–S. soccata–S. socculus* shows the same tendency.

Figures.—Plate VII, fig. 1. Part of the type-specimen, showing three complete orthœcia, parts of others, and eleven aviculœcia. × about 27 diameters.

Specimens.—The type-specimen. Distribution and collection as above.

3. **Sandalopora crepidata** *, new species.

Diagnosis.—*Sandalopora* with median process of the apertural bar spiniform; interœcial secondary tissue scanty; orthœcia about ·8 mm. long; costæ about 15; asty incrusting, unilaminar.

Description.—Asty incrusting, unilaminar; œcia dimorphic. Orthœcia about ·8 mm. long and ·45 mm. wide, elliptical; extraterminal front-wall well developed proximally, though sometimes hidden by the aviculœcia and, to a small extent, by a very scanty interœcial secondary tissue; intraterminal front-wall well arched, consisting of fifteen or sixteen somewhat widely-spaced costæ, each with a pelma at its distal end close to the mid-line; apertural bar wider than the normal costæ, and bearing a slight, spiniform, median projection; apertures normal to super-normal; apertural spines four and not at all enlarged. Aviculœcia numerous,

* *Crepidatus*—" Wearing soles." The orthœcia are shaped like a sole.

sporadically distributed, small, borne on short tubular bases, with constricted blunt apertures.

Distribution.—Senonian, Coniacian, zone of *M. cortestudinarium*, or Santonian, base of zone of *M. coranguinum* (probably the former). Chatham, Kent.

Type-specimen.—**D. 29069.** W. Gamble collection. 1898.

Remarks.—In considering the phylogeny of *Sandalopora* in a former publication (Lang, 1919[4], p. 209), it was assumed that an incrusting form resembling *S. supplosa* existed, from which that species as well as the forms *S. soccata*, *S. socculus*, and *S. caligata* could be derived. Such a form has now been found, and is here described as *S. crepidata*.

Figures.—Plate VII, fig. 2. Part of the type-specimen, showing four complete orthœcia, parts of others, and twenty-three aviculœcia. × about 27 diameters.

Specimens.—The type-specimen. Distribution and collection as above.

4. Sandalopora supplosa, Lang.

Sandalopora supplosa, sp. n.; Lang, 1916, p. 108; *M. cortestudinarium*-zone; Cuckmere Haven, Sussex.

Sandalopora supplosa, Lang; Lang, 1919[4], pp. 209, 223.

Diagnosis.—*Sandalopora* with the median process of the apertural bar spiniform; little or no interœcial secondary tissue; orthœcial length ·8 mm.; costæ about 16; asty erect, unilaminar.

Description.—Asty erect, unilaminar; œcia dimorphic. Orthœcia about ·8 mm. long and about ·5 mm. wide, elliptical; extraterminal front-wall of small extent, except proximally where it may be fairly well developed, or somewhat obscured by the numerous aviculœcia, but hardly obscured by interœcial secondary tissue, which is absent or very scanty; the intraterminal front-wall is well arched and consists of about sixteen rather widely-spaced costæ, each of which bears a pelma at its distal end and is firmly united to its neighbours in a median line of fusion; apertural bar wide, bearing a spiniform median process, which probably fuses with the proximal pair of apertural spines to form a tripod-like proximal shield; apertural spines four in number; apertures normal, rather large. Aviculœcia numerous, sporadically distributed in the interœcial valleys, small, consisting of somewhat blunt, slightly elongate, and constricted apertures borne on long tubular bases.

Distribution.—Senonian, zone of *M. cortestudinarium.* Between Hope Gap and Cuckmere Haven, Sussex.

Type-specimen.—**D. 28887.** Collected by C. T. A. Gaster, Esq., and presented by him, 1915.

Remarks.—*Sandalopora supplosa* was directly derived from *S. crepidata*, of which it is a free unilaminar development.

Figures.—Text-fig. 104. Orthœcium and four aviculœcia.

Specimens.—The type-specimen. Distribution and collection as above.

5. Sandalopora soccata, Lang.

Sandalopora soccata, sp. n.; Lang, 1916, pp. 108, 107; *M. cortestudinarium*-zone; Cuckmere Haven, Sussex.
Sandalopora soccata, Lang; Lang, 1919[4], pp. 201, 208–9, 223, fig. 73 on p. 208.

Diagnosis.—*Sandalopora* with the median process of the apertural bar spiniform; little or no interœcial secondary tissue; orthœcial length about ·66 mm.; costæ about 14; asty erect, unilaminar.

Description.—As *Sandalopora supplosa*, except that the orthœcia are somewhat smaller and the costæ fewer.

Distribution.—Senonian, zone of *M. cortestudinarium*, possibly extending upwards into the base of the zone of *M. coranguinum.* S. of England.

Type-specimen.—**D. 28257.**

Remarks.—*Sandalopora soccata* is intermediate between *S. crepidata* and *S. socculus*, and lies in a lineage exhibiting catagenesis in orthœcial length and in the costæ. It is significant that, while *S. soccata* and probably *S. crepidata* are characteristic of the *M. cortestudinarium*-zone, if not confined to it, the extreme term in the lineage—namely, *S. socculus*—occurs in the higher zone of *M. coranguinum.*

Figures.—Plate VII, fig. 3. Part of the type-specimen, showing three orthœcia, parts of others, and fifteen aviculœcia. × about 27 diameters.

LIST OF SPECIMENS.

D. 25158. Paratype. Senonian, base of zone of *M. cortestudinarium*. Nash Mills, S.E. of Boxmoor, Herts. F. Möckler collection. 1912.

D. 25038. Paratype. Senonian, zone of *M. cortestudinarium*. Seaford, Sussex. F. Möckler collection. 1912.

D. 28257. Type-specimen. Senonian, zone of *M. cortestudinarium*. Between Hope Gap and Cuckmere Haven, Sussex. Collected by C. T. A. Gaster, Esq., and presented by him, 1915.

D. 346. D. 11119. Paratypes. Senonian, zone of *M. cortestudinarium* or base of *M. coranguinum*. Chatham, Kent. W. Gamble collection. 1893, 1901.

6. Sandalopora socculus, Lang.

Sandalopora socculus, sp. n.; Lang, 1916, p. 108; *M. coranguinum*-zone; Gillingham, Kent.

Sandalopora socculus, Lang; Lang, 1919[4], pp. 209, 222.

Diagnosis.—*Sandalopora* with the median process of the apertural bar spiniform; little or no interœcial secondary tissue; orthœcial length about ·5 mm.; costæ about 10; asty incrusting, unilaminar.

Description.—As *Sandalopora soccata*, but the asty is incrusting, the orthœcial length is about ·5 mm. and breadth about ·3 mm., and the costæ are but nine or ten in number.

Distribution.—Senonian, zone of *M. coranguinum*. Gillingham, N.E. of Chatham, Kent.

Type-specimen.—**D. 24538.** W. Gamble collection. 1911.

Remarks.—See remarks under *Sandalopora soccata*.

Figures.—Text-fig. 105. Diagram of an orthœcium and four aviculœcia, from above. × about 75 diameters.

Plate VII, fig. 4. The type-specimen, consisting of seven complete orthœcia and eleven aviculœcia. × about 27 diameters.

Specimens.—The type-specimen. Distribution and collection as above.

7. Sandalopora caligata, Lang.

Sandalopora caligata, sp. n.; Lang, 1916, p. 108; Lower Senonian; Chatham, Kent.

Sandalopora caligata, Lang; Lang, 1919[4], pp. 201, 209, 222.

DIAGNOSIS.—*Sandalopora* with the median process of the apertural bar spiniform; a considerable amount of interœcial secondary tissue; orthœcial length about ·8 mm.; costæ about 18; asty erect, cylindrical.

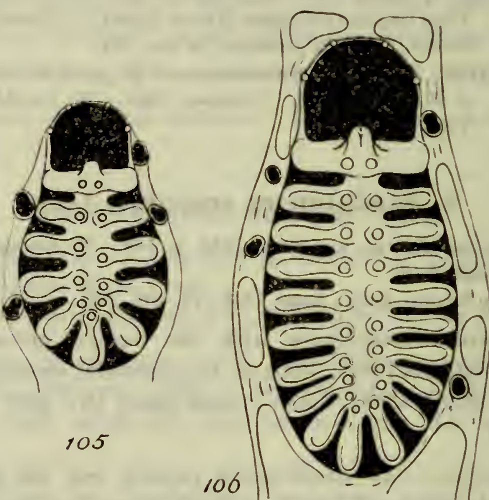


Fig. 105.—*Sandalopora socculus.* Diagram of an orthœcium and four aviculœcia, from above. × about 75 diameters.

Fig. 106.—*Sandalopora caligata.* Diagram of an orthœcium and four aviculœcia, from above. × about 75 diameters.

DESCRIPTION.—Asty erect, cylindrical; œcia dimorphic. Orthœcia about ·8 mm. long and about ·45 mm. wide, elliptical, with somewhat parallel sides; extraterminal front-wall entirely concealed beneath an abundant interœcial secondary tissue, which has, however, large, shallow, median lacunæ; the intraterminal front-wall is well arched and consists of about eighteen somewhat widely-spaced costæ, each of which bears a pelma at its distal end close to the mid-line, and is firmly united with its fellows in a median line of fusion; apertural bar somewhat wider than the normal costæ, produced medianly into a spine-like process; apertures normal; apertural spines four in number, tending to be overwhelmed by secondary circum-apertural tissue. Aviculœcia numerous, small, sporadically distributed, and with blunt apertures.

Distribution.—Senonian, zone of *M. cortestudinarium* and *M. coranguinum.*

Type-specimen.—D. 2639.

Remarks.—*Sandalopora caligata* has developed along a line different from that followed by *S. soccata* and *S. socculus.* It may, with these two species, have been derived from *S. crepidata*; but, instead of exhibiting catagenesis in orthœcial length and in number of costæ, it remains of about the same size as *S. supplosa* and even increases slightly its number of costæ; the asty also advances in habit, becoming erect and cylindrical, and acquires a considerable amount of interœcial secondary tissue.

Figures.—Text-fig. 106. Orthœcium and four aviculœcia.

Plate VII, fig. 5. Part of the type-specimen, showing five orthœcia, one of which has an ovicell, and more than a dozen aviculœcia. × about 27 diameters.

LIST OF SPECIMENS.

D. 28258. Paratype. Senonian, zone of *M. cortestudinarium.* Chalk-pit west of large pit, Offham Hill, Lewes, Sussex. Collected by C. T. A. Gaster, Esq., and presented by him, 1915.

D. 28259. Paratype. Horizon, collection, and donation as the last. Between Hope Gap and Cuckmere Haven, Sussex.

D. 2639. D. 2632. D. 2811. Type-specimen and two paratypes. The type-specimen shows endozoœcial ovicells. Senonian, zone of *M. cortestudinarium* or base of the zone of *M. coranguinum.* Chatham, Kent. G. R. Vine collection. 1893.

D. 348–50. D. 4043. D. 4191. D. 4223–4. D. 11123. D. 27906–7. D. 28158. Eleven paratypes. From the same horizon and locality as the type-specimen. W. Gamble collection. 1893, 1898, 1901.

D. 4108. An asty, probably of this species, from the same horizon and locality as the last. W. Gamble collection. 1898.

D. 24540. D. 24591. Two paratypes. Senonian, low in the zone of *M. coranguinum.* Gillingham, N.E. of Chatham, Kent. W. Gamble collection. 1911.

III. ICHNOPORA, Lang, 1916.

Escharipora [partim]; d'Orbigny, 1852, pp. 230, 232; 1854, p. 1097.
[*Semiescharipora* [partim]; d'Orbigny, 1853, p. 482; 1854, p. 1097.]
Eschara [partim]; Stoliczka, 1872, pp. 15, 53.
Collarina [partim]; Jullien, 1886, p. 607.
Cribrilina (*Cribrilina*) [partim]; Canu, 1900 [2], p. 447.
[*Cribrilina* (*Decurtaria*) [partim]; Canu, 1900 [2], 451.]
Escharipora [partim]; Canu, 1900 [2], p. 457.
Semiescharipora; Brydone, 1906, p. 300.
Steginopora [partim]; Brydone, 1910, pp. 481, 483.
Ichnopora, gen. nov.; Lang, 1916, pp. 101, 108–110.
Membraniporella [partim]; Brydone, 1917, pp. 50, 53.
Ichnopora; Lang, 1919 [3], p. 105.
Ichnopora; Lang, 1919 [4], pp. 192, 197, 199, 201–4, 207–8, 210, 212, 219, 220, 222–3.
? *Semiescharipora*; Lang, 1919 [4], p. 207.

Diagnosis.—Pelmatoporinæ in which the secondary aperture, in so far as it is present, consists of a proximal shield only, or may also have a distal shield; the former consists of a pair of aviculœcia situated one on each side of the aperture—and proximally, rather than distally; these aviculœcia are somewhat large in the most primitive species, and in the more advanced species increase greatly in size, are raised above the level of the aperture, and finally fuse with one another above the apertural bar, which takes no part in the formation of this proximal shield; the distal shield, if present, is formed by the fusion of the distal pair of apertural spines, which may be branched; the intraterminal front-wall typically bears one paired row of pelmata only, but sometimes the beginnings of a second row appear; the orthœcial apertures are neither tubular nor very wide.

Distribution.—Senonian, Coniacian, and Lower Santonian.

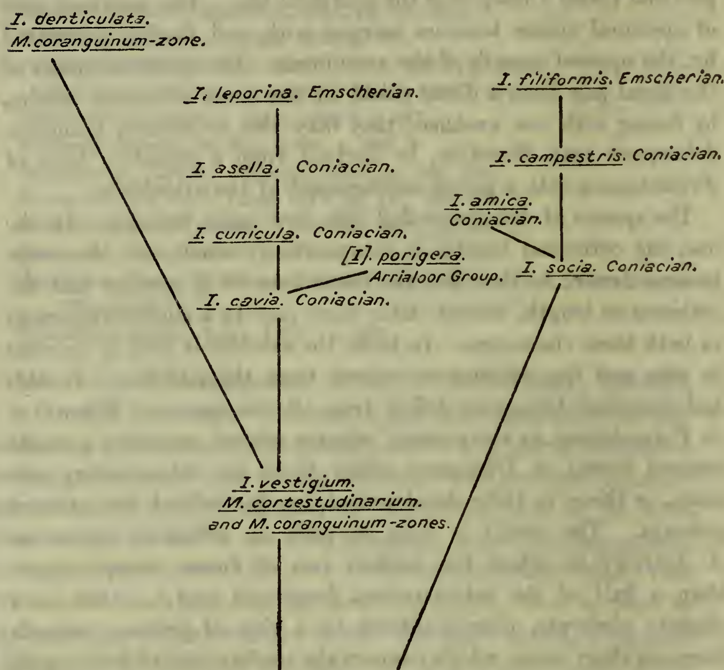
Genotype.—*Ichnopora vestigium*, Lang.

Remarks.—Certain primitive species of *Pelmatopora*, such as *P. d'orbignyi*, show occasionally as a tendency, or constantly as a character, a paired arrangement of aviculœcia at the orthœcial apertures, so that there is an aviculœcium near the lateral-proximal corners of each aperture. In *Ichnopora* this is always the case, and, even in the primitive species of *Ichnopora*, these aviculœcia are larger than those of *Pelmatopora*. In the more advanced species of *Ichnopora* the aviculœcia not only increase still more in size, but are raised upon pedicels, and, finally, each fuses with its pair and forms a hoop over the apertural bar. The proximal pair of apertural spines becomes merged with, and, finally, obliterated by, the upward growth of the aviculœcia. The apertural spines of the distal pair form a distal shield in the most advanced species, by fusing with one another; they may also be distally branched. *Ichnopora* may, therefore, be derived from a primitive form of *Pelmatopora* with a paired arrangement of the aviculœcia.

The species of *Ichnopora* fall into two main lineages. In the one, the orthœcial length is comparatively small and the costæ become fewer; in the other the costæ increase in number and the orthœcia in length, though later there may be a slight catagenesis in both these characters. In both, the aviculœcia tend to increase in size and the pelmata to retreat from the mid-line. In this last character *Ichnopora* differs from *Pelmatopora* as follows:—in *Pelmatopora*, as the primary pelmata retreat, secondary pelmata succeed them; in *Ichnopora* either there are no secondary pelmata, or these, in their development, lag far behind the primary pelmata. The result is seen in such an advanced species as *I. denticulata*, where the median area of fusion occupies more than a half of the intraterminal front-wall and is a flat, only slightly perforate, plate bordered by a ring of primary pelmata borne on short costæ, which connect the median area of fusion with the termen, and constitute the smaller half of the intraterminal front-wall. Secondary pelmata are poorly developed near the mid-line. *Pelmatopora* in a corresponding developmental stage would show the original median area of fusion perforated by two paired rows of pores, and secondary and tertiary pelmata on the inward continuations of the costæ, thus giving the whole intraterminal front-wall the appearance of a lattice-work with pelmata at the nodes.

The first main lineage consists of the species *I. socia–I. campestris–I. filiformis*, with *I. amica* as a development of *I. socia*. The second main lineage is based on *I. vestigium* and continues through *I. cavia–I. cunicula–I. asella* to *I. leporina*. *I. denticulata* is probably a direct development of *I. vestigium*. If [*I.*] *porigera* is an *Ichnopora* it is probably derived from *I. cavia*.

[*I.*] *dentata* is another species but doubtfully referred to *Ichnopora*, and, if included in this genus, its affinities are obscure. The following table expresses these relations :—



Key to the Species of *Ichnopora*.

A. Pelmata close to the mid-line.
- I. Costæ 17 to more than 20 ; orthœcial length about 1 mm.
  - *a.* Erect, unilaminar.
    - 1. Aviculœcia placed more proximally .... 1. [*I.*] *dentata.*
    - 2. Aviculœcia placed more distally (fig. 107)...... 2. *I. socia.*
  - *b.* Erect, bilaminar .... 4. *I. campestris.*
- II. Costæ 15 to 20 ; orthœcial length less than 1 mm.; erect, cylindrical .... 5. *I. filiformis.*

B. Pelmata close to the mid-line in some orthœcia, and somewhat separate in others ; orthœcial length less than 1 mm. ; incrusting, unilaminar (fig. 109)......... 6. *I. vestigium.*

C. Pelmata widely separated, and with occasional perforations in the median area of fusion, and occasional secondary pelmata (in a pelmatidial condition).

I. Costæ 15 to 20; orthœcial length about 1 mm. (fig. 108) .... 3. *I. amica.*

II. Costæ 10 to 15.

a. Aviculœcia do not fuse above the apertural bar.

1. Incrusting; aviculœcia very small and low ... 7. *I. cavia.*

2. Erect, unilaminar.

α. Aviculœcia small and low (fig. 110) .... 9. *I. cunicula.*

β. Aviculœcia large and fairly high (fig. 111)... 10. *I. asella.*

3. Erect, bilaminar.

α. Aviculœcia rather small and low .... 8. [*I.*] *porigera.*

β. Aviculœcia large and very high (fig. 112) ... 11. *I. leporina.*

b. Aviculœcia fuse above the apertural bar (fig. 113) .... 12. *I. denticulata.*

1. [Ichnopora] dentata (d'Orbigny).

Semiescharipora dentata, d'Orb., 1851; d'Orbigny, 1852, pl. 718, figs. 5–8; 1853, p. 482; 1854, p. 1097; Sénonien; Meudon, près de Paris, Sainte-Colombe (Manche), Mancy (Marne).

Cribrilina (*Decurtaria*) *dentata* (d'Orb.); Canu, 1900 [2], p. 451; Sénonien.

Semiescharipora dentata, D'Orb.; Brydone, 1906, p. 300.

? *Ichnopora dentata* (d'Orbigny); Lang, 1916, p. 109; Senonian; Meudon and Sainte Colombe.

? *Ichnopora* [*Semiescharipora*] *dentata* (d'Orbigny); Lang, 1919 [4], p. 207.

Diagnosis.—[*Ichnopora*] having the pelmata close to the midline; costæ more than 20; orthœcial length about 1 mm.; asty erect, unilaminar; aviculœcia placed proximally with regard to the aperture.

Distribution.—Senonian, France.

Type-specimen.—That figured by d'Orbigny, 1852, pl. 718, fig. 6, is hereby selected.

Remarks.—With d'Orbigny's description and figure alone to elucidate this species, it is difficult to assign it with certainty to *Ichnopora*. On the other hand, if not an *Ichnopora*, it is still more difficult to place. D'Orbigny quotes Meudon as one of its localities, and the horizon of the Meudon Chalk is far above that of any known *Ichnopora*. Since, however, other localities are mentioned, it is possible that d'Orbigny's Meudon form was different from the rest, and that his figure represents a specimen from some other locality.

Specimens.—None in the Collection.

2. Ichnopora socia, Lang.

Ichnopora socia, sp. n.; Lang, 1916, p. 109; Coniacian; Fécamp, France.
Ichnopora socia, Lang; Lang, 1919[4], pp. 207, 208, 222, fig. 79 on p. 208.

Diagnosis.—*Ichnopora* with the pelmata close to the mid-line; costæ about 18; orthœcial length about 1 mm.; asty erect, unilaminar; aviculœcia laterally placed with regard to the aperture.

Description.—Asty erect, unilaminar; œcia dimorphic. Orthœcia about 1 mm. long and ·4 mm. wide, elliptical, with a tendency to parallelism of the sides; extraterminal front-wall of small extent and largely concealed by aviculœcia and interœcial secondary tissue, which has, however, large median lacunæ; intraterminal front-wall somewhat arched and consisting of about eighteen somewhat widely-spaced costæ, each of which bears a pelma at its distal end and close to the mid-line, and is firmly united with its neighbours in a median band of fusion; in some cases there are lateral costal fusions at the pelmata and, consequently, perforations in the median area of fusion; apertural bar wide and flat, with slight median ridge; aperture normal to somewhat supernormal; apertural spines four in number and small, but the proximal pair becomes involved in the upward growth of the aviculœcia and generally is invisible, being obliterated by this upgrowth. Aviculœcia almost entirely confined to the large apertural pair, but occasionally a small sporadic aviculœcium appears in the interœcial secondary tissue; the apertural aviculœcia grow to some height, and are then directed distally and upwards, but do not fuse above the apertural bar; the apertures have sharply pointed, somewhat produced, triangular rostra.

Distribution.—Senonian, Coniacian. Fécamp, N.E. of Le Havre, Seine-Inférieure, France.

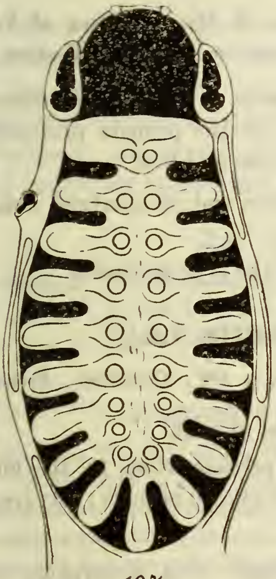
Type-specimen.—D. 28479.

Remarks.—*Ichnopora socia* lies at the base of that lineage of

Ichnopora in which the orthœcial length and number of costæ are at first increased. The position of the pelmata close to the mid-line, the comparatively small size of the aviculœcia, which show no tendency to fusion with one another, and the colonial habit are all primitive characters.

Figures.—Text-fig. 107. Orthœcium with its two apertural aviculœcia and a sporadic aviculœcium.

Plate VII, fig. 6. Part of the type-specimen, showing two complete orthœcia each with its apertural pair of aviculœcia and five sporadic aviculœcia. × about 27 diameters.



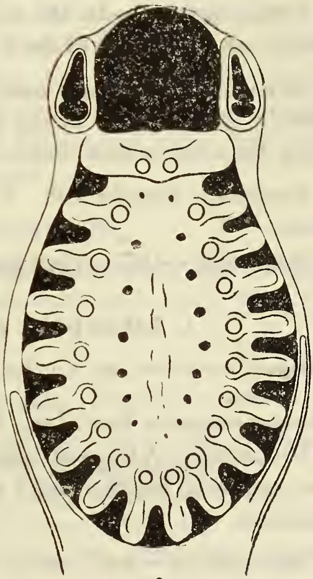


Fig. 107.—*Ichnopora socia.* Diagram of an orthœcium with its apertural pair of aviculœcia and a sporadic aviculœcium, from above. × about 75 diameters.

Fig. 108.—*Ichnopora amica.* Diagram of an orthœcium with its apertural pair of aviculœcia, from above. × about 75 diameters.

LIST OF SPECIMENS.

D. 28479. D. 28478. Type-specimen and paratype. Coniacian. Fécamp, N.E. of Le Havre, Seine-Inférieure, France. In exchange with Mr. F. Canu. 1914.

3. Ichnopora amica, Lang.

Ichnopora amica, sp. n.; Lang, 1916, pp. 109, 110; Coniacian; Fécamp.
Ichnopora amica, Lang; Lang, 1919 [4], pp. 207, 222.

DIAGNOSIS.—*Ichnopora* in which the pelmata have retreated considerably from the mid-line of the intraterminal front-wall, and there are perforations in the median area of fusion; the orthœcial length about 1 mm.; costæ about 17.

DISTRIBUTION.—Coniacian. Fécamp, N.E. of Le Havre, Seine-Inférieure, France.

TYPE-SPECIMEN.—In the collection of Mr. F. Canu, of Versailles. A photograph of the type-specimen is in the Collection.

REMARKS.—*Ichnopora amica* appears to have been derived directly from *I. socia* by the retreat of the pelmata proximally along the costa to some distance from the mid-line.

FIGURES.—Text-fig. 108. Orthœcium and its apertural aviculœcia.

SPECIMENS.—Only a photograph of the type-specimen.

4. Ichnopora campestris, Lang.

Ichnopora campestris, sp. n.; Lang, 1916, p. 109; Coniacian; Fécamp, France.
Ichnopora campestris, Lang; Lang, 1919 [4], pp. 207, 222.

DIAGNOSIS.—*Ichnopora* with the pelmata close to the mid-line; orthœcial length about 1 mm.; costæ 20 or more; asty erect, bilaminar.

DESCRIPTION.—Asty erect, bilaminar; œcia dimorphic; orthœcia about 1 mm. long and ·35 to ·4 mm. wide, long-elliptical with a tendency to parallelism of the sides; extraterminal front-wall of small extent and concealed by aviculœcia and interœcial secondary tissue, which is fairly abundant and has shallow, but often wide, median lacunæ; intraterminal front-wall well arched and consisting of about twenty somewhat widely-spaced costæ, each of which bears distally a pelma close to the mid-line and is here firmly fused with its neighbours; apertural bar not very wide, but low, with a median seam or ridge; apertures normal to supernormal; apertural spines four, the proximal pair being more-or-less obliterated by the apertural aviculœcia. Aviculœcia, a large apertural pair and an occasional smaller unpaired aviculœcium, the latter situated in the interœcial secondary tissue; those of the apertural pair are slightly larger than in *I. socia*, but, as in that species, do not fuse above the apertural bar and have pointed triangular rostra directed distally and upwards.

Distribution.—Senonian, Coniacian. Fécamp, N.E. of Le Havre, Seine Inférieure, France.

Type-specimen.—D. 28461.

Remarks.—*Ichnopora campestris*, like *I. amica*, may have been directly derived from *I. socia*, not, as in *I. amica*, by the retreat of the pelmata from the mid-line, but by an increase in the number of costæ and a slight increase in the size of the apertural aviculœcia; also by the change of the colonial habit, from erect and unilaminar to erect and bilaminar.

LIST OF SPECIMENS.

D. 28461–2. Type-specimen and paratype. Senonian, Coniacian. Fécamp, N.E. of Le Havre, Seine Inférieure, France. In exchange with Mr. F. Canu. 1914.

5. Ichnopora filiformis (d'Orbigny).

Escharipora filiformis, d'Orb., 1851; d'Orbigny, 1852, p. 232, pl. 700, figs. 13–15; 1854, p. 1097; Sénonien; Fécamp (Seine Inférieure).
Collarina filiformis (d'Orbigny); Jullien, 1886, p. 607; Craie; Fécamp.
Cribrilina (Cribrilina) filiformis (d'Orb.); Canu, 1900 [2], p. 447; Sénonien.
Ichnopora filiformis (d'Orbigny); Lang, 1916, p. 109; [Emscherian]; Fécamp, France.
Ichnopora filiformis (d'Orbigny); Lang, 1919 [4], pp. 207–8, 222, fig. 80 on p. 208.

Diagnosis.—*Ichnopora* with the pelmata close to the mid-line of the intraterminal front-wall; costæ between 15 and 20; orthœcial length rather less than 1 mm.; asty erect, cylindrical.

Distribution.—Senonian [Emscherian]. Fécamp, Seine Inférieure, France.

Type-specimen.—That figured by d'Orbigny, 1852, pl. 700, fig. 14, is hereby selected. See, however, under Remarks.

Remarks.—*Ichnopora filiformis*, as diagnosed above, is interpreted according to a specimen in Mr. Canu's collection—one of fifteen on a slide labelled "*Cribrilina Escharipora filiformis*, d'O." Of these fifteen specimens, ten appear to be alike and were considered to represent this species; one of these ten was photographed, and the photograph retained in the Collection. The other five have been described as *Francopora canui*. Thus *Escharipora filiformis* has been re-diagnosed from a topotype determined by Mr. Canu, who examined d'Orbigny's types. But d'Orbigny's original figure does not agree with this diagnosis, in that it shows a number of lateral costal fusions on each costa; and he describes the "fossettes" as "interrompues au milieu." Therefore, while accepting Mr. Canu's interpretation of this species, it is necessary to point out this discrepancy, which is a serious one, and to assume either that d'Orbigny totally misunderstood the species, or, as is more probable, that the types have been mixed, and that it has become necessary either to discard the species or to re-define it.

As here defined, *Ichnopora filiformis* may have been derived from *I. campestris* by a slight catagenesis in orthœcial length and in the number of costæ, by an increase in the amount of interœcial secondary tissue and in the height of the aviculœcia, and by the assumption of a cylindrical condition.

Figures.—Plate VII, fig. 7. Part of specimen **D. 28888**, showing two complete orthœcia, each with its pair of apertural aviculœcia and parts of eight others. × about 27 diameters.

Specimens.—**D. 28888**. A fragment of an asty. Senonian, zone of *M. coranguinum*, about 20 ft. from the base, *Trochiliopora* Bed of Gaster. Summit of Downs, Mt. Harry, Lewes, Sussex. Collected by C. T. A. Gaster, Esq., and presented by him, 1915.

6. Ichnopora vestigium, Lang.

Ichnopora vestigium, sp. n.; Lang, 1916, pp. 108, 109; *M. coranguinum*-zone; Gillingham, Kent.

Membraniporella bitubularis, sp. n.; Brydone, 1917, pp. 50, 53, pl. iii, fig. 6, but probably not fig. 5; Senonian, zone of *M. cortestudinarium*; Seaford, Sussex.

Ichnopora vestigium, Lang; Lang, 1919 [4], pp. 202, 207–8, 219, 222, figs. 24–26 on p. 202, fig. 74 on p. 208.

Diagnosis.—*Ichnopora* with the pelmata of some of the orthœcia close to the mid-line, while those of others retreat somewhat proximally along the costa; orthœcial length about ·66 mm.; costæ about 14; asty incrusting, unilaminar.

Description.—Asty incrusting, unilaminar; œcia dimorphic. Orthœcia about ·66 mm. long and about ·35 to ·4 mm. wide, oval to elliptical; extraterminal front-wall of small extent, and obscured by the aviculœcia and, to some extent, by a scanty interœcial secondary tissue; intraterminal front-wall well arched and consisting of about fourteen somewhat widely-spaced costæ, each of which has a pelma at its distal end and generally close to the mid-line, but sometimes at some distance from it; apertural bar with a thin, median spiniform projection; apertures normal to super-normal or sub-circular; apertural spines four in number, the proximal pair not generally interfered with by the apertural aviculœcia. The aviculœcia constituting the apertural pair are relatively small, and when perfect are seen to be more-or-less tubular and directed vertically upwards, with the pointed rostra situated on the proximal side of the tubular structure; their appearance somewhat recalls that of the 'secondary aviculœcia' of *Pelmatopora*, but in those the 'apertures' are situated on the distal face of the structure; other aviculœcia are fairly frequently seen in the interœcial secondary tissue, are generally smaller than the apertural aviculœcia, and often lie close to them; specimen **D. 4091**, however, shows one occasional aviculœcium of a gigantic size, about ·4 mm. in length, with a tapering aperture divided into a nearly circular proximal portion and prolonged, beak-like, and slightly curved rostrum.

Distribution.—Senonian, zones of *M. cortestudinarium* and *M. coranguinum*. Southern England.

Type-specimen.—**D. 8133.**

Remarks.—On *Ichnopora vestigium* are based those forms in which a catagenesis in the orthœcial length and the number of costæ accompanies a marked retreat of the pelmata from the mid-line and an increase in size of the apertural aviculœcia. These lineages culminate in such forms as *I. leporina*, with comparatively gigantic aviculœcia, and *I. denticulata*, in which the aviculœcia are not only as large, but are fused with one another and laterally expanded so as to form an incomplete tertiary front-wall. The amount of retreat of the pelmata in *I. vestigium* varies a good deal, and, it seems, irregularly, but is in general hardly or not at all apparent. The small spiniform process sometimes to be seen on the apertural bar recalls that of *Sandalopora*, and possibly implies a relationship with that genus nearer than by way of *Pelmatopora*. It is possible that more than one species is represented in the specimens here included under this name, but at

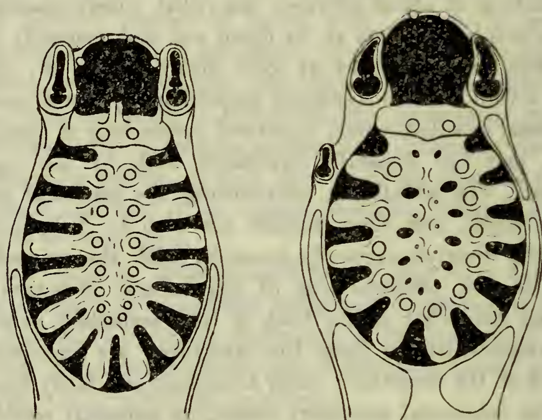


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Fig. 109.—*Ichnopora vestigium*. Diagram of an orthœcium with its apertural pair of aviculœcia, from above. × about 75 diameters.

Fig. 110.—*Ichnopora cunicula*. Diagram of an orthœcium with its apertural pair of aviculœcia, from above. × about 75 diameters.

present it has not been found advisable to separate any from the rest. The specimen figured by Brydone (1917, pl. iii, fig. 6) as *Membraniporella bitubularis* is evidently an *Ichnopora vestigium*, but the "more typical" form reproduced in Brydone's fig. 5 does not appear to be an *Ichnopora*. The 'bitubular' appearance seems due to the juxtaposition and wearing down of an apertural aviculœcium and a smaller occasional aviculœcium.

Figures.—Text-fig. 109. Orthœcium and its two apertural aviculœcia.

Plate VII, fig. 8. Part of the type-specimen, showing four complete orthœcia, each with its apertural pair of aviculœcia, and several sporadic aviculœcia. × about 27 diameters.

LIST OF SPECIMENS.

D. 4029. D. 4038. D. 4091. D. 4222. D. 4968. D. 28519. Six paratypes, of which **D. 4091** shows a gigantic aviculœcium. Senonian, zone of *M. cortestudinarium* or base of zone of *M. coranguinum.* Chatham, Kent. W. Gamble collection. 1898, 1901.

D. 27041. Paratype. Senonian, zone of *M. cortestudinarium.* Lower Pit, Slines Oak, Worm's Heath, Warlingham, Surrey. F. Möckler collection. 1912.

D. 28260. D. 28262–4. Four paratypes. Senonian, zone of *M. cortestudinarium.* Between Hope Gap and Cuckmere Haven, Sussex. Collected by C. T. A. Gaster, Esq., and presented by him, 1915.

D. 28913. Paratype. Horizon as the last. Pit west of large pit on Offham Hill, Lewis, Sussex. Collected by C. T. A. Gaster, Esq., and presented by him, 1916.

D. 21201. Paratype. Senonian, top of zone of *M. cortestudinarium* or base of *M. coranguinum.* Great Central Ry.-cutting, near Loudwater, S.E. of High Wycombe, Bucks. L. Treacher collection. 1911.

D. 28261. Paratype. Senonian, zone of *M. coranguinum*, about 20 ft. from the base of the zone, *Trochiliopora* Bed of Gaster. Cliff End, east side of Cuckmere Haven, Sussex. Collected by C. T. A. Gaster, Esq., and presented by him, 1915.

D. 8133. D. 8132. D. 8143–4. D. 8322. D. 24411. D. 24521. D. 24527–31. Type-specimen and eleven paratypes. Senonian, zone of *M. coranguinum.* Gillingham, N.E. of Chatham, Kent. W. Gamble collection. 1903, 1905, 1911.

7. Ichnopora cavia, Lang.

Ichnopora cavia, sp. n.: Lang, 1916, pp. 109, 110; Coniacian; St. Avertin, France.

Ichnopora cavia, Lang; Lang, 1919 [4], pp. 207–8, 222, fig. 76 on p. 208.

Diagnosis.—*Ichnopora* in which the pelmata have retreated considerably from the mid-line of the intraterminal front-wall; there are perforations in the median area of fusion, and small (pelmatidial) secondary pelmata near the mid-line; orthœcial length considerably less than 1 mm. (about ·66 mm.); costæ about 12; aviculœcia small, low, and do not fuse above the apertural bar; asty unilaminar, incrusting.

Description.—Asty incrusting, unilaminar; œcia dimorphic. Orthœcia about ·66 mm. long, or less, and about ·4 mm. wide, oval; extraterminal front-wall hardly at all concealed by a scanty interœcial secondary tissue; intraterminal front-wall well arched, and consisting of about twelve somewhat widely-spaced costæ, each of which bears a primary pelma at about half-way, and often a secondary pelma in the pelmatidial stage of development close to the mid-line; lateral costal fusions occur at the level of the pelmata, and intercostal perforations in the original median area of fusion; apertural bar rather narrow; apertures normal; apertural spines presumably four in number, but the proximal pair is obliterated by the aviculœcia. Aviculœcia consist of a small apertural pair and an occasional smaller unpaired aviculœcium in the interœcial valleys; those of the apertural pair are low, and do not bend towards one another as if about to fuse above the apertural bar.

Distribution.—Senonian, Coniacian. Indre-et-Loire, France.

Type-specimen.—D. 28451.

Remarks.—*Ichnopora cavia* can be called intermediate between *I. vestigium* and *I. cunicula* only in a general sense. There is some difficulty in considering it a term in a direct lineage composed of these three terms. For instance, the aviculœcia, though on the whole intermediate in size between those of *I. vestigium* and *I. cunicula*, are generally lower than those of the former; and in this respect both *I. cavia* and *I. cunicula* appear to be more primitive than *I. vestigium*. Again, the orthœcial length of *I. cavia* is rather less than that of the succeeding terms in the supposed lineage *I. vestigium*–*I. cavia*–*I. cunicula*–*I. asella*–*I. leporina*, in which there is a general catagenesis in orthœcial length. Nevertheless, in the absence of many of the terms that presumably existed, forming many subsidiary lineages, it is probable that the phylogeny put forward above does express in the main the general tendencies of evolution in the forms described and, to some extent, their mutual relationship.

Figures.—Plate VII, fig. 9. The type-specimen, consisting of four complete and several incomplete orthœcia, apertural pairs of aviculœcia, and two sporadic aviculœcia. × about 27 diameters.

LIST OF SPECIMENS.

D. 28451. Type-specimen. Senonian, Coniacian. St. Avertin, S.E. of Tours, Indre-et-Loire, France. In exchange with Mr. F. Canu. 1914.

D. 28417. Paratype. Senonian, Coniacian. Tours, Indre-et-Loire, France. In exchange with Mr. F. Canu. 1914.

8. [Ichnopora] porigera (Stoliczka).

Eschara porigera, Stoliczka; Stoliczka, 1872, pp. 15, 33, pl. i, fig. 8; Arrialoor Group [includes Turonian-Danian]; Chokonadapooram.

? *Ichnopora porigera* (Stoliczka); Lang, 1916, pp. 109, 110; Arrialoor Group, Chokonadapooram.

? *Ichnopora porigera*; Lang, 1919 [4], p. 207.

Diagnosis.—? *Ichnopora* in which the pelmata have retreated considerably from the mid-line of the intraterminal front-wall; costæ about 12; aviculœcia not fusing above the apertural bar, but rather small and low; asty erect, bilaminar.

Distribution.—Arrialoor Group (includes Turonian-Danian). Chokonadapooram, N.N.E. of Arrialoor, N.E. of Trichinopoly, Madras.

Type-specimen.—That figured by Stoliczka, 1872, pl. i, fig. 8, is hereby selected.

Remarks.—If an *Ichnopora*, [*I.*] *porigera* may have been derived from *I. cavia*, which it generally resembles, but it has advanced in colonial habit and condition, which are, respectively, erect and bilaminar.

Specimens.—None in the Collection.

9. Ichnopora cunicula, Lang.

Ichnopora cunicula, sp. n.; Lang, 1916, pp. 109, 110; Coniacian; La Ribochère, France.

Ichnopora cunicula, Lang; Lang, 1919 [4], pp. 207–8, 222, fig. 77 on p. 208.

Diagnosis.—*Ichnopora* in which the pelmata have retreated considerably from the mid-line of the intraterminal front-wall; there are perforations in the median area of fusion and small (pelmatidial) secondary pelmata near the mid-line; orthœcial length considerably less than 1 mm. (about ·66 mm.); costæ 10 or 11;

the aviculœcia not fusing above the apertural bar, but comparatively small and low; asty erect, bilaminar.

DESCRIPTION.—Asty erect, bilaminar; œcia dimorphic. Orthœcia about ·66 mm. long and ·4 mm. wide, oval; extraterminal front-wall entirely concealed by interœcial secondary tissue with large median lacunæ; the intraterminal front-wall is moderately arched laterally, with the median area of fusion wide and flat, and is composed of ten or eleven somewhat widely spaced costæ, each of which bears a pelma at about halfway, and often a secondary pelma, in the pelmatidial stage, close to the mid-line; at the level of the pelmata are lateral costal fusions, and intercostal perforations in the wide flat median area of fusion of the intraterminal front-wall; apertural bar rather low; apertures large, normal to super-normal or cribriline; apertural spines four in number, but the proximal pair is more-or-less obliterated by the apertural aviculœcia. Aviculœcia, a large apertural pair and an occasional small unpaired aviculœcium in the interœcial secondary tissue; the apertural aviculœcia are larger than those of *I. cavia*, and not much raised; they are directed distally and obliquely upwards, and the pointed rostra are slightly curved towards the mid-line of the orthœcium whose aperture they accompany; the rostra are produced into a long narrow point.

DISTRIBUTION.—Senonian, Coniacian. La Ribochère, Loir-et-Cher, E. of La Chartre-sur-le-Loir, Sarthe, France.

TYPE-SPECIMEN.—**D. 28437**. In exchange with Mr. F. Canu. 1914.

REMARKS.—Except for the orthœcial length, which is somewhat greater, *Ichnopora cunicula* appears to have been derived from *I. cavia*. One would have expected the orthœcial length of *I. cunicula* to be less than that of *I. cavia*, since the lineage to which they belong is, as a whole, catagenetic in this character. The chief difference between the species lies in the further development of the apertural aviculœcia of *I. cunicula*, and in its more advanced asty, which is erect and unilaminar.

FIGURES.—Text-fig. 110 (p. 346). Orthœcium with its two apertural aviculœcia and a sporadic aviculœcium.

Plate VII, fig. 10. Part of the type-specimen, showing three complete orthœcia, each with its pair of apertural aviculœcia. × about 27 diameters.

Specimens.—The type-specimen. Distribution and collection as above.

10. Ichnopora asella, Lang.

Ichnopora asella, sp. n.; Lang, 1916, pp. 109, 110; Coniacian; St. Avertin, France.

Ichnopora asella, Lang; Lang, 1919[4], pp. 202, 207–8, 222, figs. 27–9 on p. 202, fig. 78 on p. 208.

Diagnosis.—*Ichnopora* in which the pelmata have retreated considerably from the mid-line of the intraterminal front-wall; there are perforations in the median area of fusion, and small (pelmatidial) secondary pelmata near the mid-line; orthœcial length considerably less than 1 mm. (about ·66 mm.); costæ about 10; the paired apertural aviculœcia are large and fairly high, and the distal ends of their rostra approach each other but do not fuse over the apertural bar; asty erect, unilaminar.

Description.—Asty erect, unilaminar; œcia dimorphic. Orthœcia about ·66 mm. long and about ·45 mm. wide, oval; extraterminal front-wall concealed beneath aviculœcia and interœcial secondary tissue, which is moderately developed and has but shallow insignificant lacunæ; intraterminal front-wall somewhat flat, and consisting of about ten rather widely separated costæ, each of which has a pelma at about halfway along its length and often a secondary pelma, in the pelmatidial stage of development, near the mid-line; there are lateral costal fusions at the level of the pelmata, and intercostal perforations in the original median area of fusion; apertural bar rather wide and low; apertures large, normal to super-normal; apertural spines, presumably, four in number, but the proximal pair is obliterated by the apertural aviculœcia, and the distal pair more-or-less so by circum-apertural secondary tissue. Aviculœcia, a large apertural pair and an occasional smaller, unpaired aviculœcium situated in the interœcial secondary tissue; the apertural aviculœcia are well raised, directed partly distally and partly towards the mid-line of the orthœcium whose aperture they accompany, also obliquely upwards; the distal ends of each pair thus approach each other, but do not fuse; the apertures are acutely pointed and each rostral point is somewhat drawn out and very slightly curved towards its fellow of the apertural pair; the smaller sporadically-distributed aviculœcia also have acutely pointed rostra, which are variously, but always more-or-less distally and upwardly, directed.

Distribution.—Senonian, Coniacian. St. Avertin, S.E. of Tours, Indre-et-Loire, France.

Type-specimen.—**D. 28449.**

Figures.—Text-fig. 111. Orthœcium, its two apertural aviculœcia, and a sporadic aviculœcium.

Plate VII, fig. 11. Part of the type-specimen, showing three complete orthœcia, each with its pair of apertural aviculœcia and parts of others, and some sporadic aviculœcia. × about 27 diameters.

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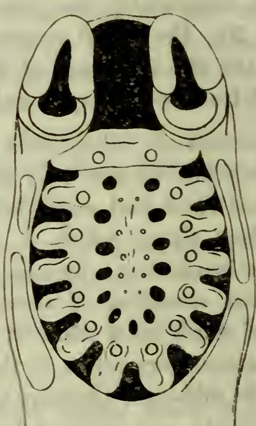

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Fig. 111.—*Ichnopora asella.* Diagram of an orthœcium with its pair of aviculœcia and a sporadic aviculœcium, from above. × about 75 diameters.

Fig. 112.—*Ichnopora leporina.* Diagram of an orthœcium with its apertural pair of aviculœcia, from above. × about 75 diameters.

Remarks.—*Ichnopora asella* appears to have been directly derived from *I. cunicula* by a further development of the apertural aviculœcia and a continuance of the catagenesis exhibited in the orthœcial length and the number of costæ.

LIST OF SPECIMENS.

D. 28449. D. 28450. Type-specimen and paratype. Senonian, Coniacian. St. Avertin, S.E. of Tours, Indre-et-Loire, France. In exchange with Mr. F. Canu. 1914.

11. Ichnopora leporina (d'Orbigny).

Escharipora leporina, d'Orb., 1851; d'Orbigny, 1851, pl. 686, figs. 13–16; 1852, p. 230; 1854, p. 1097; Sénonien; Villavard (Loir-et-Cher).

Escharipora leporina; Canu, 1900[2], p. 457.

Ichnopora leporina (d'Orbigny); Lang, 1916, pp. 109, 110; Senonian; Villavard, France.

Ichnopora leporina (d'Orbigny); Lang, 1919[4], pp. 207, 222.

Diagnosis.—*Ichnopora* in which the pelmata have retreated considerably from the mid-line of the intraterminal front-wall; there are perforations in the median area of fusion; orthœcial length is considerably less than 1 mm. (about ·7 mm.); costæ about 12; aviculœcia very large and very high, but not fusing above the apertural bar; asty erect, bilaminar.

Distribution.—Senonian, Emscherian. Northern France.

Type-specimen.—That figured by d'Orbigny, 1851, pl. 686, fig. 14, is hereby selected.

Remarks.—*Ichnopora leporina* is here interpreted according to a specimen (of which only a photograph is in the Collection) belonging to Mr. Canu of Versailles, and labelled "*Cribrilina leporina* d'O. 230, pl. 686, fig. 13–16." There is no reason to doubt that this specimen is rightly determined, though, as is to be expected, it agrees only generally with d'Orbigny's figure; in detail, for instance with regard to the presence of pelmata, there are some discrepancies. Thus interpreted, *Ichnopora leporina* differs from *I. asella* chiefly in the greater height of its aviculœcia and in its bilaminar asty. It may thus be considered generally as an advanced descendant of that form: but the orthœcial length and the number of costæ are slightly greater than in *I. asella*, so that, if directly derived from it, anagenesis of these characters has again set in.

Figures.—Text-fig. 112. Orthœcium and its apertural aviculœcia.

Specimens.—Only a photograph of Mr. Canu's specimen.

12. Ichnopora denticulata (Brydone).

Steginopora denticulata, nov.; Brydone, 1910, pp. 481, 483, pl. xxxvi, figs. 1–3; zone of *M. coranguinum*; various locc. in Kent.

Ichnopora denticulata (Brydone); Lang, 1916, pp. 109, 110; *M. coranguinum*-zone; Kent.

Ichnopora denticulata (Brydone); Lang, 1919[4], pp. 202, 207–8, 219, 222, figs. 30–2 on p. 202, fig. 75 on 208.

Diagnosis.—*Ichnopora* in which the pelmata have retreated considerably from the mid-line of the intraterminal front-wall; there are perforations in the extremely wide original median area of fusion, and secondary pelmata tend to develop near the mid-line; orthœcial length about ·7 mm.; costæ 12 or 14; the apertural aviculœcia are very large, fuse over the apertural bar, and, spreading laterally, form a wide proximal shield of a secondary aperture and even constitute a rudimentary lamina peristomica; asty unilaminar, incrusting.

Description.—Asty unilaminar and incrusting (though some apparently erect, unilaminar forms, mentioned in the list of specimens, are included under this species until their colonial condition is finally established); œcia dimorphic. Orthœcia about ·7 mm. long and about ·5 mm. wide, oval; extraterminal front-wall more-or-less concealed by a rather scanty interœcial secondary tissue with large median lacunæ, and to a certain extent by sporadically-placed aviculœcia; intraterminal front-wall consisting of about ten to fourteen stout costæ, somewhat widely spaced, with their parts near the termen vertically directed, bearing a pelma nearer the proximal than the distal end and tending to develop a secondary pelma nearer the mid-line; there are lateral costal fusions at the level of the pelmata, and here the intraterminal front-wall, from being nearly in a vertical plane, bends into a horizontal plane and continues as a very wide, flat, more-or-less perforate median area of fusion; apertural bar wide and low; aperture sub-normal; apertural spines originally (presumably) four in number, but the proximal pair is obliterated by the apertural aviculœcia, and those of the distal pair become flattened and fuse with each other to form a distal shield of the secondary aperture; distally the distal apertural spines divide into two or three branches or lobes. Aviculœcia consist of a very large apertural pair and an occasional unpaired aviculœcium placed in the interœcial secondary tissue; the apertural aviculœcia grow upwards and fuse above the apertural bar to form a hoop-like proximal shield of the secondary aperture; there is a further expansion proximally in the mid-line and distally at the distal-lateral corners, so that the original hoop-like structure becomes flattened above into a shield-shaped expansion lying more-or-less horizontally, but rather obliquely, and forming a rudimentary tertiary front-wall; this tendency is amplified in *Batrachopora*, where a more perfect lamina peristomica is formed on exactly similar lines; the apertures of the apertural aviculœcia are very elongate and are divided by a constriction (probably by a bar in perfect specimens) into a more-or-less circular proximal portion and a triangular rostrum, the apex of which is drawn out into an extremely long point.

Distribution.—Senonian, zone of *M. coranguinum*. Southern England.

Type-specimen.—That figured by Brydone, 1910, pl. xxxvi, fig. 1, is hereby selected.

Remarks.—Though *Ichnopora denticulata* contains many characteristics of the *I. cavia*–*I. leporina* lineage (*e.g.*, the great development of the apertural aviculœcia and the distal retreat of the pelmata from the mid-line), it was nevertheless probably derived directly from *I. vestigium*, the common form of the *M. cortestudinarium*-zone in England. The orthœcial length does not appear to undergo catagenesis, but rather to increase. On the other hand, the costæ are somewhat fewer. The most remarkable development is seen in the aviculœcia, which become greatly enlarged, fuse above the apertural bar, and expand into a wide and shield-shaped area. While the aviculœcia of the *I. cavia* –*I. leporina* lineage greatly increase in size, they do not actually fuse with one another even in the last-named species, but rather extend in a distal direction. It is true that those of *I. asella* have a bias towards one another, but this (if their lineage has been rightly determined) is carried no further, and during evolution they never meet. Two lineages, then, arise from *I. vestigium*, both tending greatly to enlarge their apertural aviculœcia, but evolution in the one—that of *I. cavia*–*I. leporina*—is directed towards a distal extension, and in the other, represented by *I. denticulata*, to the lateral expansion and fusion of the aviculœcia.

FIGURES.—Text-fig. 113. Orthœcium, its two apertural aviculœcia, and two small unpaired aviculœcia.

Plate VII, fig. 12. Part of specimen **D. 8136**, showing four complete orthœcia, three of which have complete proximal shields formed of apertural aviculœcia, the proximal ends of two others, two other apertures, and nine sporadic aviculœcia. × about 27 diameters.

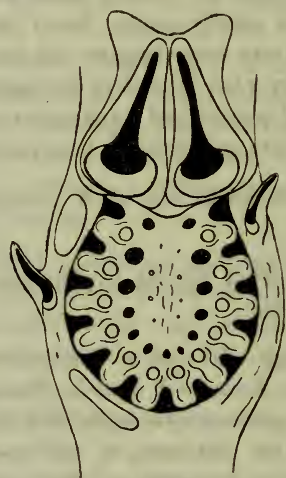


Fig. 113.—*Ichnopora denticulata.* Diagram of an orthœcium with its very large apertural pair of aviculœcia fused together and hiding the underlying aperture, and two small sporadic aviculœcia, from above. × about 75 diameters.

LIST OF SPECIMENS.

D. 4034. Senonian, zone of *M. cortestudinarium* or base of zone of *M. coranguinum*, probably the latter, in view of the evidence of other specimens. Chatham, Kent. W. Gamble collection. 1898.

D. 29909. Idiotype. Senonian, zone of *M. coranguinum.* Grays, Essex. Collected by G. E. Dibley, F.G.S., and presented by him, 1919.

D. 8130. D. 8136. D. 24532. Senonian, zone of *M. coranguinum.* Gillingham, N.E. of Chatham, Kent. W. Gamble collection. 1903, 1911.

D. 21189–90. Senonian, zone of *M. coranguinum.* Bedwyn railway-station, Wilts, S.W. of Hungerford, Berks. L. Treacher collection, 1911.

D. 21191. Senonian, high in the zone of *M. coranguinum*. Span Hill, Oxon, N.W. of Sonning, Berks. L. Treacher collection. 1911.

D. 29879. Senonian, high in the zone of *M. coranguinum*. Coomb's Pit, West Horsley, N.E. of Guildford, Surrey. Collected by C. T. A. Gaster, Esq., and presented by him, 1919.

IV. BATRACHOPORA, Lang, 1916.

Cellepora [partim]; Goldfuss, 1826, pp. 26, 248.
Cellepora [partim]; Morren, 1828, p. 34.
Cellepora [partim]; Dumont, 1832, p. 360.
Cellepora [partim]; von Klöden, 1834, pp. 266, 341.
Discopora [partim]; Edwards in Lamarck, 1836, p. 253.
Cellepora [partim]; Geinitz, 1846, p. 612.
Cellepora [partim]; Bronn, 1848, p. 255.
Discopora [partim]; Bronn, 1848, pp. 255, 432.
Discopora [partim]; Bronn, 1849, p. 130.
Cellepora [partim]; Geinitz, 1849–50, pp. 252–3.
Escharina [partim]; d'Orbigny, 1850, p. 262.
Cellepora (*Dermatopora*) [partim]; von Hagenow, 1851, p. 98.
? *Cellepora* (*Discopora*) [partim]; von Hagenow, 1851, p. 96.
Cellepora (*Dermatopora*); Bronn & Römer, 1851, p. 103.
? *Reptescharella* [partim]; d'Orbigny, 1853, p. 464.
Reptescharipora [partim]; d'Orbigny, 1853, p. 492; 1854, p. 1098.
Semiescharipora [partim]; d'Orbigny, 1853, pp. 480, 488; 1854, p. 1097–8.
? *Reptescharella* [partim]; Pictet, 1857, p. 110.
Semiescharipora [partim]; Pictet, 1857, p. 112.
Semiescharipora; Coquand, 1860, p. 183.
Cellepora [partim]; Quenstedt, 1879, p. 313.
Semiescharipora [partim]; Ubaghs, 1879, p. 217.
? *Lepralia* [partim]; Ubaghs, 1879, p. 221.
Semiescharipora [partim]; Mourlon, 1881, p. 116.
? *Lepralia* [partim]; Mourlon, 1881, p. 119.
Cellepora [partim]; Vine, 1885, p. 161.
Cellepora (*Dermatopora*) [partim]; Vine, 1885, p. 164.
? *Cellepora* (*Discopora*) [partim]; Vine, 1885, p. 164.
Semiescharipora [partim]; Vine, 1885, pp. 116, 156.
Cribrilina [partim]; Marsson, 1887, pp. 98, 109.
Semiescharipora; Ubaghs, 1889, p. 52.
Cribillina [sic] [partim]; Deecke, 1895, p. 80.
Cribrilina [partim]; Canu, 1900 [2], p. 445.
Cribrilina (*Cribrilina*) [partim]; Canu, 1900 [2], p. 449
Cribrilina (*Costula*); Canu, 1900 [2], p. 450.
Semiescharipora [partim]; Canu, 1900 [2], p. 457.
Reptescharipora [partim]; Canu, 1900 [2], p. 457.
Reptescharipora; Levinsen, 1909, p. 22.

Semiescharipora; Levinsen, 1909, p. 22.
Cribrilina [partim]; Canu in Douvillé, 1910, p. 63.
Batrachopora, gen. nov.; Lang, 1916, pp. 101, 110–112.
Dermatopora (*Cellepora*) [partim]; Lang, 1917, p. 169.
Batrachopora; Lang, 1919 [3], p. 105.
Batrachopora; Lang, 1919 [4], pp. 192, 197, 199, 203–6, 208, 217–221, 223.
? *Cellepora* (*Discopora*); Lang, 1919 [4], p. 205.

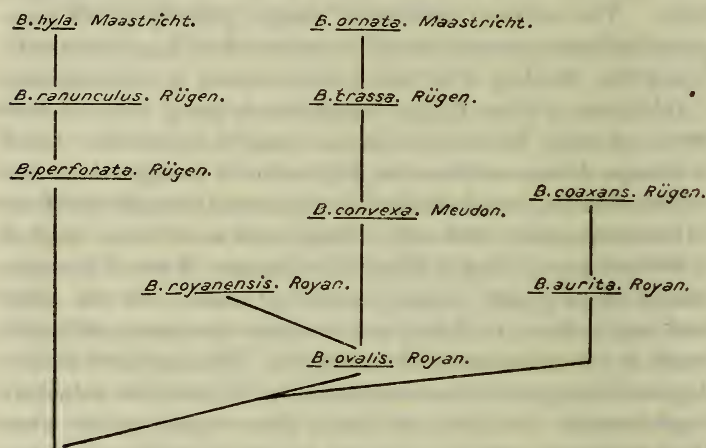
Diagnosis.—Pelmatoporinæ in which the secondary aperture, in so far as it is present, consists of both proximal and distal shields, and the former is constituted by a pair of large aviculœcia; these aviculœcia are situated one on each side of every orthœcial aperture, are raised, and fuse with one another over the apertural bar, which takes no part in the formation of the proximal shield; the distal shield is never so prominent as the proximal shield, it consists of a rim of secondary circum-apertural tissue, from which project the fused distal apertural spines in the most advanced forms; there are two or more rows of pelmata on each side of the intraterminal front-wall, though the secondary pelmata and those of a higher order may be yet in the pelmatidial stage of development; the apertures are very wide; the tissue of the secondary aperture in advanced forms is spread on all sides, and fuses with that of neighbouring apertures to form a tertiary front-wall or lamina peristomica.

Distribution.—Senonian, Campanian, zone of *B. mucronata*, and Maastrichtian.

Genotype.—*Batrachopora ranunculus*, Lang.

Remarks.—Two lines of development diverge from *Ichnopora*, both elaborating a peculiar secondary aperture. In *Pachydera*, proximal and distal shields unite and are produced to form a tubular secondary aperture. In *Batrachopora* the proximal shields spread laterally and fuse with their neighbours to form a tertiary front-wall; the primary apertures, too, become very wide and generally larger, so as to equal, in such forms as *B. ornata*, the intraterminal front-wall in area. In the first line of evolution, therefore, the apertures tend towards *extension*, in the other towards *expansion*. In both, the intraterminal front-wall is more advanced than in *Ichnopora*, since secondary pelmata are always, and tertiary pelmata generally, present: both secondary and tertiary pelmata, however, may remain in the pelmatidial stage of development; but, with lateral costal fusions and intercostal perforations, they occur in regular sequence, following the retreat of the primary pelmata, as in *Pelmatopora*, and not lagging behind the retreat, as in *Ichnopora*. Moreover, at least the secondary pelmata emerge from their pelmatidial stage in the more advanced forms. The apertural aviculœcia, though probably in all cases fusing to form a proximal shield, do not reach so large a size as in *Ichnopora*. So if, as is probable, *Batrachopora* is a development of *Ichnopora*, it arose from a comparatively lowly form of that genus. Another likeness to *Ichnopora* may be mentioned. In all its lineages *Ichnopora* shows an inclination to catagenesis in the number of costæ, though it is in *I. vestigium* and forms derived from it that catagenesis is best seen. Catagenesis is still more marked in *Batrachopora*, which in the advanced species of two of its main lineages has a greatly reduced number of costæ. On the other hand, any tendency in *Ichnopora* towards a decrease in orthœcial length, is not carried on in *Batrachopora*. The species of *Batrachopora* lie along two main lineages, in one of which the orthœcial length increases but slowly, and in the other rapidly, so that even its otherwise primitive members are comparatively large. In the first lineage, consisting of the species *B. perforata–B. ranunculus –B. hyla*, the orthœcial apertures and the aviculœcia increase in size and the number of costæ decreases. The second main lineage immediately divides into two branches, in one of which (*B. aurita –B. coaxans*) the costæ remain numerous, while the other characters become less primitive; in the other (*B. ovalis–B. convexa–B. crassa–B. ornata*) the costæ undergo catagenesis, while the other characters are developed along the expected lines. *B. royanensis* is an independent development of *B. ovalis*. Excluding, then, *B. royanensis*, three lineages of *Batrachopora* can be traced, the first characterised by a gradual increase in size accompanied by costal catagenesis, a second by a rapid increase in size with a costal catagenesis, and a third by a rapid increase in size without catagenesis of the costæ.

These relationships are expressed in the following table. Its grouping suggests that the horizon of Royan is below that of Rügen, and even that of Meudon, whereas the condition and general appearance of the Royan specimens suggest a Maastrichtian age, to which it is customary to refer them. It is possible that the Royan fauna has but a Maastrichtian *facies*, and is really approximately contemporary with the Meudon fauna, just as the Maastrichtian fauna, though really occurring a little above it, is essentially a facies of the Rügen fauna (see Lang, 1919[4], pp. 205–6):—



Key to the Species of *Batrachopora*.

A. Orthœcial apertures decidedly smaller than the intraterminal front-wall.
- I. Apertural aviculœcia remain small and do not appear to meet above the apertural bar.
  - *a*. Orthœcial apertures comparatively small and narrow.
    - 1. Orthœcia widely spaced .... 2. *B. perforata*.
    - 2. Orthœcia fairly close together.
      - *α*. Orthœcia less squat, about twice as long as broad.
        - *a*. Erect, unilaminar .... 5. *B. ovalis*.
        - *b*. Erect, bilaminar (fig. 118) .... 9. *B. royanensis*.
      - *β*. Orthœcia squatter, less than twice as long as broad .... 6. *B. convexa*.
  - *b*. Orthœcial apertures comparatively wide.
    - 1. Costal fusions generally four; costæ about 10 .... [6. *B. convexa*.]
    - 2. Costal fusions generally three; costæ about 7 (fig. 116) .... 7. *B. crassa*.

II. Apertural aviculœcia meet above the apertural bar, or, at least, are large.

a. Orthœcia shorter, 1 mm. or less (fig. 114) ...... 3. *B. ranunculus.*

b. Orthœcia longer, more than 1 mm.

1. Orthœcia larger, twice as long as broad (fig. 119) .... 10. *B. aurita.*

2. Orthœcia squatter, not twice as long as broad (fig. 120) .... 11. *B. coaxans.*

B. Orthœcial apertures nearly as large as, or as large as, the intraterminal front-wall; a secondary front-wall is (? always) attained.

I. Orthœcial length rather less than 1 mm.; costæ about 6 or 7; intercostal fusions about three (fig. 115) .... 4. *B. hyla.*

II. Orthœcial length decidedly more than 1 mm.; costæ about 4 or 5; intercostal fusions about 2 (fig. 117) .... 8. *B. ornata.*

1. [Batrachopora] signata (von Hagenow).

Cellepora (*Discopora*) *signata*, Hag.; von Hagenow, 1851, p. 96, pl. x, fig. 17 *a*, *b*; Maastrichter kreidebildung; Maastricht.

Reptescharella signata (Hagenow); d'Orbigny, 1853, p. 464; Sénonien; Maëstrich.

Reptescharella signata (Hagenow); Pictet, 1857, p. 110; Maestricht.

Lepralia signata (Hag., 1851); Ubaghs, 1879, p. 221; Maestrichtien supérieur; Limbourg.

Lepralia signata (Hag., 1851); Mourlon, 1881, p. 119; Maastrichtien; Limbourg.

Cellepora (*Discopora*) *signata*, H., Vine, 1885, p. 164; Maestricht Beds.

? *Batrachopora signata* (von Hagenow); Lang, 1916, p. 111; Maastrichtian; Maastricht.

? *Batrachopora* [*Cellepora* (*Discopora*)] *signata* (von Hagenow); Lang, 1919[4], p. 205.

Type-specimen.—That figured by von Hagenow, pl. x, fig. 17 *b*, is hereby selected.

Remarks.—From the evidence available, it is impossible to diagnose this species or more than tentatively to refer it to *Batrachopora*.

Specimens.—None in the Collection.

2. Batrachopora perforata (Marsson).

Cribrilina perforata, n. sp.; Marsson, 1887, pp. 98, 109, pl. x, fig. 11; Senon., weisse Schreibkreide; Rügen.
Cribillina [sic] *perforata* Marss.; Deecke, 1895, p. 80; Senon; Rügen.
Cribrilina perforata (Marss.); Canu, 1900 [2], p. 445.
Batrachopora perforata (Marsson); Lang, 1916, pp. 110, 111; *B. mucronata*-zone; Rügen, Germany.
Batrachopora perforata (Marsson); Lang, 1919 [4], pp. 206, 219, 221.

Diagnosis.—*Batrachopora* with orthœcial apertures small and narrow; apertural aviculœcia comparatively small; orthœcia widely spaced; costæ 10 or 11; asty erect, unilaminar; orthœcial length about ·73 mm.

Distribution.—Senonian, Campanian, zone of *B. mucronata*. Rügen.

Type-specimen.—That figured by Marsson, 1887, pl. x, fig. 11, is hereby selected.

Remarks.—*Batrachopora perforata* is primitive in most of its features, but has comparatively few costæ. Probably it was derived from a more primitive stock with more costæ. From it arose the lineage *B. perforata*–*B. ranunculus*–*B. hyla*, characterised by a gradual increase in the orthœcial length, in the size of the aperture and of the apertural aviculœcia, and a decrease in the number of costæ.

Specimens.—None in the Collection.

3. Batrachopora ranunculus, Lang.

Batrachopora ranunculus, sp. n.; Lang, 1916, pp. 111, 110; *B. mucronata*-zone; Rügen, Germany.
Batrachopora ranunculus, Lang; Lang, 1919 [4], pp. 203, 206, 203, 219, 221, figs. 33–35 on p. 203, fig. 81 on p. 208.

Diagnosis.—*Batrachopora* with orthœcial apertures decidedly smaller than the intraterminal front-wall; apertural aviculœcia comparatively large and meeting over the apertural bar; orthœcia rather less than 1 mm. in length (about ·8 mm); costæ about 10; asty incrusting, unilaminar.

Description.—Asty incrusting and unilaminar; œcia dimorphic.

Orthœcia about ·8 mm. long and ·5 mm. wide, oval; extraterminal front-wall concealed by a considerable development of interœcial secondary tissue, which has median lacunæ; the intraterminal front-wall consists of about ten rather widely-spaced costæ, each of which bears a primary pelma considerably nearer to its proximal than its distal end; proximal to the pelmata the intraterminal front-wall is nearly vertical, distal to them it is nearly horizontal, so that the original median area of fusion is very wide and flat, with two rows of intercostal perforations, and often the beginning

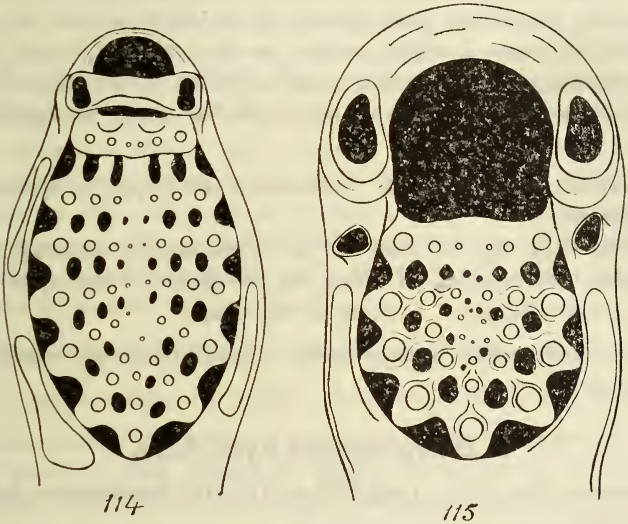


Fig. 114.—*Batrachopora ranunculus.* Diagram of an orthœcium and its apertural pair of aviculœcia fused above the apertural bar, from above. × about 75 diameters.

Fig. 115.—*Batrachopora hyla.* Diagram of an orthœcium with its very large pair of apertural aviculœcia and a low-lying pair of small aviculœcia, from above. × about 75 diameters.

of a third near the mid-line; the intercostal perforations are the result of lateral costal fusions at the level of the pelmata; each costa bears secondary, tertiary, and even, in their pelmatidial stages, quaternary pelmata, between the primary pelmata and the mid-line; apertural bar low; apertures sub-normal; apertural spines obliterated by secondary circum-apertural tissue. Aviculœcia chiefly confined to the large apertural pair, though occasional sporadically-distributed aviculœcia appear in the interœcial secondary tissue; those of the apertural pair fuse with one another forming a hoop-like structure over the apertural bar.

Distribution.—Senonian, Campanian, zone of *B. mucronata*. Rügen.

Type-specimen.—D. 23388. Agnes Laur collection. 1912.

Remarks.—*Batrachopora ranunculus* may have been derived from *B. perforata* (or rather from an incrusting unilaminar form otherwise resembling that species) by a slight decrease in the number of costæ, a slight increase in the orthœcial length and comparative size of the aperture, and a further development of the apertural aviculœcia, which are larger and fuse above the apertural bar.

Figures.—Text-fig. 114. Orthœcium and its pair of apertural aviculœcia.

Plate VIII, fig. 1. Part of the type-specimen showing two complete orthœcia, one of which has the fusion of the apertural aviculœcia unbroken. × about 27 diameters.

Specimens.—The type-specimen. Distribution and collection as above.

4. Batrachopora hyla, Lang.

Batrachopora hyla, sp. n.; Lang, 1916, pp. 111, 112; Maastrichtian; Maastricht.

Batrachopora hyla, Lang; Lang, 1919 [4], pp. 205-6, 208, 219, 221, fig. 82 on p. 208.

Diagnosis.—*Batrachopora* with orthœcial apertures nearly as large as the intraterminal front-wall; orthœcial length about ·9 mm.; costæ 6 or 7, with three intercostal fusions and pelmata, and there may be suggestions of pelmatidial quaternary pelmata in the mid-line.

Description.—Asty incrusting, unilaminar; œcia dimorphic. Orthœcia about ·9 mm. long and about ·66 mm. in width, broadly oval; extraterminal front-wall of small extent and but little concealed by interœcial secondary tissue, which is very feebly developed; the intraterminal front-wall is almost entirely taken up by the flat, enormously-widened, original median area of fusion, and consists of six or seven costæ, each of which bears a primary pelma near its proximal end, secondary and tertiary pelmata mid-way, and sometimes a quaternary pelma, in the pelmatidial stage, at its distal end and close to the mid-line; there are lateral costal fusions at the levels of the pelmata, so that the original median area of fusion is pierced by three paired rows of perforations; the apertural bar is low and flat; the apertures are nearly as large as the intraterminal front-wall, and sub-normal in shape; the apertural spines are obliterated by secondary circum-apertural tissue, which grows up in connection with the apertural aviculœcia to form round the distal end of the secondary aperture a very thick collar-like rim. The occasional small aviculœcia in the interœcial valleys tend to have a paired arrangement, and to be placed one immediately proximal to each large apertural aviculœcium; the latter are borne high on the secondary apertural rim and, probably, in perfect specimens, fuse over the apertural bar and expand laterally, as in *B. ornata*; but this is not shown in the type-specimen.

Distribution.—Senonian, Maastrichtian. Maastricht.

Type-specimen.—**D. 11852.** Van Breda collection. 1871.

Remarks.—The general resemblance of *Batrachopora hyla* to *B. ornata* is close enough to suggest that they are intimately related; and, were it not for the continually recurring instances in this and other Cribrimorph families of more-or-less complete homœomorphy, it is probable that the two species would have been regarded as more nearly related to each other than is either to a third species. Yet *B. hyla* may easily have been derived from *B. ranunculus*, since it carries on the tendencies of a gradual increase in orthœcial length and in the size of the aperture, a further development of the apertural aviculœcia, and a decrease in the number of costæ, of pelmata, and of intercostal perforations—tendencies that characterise the lineage of *B. ranunculus*. *B. ornata*, on the other hand, is regarded as the last term of a series whose characteristics were similar, but the increase in orthœcial length was greater and more rapid. Therefore, on this hypothesis, it is to be expected that *B. ornata* will be considerably larger than *B. hyla*, and that probably the other characters will not have developed at the same comparative rates in the two species. Now, not only is *B. ornata* far larger than *B. hyla*, but its aperture is even larger compared with its intraterminal front-wall than is the aperture of *B. hyla*, and the number of costæ, pelmata, and intercostal perforations is rather less. That is to say (on the hypothesis that the two species are of different lineages), the ultimate terms of two lineages, whose penultimate terms occur in the Rügen Chalk, are found in the Maastricht Beds; and in one case (that of *B. ornata*) a further development is reached than in the other case (that of *B. hyla*).

But none of these considerations disproves the alternative hypothesis that *B. ornata* is derived from *B. hyla*, since no one character of the former is more primitive than the corresponding character in the latter, if catagenesis in the number of costæ, pelmata, and intercostal perforations is regarded as normal to both. Both hypotheses, then, are tenable; but, perhaps, not equally tenable. For the main characteristic of the *B. perforata–B. ranunculus* lineage is a gradual increase in size without any great achievement in orthœcial length; and *B. hyla* is less than 1 mm. long. If *B. ornata* is to be derived from *B. hyla*, a large increase in length is suddenly achieved. On the other hand, one characteristic of the *B. ovalis–B. convexa–B. crassa* lineage is a rapid and great increase in orthœcial length while the lineage is yet young, and but a slight increase as the lineage develops. But *B. crassa* has already attained an orthœcial length of more than 1 mm., and *B. ornata*, if derived from *B. crassa*, merely carries it a little further.

Specimens.—The type-specimen. Distribution and collection as above.

Figures.—Text-fig. 115. Orthœcium, its two apertural aviculœcia, and two aviculœcia in the interœcial secondary tissue.

Plate VIII, fig. 2. Two orthœcia of the type-specimen, each with its pair of apertural aviculœcia and each with a pair of low-lying aviculœcia just proximal to its aperture. × about 27 diameters.

5. Batrachopora ovalis (d'Orbigny).

Semiescharipora ovalis, d'Orb., 1851; d'Orbigny, 1852, pl. 719, figs. 13–16; 1853, p. 488; 1854, p. 1098; Sénonien; Royan (Charente-Inférieure).
Semiescharipora ovalis, d'Orb.; Coquand, 1860, p. 183; Campanien; Royan.
Semiescharipora ovalis, D'Orb.; Vine, 1885, pp. 116, 156.
Semiescharipora ovalis; Canu, 1900 [2], p. 457.
Semiescharipora ovalis; Levinsen, 1909, p. 22.
Cribrilina ovalis d'Orb.; Canu in Douvillé, 1910, p. 63; Maëstrichtien; Royan.
Batrachopora ovalis (d'Orbigny); Lang, 1916, pp. 110, 111; Senonian [Maastrichtian]; Royan, France.
Batrachopora ovalis (d'Orbigny); Lang, 1919 [4], pp. 205–6, 219, 221.

Diagnosis.—*Batrachopora* in which the orthœcial apertures are decidedly smaller than the intraterminal front-wall; the apertural aviculœcia remain small and do not fuse above the apertural bar; the orthœcial apertures are comparatively small and narrow; the orthœcia lie fairly close together, and are about twice as long as wide; the asty is erect and unilaminar; there are about 12 costæ.

Distribution.—Senonian, [Campanian, zone of *B. mucronata* or] Maastrichtian. Royan, S. of Rochefort, Charente-Inférieure.

Type-specimen.—That figured by d'Orbigny, 1852, pl. 719, fig. 14, is hereby selected.

Remarks.—*Batrachopora ovalis* as figured by d'Orbigny has very primitive characters for a *Batrachopora*—that is to say, the apertural aviculœcia are poorly developed, the apertures are small and narrow, and the costæ fairly numerous. The orthœcial size, however, is considerable; consequently the species stands at the base of the two lineages, in which a large orthœcium is combined with primitive features, and apart from the *B. perforata*–*B. ranunculus* lineage, whose early members have comparatively small orthœcia.

Specimens.—None in the Collection.

6. Batrachopora convexa (d'Orbigny).

Repteschariporа convexa, d'Orb., 1851; d'Orbigny, 1852, pl. 720, figs. 1–3; 1853, p. 492; 1854, p. 1098; Sénonien; Meudon, près de Paris.
Cribrilina (Cribrilina) convexa (d'Orb.); Canu, 1900 [2], p. 449; Sénonien.
Repteschariporа convexa d'Orb.; Canu, 1900 [2], p. 457.

Repteschuripora convexa; Levinsen, 1909, p. 22.
Batrachopora convexa (d'Orbigny); Lang, 1916, pp. 111, 112; Senonian, [Campanian]; Meudon, France.
Batrachopora convexa (d'Orbigny); Lang, 1919 [4], pp. 206, 207, 219, 221.

Diagnosis.—*Batrachopora* in which the orthœcial apertures are decidedly smaller than the intraterminal front-wall; the apertural aviculœcia remain fairly small and do not fuse above the apertural bar; the orthœcial apertures are rather large and not very wide; the orthœcia lie fairly close together, and are less than twice as long as wide; the asty is incrusting and unilaminar; there are about 10 costæ and about 4 lateral costal fusions.

Distribution.—Senonian, Campanian, zone of *B. mucronata*, probably lower and middle parts of the zone. Meudon, S.W. of Paris.

Type-specimen.—That figured by d'Orbigny, 1852, pl. 720, fig. 2, is hereby selected.

Remarks.—*Batrachopora convexa* may have been derived from *B. ovalis* by a diminution in the number of costæ and a slight increase in size of the apertural aviculœcia and of the aperture. It forms a link between *B. convexa* and *B. crassa*.

Specimens.—None in the Collection.

7. Batrachopora crassa, Lang.

Batrachopora crassa, sp. n.; Lang, 1916, pp. 110, 111; *B. mucronata*-zone; Rügen, Germany.
Batrachopora crassa, Lang; Lang, 1919 [4], pp. 206, 208, 217, 219, 221, fig. 83 on p. 208.

Diagnosis.—*Batrachopora* in which the orthœcial apertures, though decidedly smaller than the intraterminal front-wall, are yet large and wide; the apertural aviculœcia are comparatively small and do not fuse above the apertural bar; there are about 7 costæ and 3 lateral costal fusions; the asty is unilaminar and incrusting.

Description.—Asty incrusting, unilaminar; œcia dimorphic. Orthœcia about 1·25 mm. long and ·7 mm. wide, oval-elliptical; extraterminal front-wall of small extent and but little concealed by interœcial secondary tissue, which is scanty; the intraterminal front-wall is well arched and consists of about seven rather widely-spaced costæ, each of which bears primary, secondary, and tertiary pelmata with lateral costal fusions at their levels; apertural bar stout and wide; apertures wide, large, and super-semicircular or sub-normal; distal apertural spines much thickened, the proximal pair being probably incorporated with the process bearing the apertural aviculœcia. Aviculœcia apparently confined to a comparatively small, somewhat raised, apertural pair.

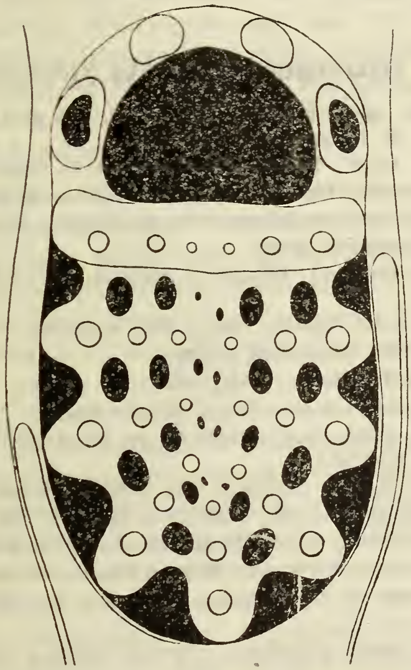


Fig. 116.—*Batrachopora crassa.* Diagram of an orthœcium and its apertural pair of aviculœcia, from above. × about 75 diameters.

Distribution.—Senonian, Campanian, zone of *B. mucronata.* Rügen.

Type-specimen.—**D. 16674.** Agnes Laur collection.

Remarks.—*Batrachopora crassa* may have been derived from *B. convexa* by an increase in size, as well as in the comparative width of the aperture, and by a diminution in the number of lateral costal fusions.

Figures.—Text-fig. 116. Orthœcium and its two apertural aviculœcia.

Plate VIII, fig. 3. An orthœcium of the type-specimen with its pair of apertural aviculœcia much worn. × about 27 diameters.

Specimens.—The type-specimen. Distribution and collection as above.

8. **Batrachopora ornata** (Goldfuss).

Cellepora ornata nobis; Goldfuss, 1826, p. 26, 248. pl. ix, figs. 1, *a*, *b*: Kreidetuff; St. Petersberg, bei Mastricht.

Cellepora ornata, Goldf.; Morren, 1828, p. 34; Mt. St. Peter, Maastricht.

Cellepora ornata Gold.; Dumont, 1832, p. 360; calcaire de Maestricht.

Cellepora ornata Goldf.; von Klöden, 1834, pp. 266, 341; Kreide, Belgien; in kalkigem Feuersteine, Berlin.

Discopora ornata (Goldfuss); Edwards in Lamarck, 1836. p. 253; Montagne Saint-Pierre.

Cellepora ornata Goldf.; Geinitz, 1846, p. 612; Mastricht.

Cellepora ornata Gf.; Bronn, 1848, p. 255.

Discopora ornata (Gf.); Bronn, 1848, p. 432.

Discopora ornata Edw.; Bronn, 1849, p. 130; Kreide.

Cellepora ornata Goldf.; Geinitz, 1849–50, pp. 252–3; ober Quadermergel; Falkenberg, Mastricht.

Escharina ornata (Goldf.); d'Orbigny, 1850, p. 262; Sénonien; Maëstricht.

Cellepora (*Dermatopora*) *ornata*, Goldf.; von Hagenow, 1851, p. 98, pl. x, fig. 16; Maastrichter Kreidebildung; Maastricht und Falkenberg.

Cellepora (*Dermatopora*) *ornata* Gf.; Bronn & Römer, 1851, p. 103, pl. xxix², fig. 11 [a copy of von Hagenow, 1851, pl. x, fig. 16]; Mastrichter Kreide.

Semieschuripora Ornata (Goldfuss); d'Orbigny, 1853, p. 480; Sénonien; Maëstrich.

Semiescharipora ornata (Goldfuss); Pictet, 1857, p. 112; Sénonien; Maestricht.

Cellepora ornata Goldfuss; Quenstedt, 1879, p. 313, pl. cliv, fig. 42; Mastricht.

Semiescharipora ornata, Goldf. sp.; Ubaghs, 1879, p. 217; Maastrichtien Supérieur; Limbourg.

Semiescharipora ornata, Goldf. sp.; Mourlon, 1881, p. 116; Maastrichtien; Limbourg.

Cellepora ornata, Goldfuss; Vine, 1885, p. 161; Maestricht Beds.

Cellepora (*Dermatopora*) *ornata*, Goldf.; Vine, 1885, p. 164; Maestricht Beds, *Semiescharipora ornata*, sp. Golfd. [*sic*]; Ubaghs, 1889, p. 52; Craie tufeau, tufeau grossier, Bed E; Folx-les-Caves.

Cribrilina (*Costula*) *ornata* Goldf.; Canu, 1900 [2], p. 450.

Batrachopora ornata (Goldfuss); Lang, 1916, pp. 111, 112; Maastrichtian; Maastricht.

Cellepora ornata Goldfuss; Lang, 1916, p. 169.

Batrachopora ornata (Goldfuss); Lang, 1919 [4], pp. 205–6, 217, 219, 221.

DIAGNOSIS.—*Batrachopora* in which the orthœcial apertures are about as large as the intraterminal front-wall; the apertural aviculœcia meet and fuse above the apertural bar, and this proximal apertural shield expands and fuses with its neighbours to form a tertiary front-wall (specimens perfect enough to show even the fusion of the aviculœcia are, however, very rarely seen); the orthœcial length is about 1·5 mm.; there are about 5 costæ and 1 or 2 intercostal fusions.

DESCRIPTION.—Asty unilaminar and probably erect, but possibly incrusting; œcia dimorphic. Orthœcia about 1·5 mm. long and nearly 1 mm. wide, broadly oval; the extraterminal front-wall is very small in extent, and more-or-less concealed by a very scanty interœcial secondary tissue; the intraterminal front-wall is very flat above—that is, on the median side of, or within, the circle of the primary pelmata; proximal to the primary pelmata the costæ are vertical; the costæ are about five in number, are very widely spaced, and each bears a gigantic primary pelma near its proximal end; at this point the costæ bend into a horizontal plane and bear enormous secondary pelmata towards their distal ends; lateral costal fusions occur at the levels of the primary and secondary pelmata, but the costæ are close enough at the level of the secondary pelmata for the circumferences of these (so large are they) to touch their neighbours; the apertural bar is hardly wider than the normal costæ, and bears equally large pelmata; the aperture is enormous, as large as, or almost as large as, the intraterminal front-wall, and sub-circular in shape; the apertural spines of the distal pair fuse in the mid-line and form a distal apertural shield; the proximal apertural spines are involved in the upgrowth of the apertural aviculœcia. The aviculœcia are dimorphic and paired, and a small lowly and a large exalted pair accompany each orthœcium; one of each small pair is situated in each of the bays formed between the proximal ends of the apertural bar and the neighbouring costa of the intraterminal front-wall; one of each large pair rises on each side of the aperture of every orthœcium and fuses with its neighbour over the apertural bar; the fused structure spreads in a horizontal plane, and fuses with similar fused structures to form a more-or-less complete roof over the whole asty—in other words, to form a tertiary front-wall or lamina peristomica.

Distribution.—Senonian, Maastrichtian. Maastricht.

Type-specimen.—That figured by Goldfuss, 1826, pl. ix, fig. 1 *b*, is hereby selected.

Remarks.—*Batrachopora ornata* is probably a derivative of *B. crassa*, carrying on the lineage *B. ovalis*–*B. crassa* with gradual increase of orthœcial size, an increase of size and comparative width of aperture, an increase of development of apertural aviculœcia, and a decrease in number of costæ, of pelmata of higher orders, and of lateral costal fusions and intercostal perforations. The most remarkable features are the great development of the proximal apertural shield and the addition to the distal apertural shield of the fused distal apertural spines, which grow ahead of the general rim of secondary tissue hitherto forming the distal apertural shield. The distal shield is comparable with that of *Ichnopora denticulata*, and is a parallel development. For *I. denticulata* is an extreme development of *Ichnopora*, as *Batrachopora ornata* is of *Batrachopora*. In both genera the previous history of the distal shield is nothing more than a general up-growing of secondary tissue round the distal apertural edge, immersing the distal apertural spines. But, though *Batrachopora* is probably derived from *Ichnopora*, it is evident that it arose from a comparatively primitively-organised *Ichnopora*, one that had not yet attained the fusion and rapid up-growth of the distal apertural spines. Therefore this peculiar form of distal shield common to *Ichnopora denticulata* and *Batrachopora ornata* (and, it may be noted, to *Ubaghsia* of the Castanoporinæ, though the fusion is less complete) is independently acquired in the different forms.

The possibility of *Batrachopora ornata* having been derived from *B. hyla* has already been considered in the remarks under that species.

FIGURES.—Text-fig. 117. Orthœcium with its two apertural up-raised aviculœcia and its two small post-apertural aviculœcia.

Plate VIII, fig. 4. Part of specimen **D. 1391**, showing four complete orthœcia with their paired apertural aviculœcia and low-lying aviculœcia at the level of the apertural bar. The two distal orthœcia are partly covered with a broken lamina peristomica. × about 27 diameters.

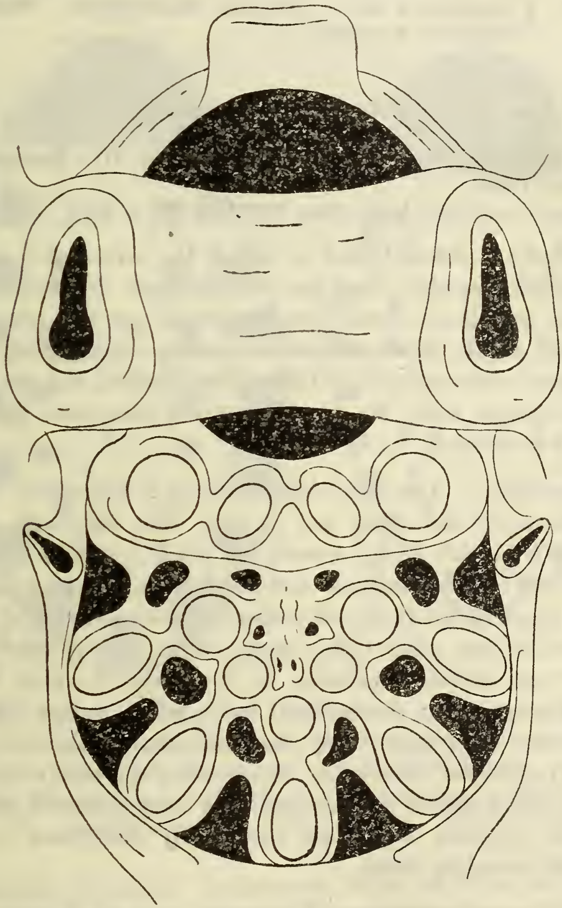


Fig. 117.—*Batrachopora ornata.* Diagram of an orthœcium with its very large apertural pair of aviculœcia fused above the aperture, and a small low-lying pair of aviculœcia, from above. × about 27 diameters.

LIST OF SPECIMENS.

D. 8529. A large fragment. Senonian, Maastrichtian. Fauquemont, E. of Maastricht, Holland. W. Gamble collection. 1905.

D. 1391. D. 19356–7. Three fragmentary asties, of which **D. 1391** here and there shows the lamina peristomica and, in some orthœcia, the distal shield. Senonian, Maastrichtian. Maastricht, Holland. G. R. Vine collection. 1893.

D. 28526. A fragmentary asty. [Senonian, Maastrichtian. Maastricht, Holland.] No history.

9. Batrachopora royanensis, Lang.

Batrachopora royanensis, sp. n.; Lang, 1916, pp. 110, 111; Maastrichtian; Royan, France.

Batrachopora royanensis, Lang; Lang, 1919 [4], pp. 205–6, 221.

Diagnosis.—*Batrachopora* in which the orthœcial apertures are decidedly smaller than the intraterminal front-wall; the apertural aviculœcia remain small, and do not fuse above the apertural bar; the orthœcial apertures remain comparatively small and narrow; the orthœcia lie fairly close together, and are about twice as long as wide; the asty is erect and bilaminar; there are about 12 to 14 costæ.

Description.—Asty erect, bilaminar; œcia dimorphic. Orthœcia about 1·2 mm. long and ·6 mm. wide, elliptical; extraterminal front-wall of fair extent, but much concealed by sporadically-distributed aviculœcia and a diffuse interœcial secondary tissue; intraterminal front-wall rather flat and consisting of about twelve or fourteen fairly widely-spaced costæ, each of which bears primary and secondary pelmata, at the levels of which lateral costal fusions occur; the apertural bar is rather narrow and low; the apertures are comparatively small and super-semicircular; the apertural spines are immersed in the secondary apertural structures. The aviculœcia consist of a comparatively small apertural pair and occasional unpaired aviculœcia sporadically distributed in the interœcial secondary tissue.

Distribution.—Senonian, [Campanian, zone of *B. mucronata* or] Maastrichtian. Royan, S. of Rochefort, Charente-Inférieure, France.

Type-specimen.—In the collection of Mr. F. Canu of Versailles. A photograph of the type-specimen is in the Collection.

Remarks.—*Batrachopora royanensis* probably was derived from *B. ovalis*, another Royan form, from which it differs chiefly in its orthœcial condition, which is bilaminar, while that of *B. ovalis* is unilaminar.

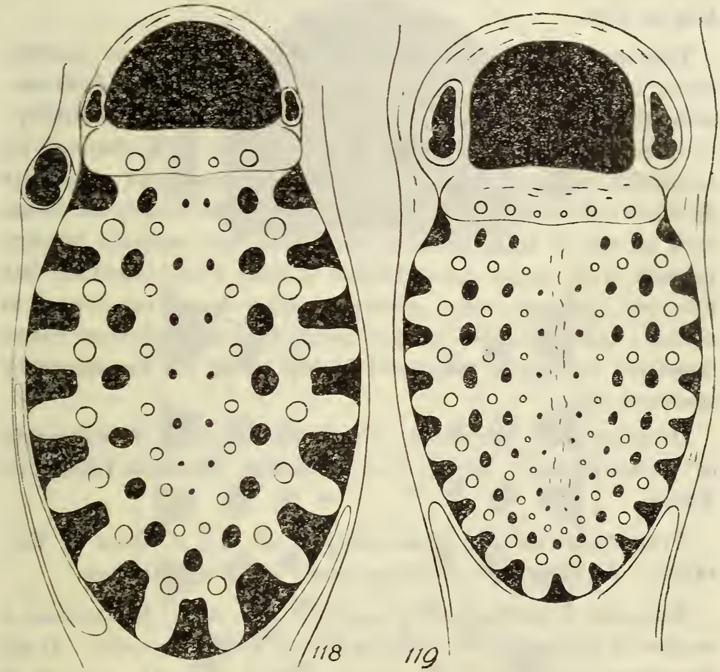


Fig. 118.—*Batrachopora royanensis.* Diagram of an orthœcium, with it small apertural pair of aviculœcia and a larger sporadic aviculœcium, from above. × about 75 diameters.

Fig. 119.—*Batrachopora aurita.* Diagram of an orthœcium, with its large apertural pair of aviculœcia, from above. × about 75 diameters.

Figures.—Fig. 118. Orthœcium, its two apertural aviculœcia, and one aviculœcium in the interœcial secondary tissue.

Specimens.—Only a photograph of the type-specimen.

10. Batrachopora aurita, Lang.

Batrachopora aurita, sp. n.; Lang, 1916, p. 111; Maastrichtian; Royan, France.

Batrachopora aurita; Lang, 1919 [4], pp. 205–6.

Diagnosis.—*Batrachopora* with orthœcial apertures decidedly smaller than the intraterminal front-wall; apertural aviculœcia large; orthœcia more than 1 mm. long, rather more than twice as long as wide.

Description.—Asty unilaminar and incrusting, or possibly erect; œcia dimorphic. Orthœcia about 1·1 mm. long and ·49 mm. wide, elliptical, but rather tapering proximally and blunt distally; extraterminal front-wall of small extent, but little obscured by interœcial secondary tissue; intraterminal front-wall somewhat flattened and consisting of about eighteen rather closely-set costæ, each of which bears primary, secondary, and probably tertiary pelmata, with lateral costal fusions at their levels; apertural bar low, but not very wide; apertures rather large, sub-normal to normal; apertural spines masked by the secondary apertural tissue. Apertural aviculœcia large and highly raised on the secondary apertural rim.

Distribution.—Senonian, [Campanian, zone of *B. mucronata* or] Maastrichtian. Royan, S. of Rochefort, Charente-Inférieure, France.

Type-specimen.—In the collection of Mr. F. Canu of Versailles. A photograph of this specimen is in the Collection.

Remarks.—*Batrachopora aurita* forms, with *B. coaxans*, a section of *Batrachopora* characterised by numerous costæ. In all the other lineages there is a marked catagenesis in the number of costæ, from 12 and 10 in *B. ovalis* and *B. perforata* to 5 and 6 or 7 in *B. ornata* and *B. hyla*, respectively. If, as is likely, *B. aurita* has been derived from *B. ovalis* or a closely allied form, there is an actual increase in the number of costæ, up to about 18, decreasing again, somewhat, in *B. coaxans*.

Figures.—Text-fig. 119. Orthœcium with its pair of apertural aviculœcia.

Specimens.—Only a photograph of the type-specimen.

11. Batrachopora coaxans, Lang.

Batrachopora coaxans, sp. n.; Lang, 1916, p. 111; *B. mucronata*-zone; Rügen, Germany.

Batrachopora coaxans, Lang; Lang, 1919[4], pp. 206, 208, 221, fig. 84 on p. 208.

DIAGNOSIS.—*Batrachopora* with orthœcial apertures decidedly smaller than the intraterminal front-wall; apertural aviculœcia

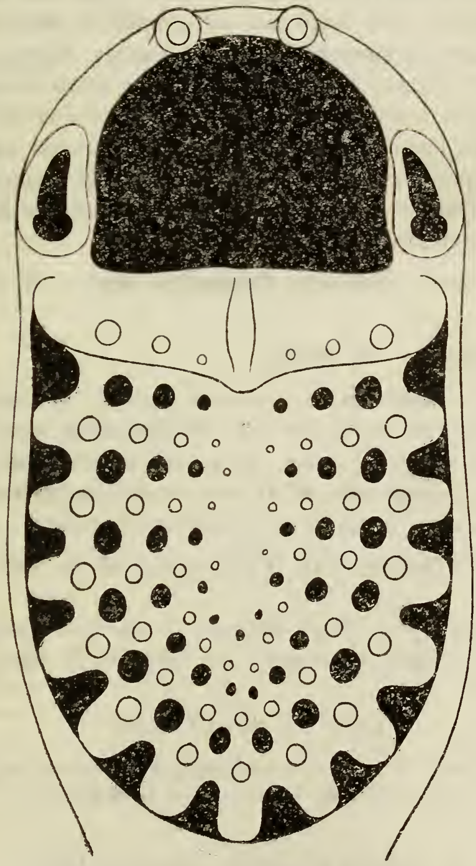


Fig. 120.—*Batrachopora coaxans*. Diagram of an orthœcium and its large apertural pair of aviculœcia, from above. × about 75 diameters.

large; orthœcia more than 1 mm. long and not twice as long as wide.

Description.—Asty erect, unilaminar; œcia dimorphic. Orthœcia about 1·5 mm. long and nearly 1 mm. wide; extraterminal front-wall of small extent, but little, or not at all, hidden by interœcial secondary tissue; intraterminal front-wall but slightly arched and consisting of about thirteen rather widely-spaced costæ, each of which bears primary, secondary, tertiary, and even quaternary pelmata with lateral fusions at their levels; apertural bar low and wide; apertures very large and sub-normal in shape; proximal apertural spines immersed in the secondary tissue round the apertural aviculœcia; distal apertural spines much thickened and retaining their individuality. The apertural aviculœcia are very large, and are borne high on the secondary apertural ring, which, however, appears to be incomplete distally; it is probable that in a better-preserved specimen the apertural aviculœcia would be seen to meet and fuse above the apertural bar.

Distribution.—Senonian, Campanian, zone of *B. mucronata*. Rügen.

Type-specimen.—D. 14209.

Remarks.—*Batrachopora coaxans* probably was derived from a form resembling *B. aurita*. It is allied to *B. aurita* by the possession of numerous costæ, though not so numerous as in that species; but the apertures of *B. coaxans* are larger than those of *B. aurita*, and the orthœcia are comparatively wider.

Figures.—Text-fig. 120. Orthœcium and its two apertural aviculœcia.

Plate VIII, fig. 5. Two orthœcia of the type-specimen, each with its pair of apertural aviculœcia. × about 27 diameters.

LIST OF SPECIMENS.

D. 14209. D. 15041. Type-specimen and paratype. Senonian, Campanian, zone of *B. mucronata*. Rügen. Agnes Laur collection. 1906, 1909.

V. PACHYDERA, Marsson, 1887.

Pachydera nov. gen.; Marsson, 1887, pp. 100, 109.
Pachydera; Osswald, 1890, p. 110.
Pachydera; Deecke, 1895, p. 80.
Pachydera; Jukes-Browne, 1904, pp. 268, 492.

Pachydera; Brydone, 1906, p. 130.
Pachydera; Lang, 1916, pp. 101, 112.
Pachydera; Lang, 1919[4], pp. 192, 199, 203–5, 219–221, 223.

Diagnosis.—Pelmatoporinæ in which the secondary aperture consists of united proximal and distal shields, and is tubular; further growth of secondary tissue prolongs the tubular aperture; the intraterminal front-wall has at least two rows of pelmata on either side of the mid-line.

Distribution.—Senonian, Campanian, to Danian.

Genotype.—*Pachydera grandis*, Marsson.

Remarks.—*Pachydera*, like *Batrachopora*, probably was derived from *Ichnopora* by a peculiar development of the secondary aperture, and by so great a further complexity of the intraterminal front-wall that the primary pelma reached the extreme proximal end of the costa. But, whereas the peculiarity of the aperture of *Batrachopora* was its great development in size and especially in breadth, *Pachydera* is characterised by a greatly extended secondary aperture. Both proximal and distal shields are present, and these are fused with one another to form a tubular aperture. The proximal shields appear to be formed, as in *Ichnopora* and *Batrachopora*, by fusions above the apertural bar of the stalked apertural aviculœcia; the proximal apertural spines, however, seem not to be merged with these stalked aviculœcia, but to maintain their integrity, and they are fused distally with the aviculœcian processes on one side, and with the distal shield on the other side, by means of an apertural rim. Thus the secondary aperture consists at first of a short tube pierced by six fenestræ—a median proximal fenestra lying between the aviculœcian processes, a proximal-lateral pair of fenestræ lying between the aviculœcian processes and the proximal pair of apertural spines, a distal-lateral pair of fenestræ lying between the proximal and distal pairs of apertural spines, and a median distal fenestra lying between the two distal apertural spines. Further extension of the secondary aperture is attained by means of a repetition of this structure: each of the upright pieces is continued beyond the apertural rim and united by another rim distally, thus superposing six more fenestræ upon the original six; and this process is again repeated, so that the fenestræ lie in superposed tiers. The distribution and formation of the fenestræ is thus easily accounted for. But on the bars of the lattice-like secondary aperture, and especially at the nodes, are depressions of a doubtful character. The original apertural aviculœcia, directed towards one another on the proximal shield and lying immediately above the apertural bar, are often fairly distinct. But the other depressions, generally occurring at the nodes of the secondary aperture, are of very uncertain nature; they often bear at least a superficial resemblance to the pelmata of the intraterminal front-wall, and may be corresponding modifications of the apertural spines, but are possibly of the nature of aviculœcia.

Pachydera exhibits catagenesis in the number of costæ and pelmata during evolution, since *P. grandis*, from the *B. mucronata*-zone of Rügen, has six to nine costæ, small quaternary, and even pelmatidial quinary pelmata; while *P. densa*, from the Danian, has but five or six costæ and pelmatidial tertiary pelmata.

Key to Species of *Pachydera*.

A. Costæ six to nine, with large primary, secondary, and tertiary, small quaternary, and sometimes minute quinary pelmata (fig. 121) .... 1. *P. grandis.*

B. Costæ five or six, with large or normal primary and secondary pelmata and minute tertiary pelmata (fig. 122) .... 2. *P. densa.*

1. Pachydera grandis, Marsson.

Pachydera grandis n. sp.; Marsson, 1887, pp. 100, 109, pl. x, fig. 14; Senon, Weisse Schreibkreide; Rügen.

Pachydera grandis Mars.; Osswald, 1890, p. 110; Kreide, probably Drift; Kluzer Orts, N.W. of Wismar, Mecklenburg, Germany.

Pachydera grandis Marss.; Deecke, 1895, p. 80; Senon; Rügen.

Pachydera grandis, Marss.; Jukes-Browne, 1904, pp. 268, 492; Zone of *Ostrea lunata*; Trimmingham.

Pachydera grandis, Mares.; Brydone, 1906, p. 130; Chalk; between Cromer and Weybourne.

Pachydera grandis Marsson; Lang, 1916, p. 112; *B. mucronata*-zone; Rügen, Germany.

Pachydera grandis, Marsson; Lang, 1919 [4], pp. 204–205, 221, figs. 36–8 on p. 204.

Diagnosis.—*Pachydera* with 6 to 9 costæ, each of which bears large primary, secondary, and tertiary pelmata, small quaternary, and, sometimes at least, minute (pelmatidial) quinary pelmata.

Description.—Asty unilaminar, incrusting, generally on a cylindrical substratum; œcia dimorphic. Orthœcia about 1·25 to 1·5 mm. long and ·5 mm. wide, somewhat pear-shaped, oval proximally, and tapering distally to a cylindrical secondary aperture; extraterminal front-wall of very small extent, but little concealed by a very scanty interœcial secondary tissue; intraterminal front-wall well arched and consisting of about six to nine well-spaced costæ, each of which bears a primary pelma at the extreme proximal end, a secondary pelma (somewhat smaller, but, nevertheless, large), and a tertiary pelma (slightly smaller than the secondary pelma) on its mid-length, a small quaternary pelma distally, and in some cases, close to the mid-line, a minute quinary pelma in the pelmatidial condition; there are lateral costal fusions at the levels of the secondary, tertiary, and quaternary pelmata (in fact, the secondary and tertiary pelmata are so large and close to their neighbours as almost to touch them), so that the intraterminal front-wall is a lattice-work with rounded meshes and, at the nodes, pelmata of about the same size as the meshes; each half of the apertural bar much resembles the normal costæ. The secondary aperture resembles a lattice-work tube, being composed of six vertical bars connected at intervals by horizontal rings. Apparently it is formed as follows:—The four more distal uprights are the four apertural spines, the two most proximal uprights are the processes bearing the apertural aviculœcia—the latter, growing towards one another, fuse above the apertural bar, and this fusion forms the proximal section of the lowest horizontal ring; the more distal portions of the lowest horizontal ring are formed by the fusions of the distal ends of the apertural spines with one another and with the aviculœcium-bearing processes; each of the uprights continues to grow beyond the lowest apertural ring, fusion again takes place at the distal ends, and so a second ring is completed; this process is repeated a third time, so that the secondary aperture finally has three horizontal rings and six vertical series of three fenestræ each. At the lowest node between the proximal series and the proximal-lateral series on each side of it are the proximal ends of the apertural aviculœcia; their distal ends stretch along the bar between the lowest and the middle fenestræ of the proximal series. On the bars of the secondary apertural lattice, and especially at the nodes, are other depressions of a doubtful nature, possibly aviculœcia, but more probably the broken ends of branches of the apertural spines; this explanation would account for their appearing very like the pelmata of the intraterminal front-wall—in fact, the

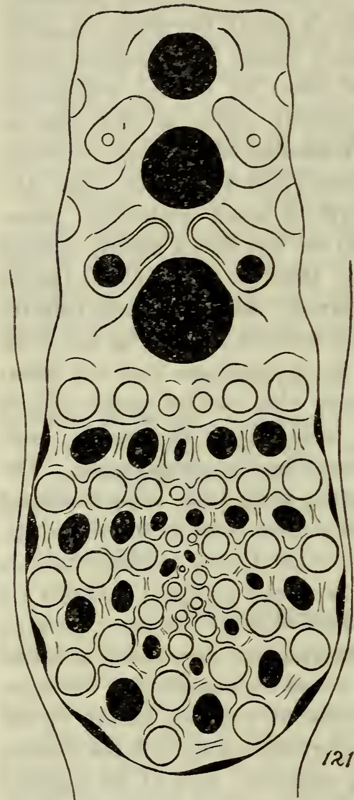

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Fig. 121.—*Pachydera grandis*. Diagram, from above, of an orthœcium with its primary pair of apertural aviculœcia fused over the apertural bar, forming a fenestra, and above this a secondary pair forming a second fenestra, and above again a third fenestra in the proximal shield of the secondary aperture. × about 75 diameters.

Fig. 122.—*Pachydera densa*. Diagram, from above, of an orthœcium showing the same structures as those described under fig. 121. × about 75 diameters.

lattice-like secondary aperture bears a general resemblance to the lattice-like intraterminal front-wall. Essentially, then, these depressions would partake of the nature of pelmata, being the original endings of terminal spines, but in their case the terminal spines of which they are the broken endings are apertural spines, and not costæ; they may provisionally, then, be termed 'apertural pelmata.' Aviculœcia as described.

Distribution.—Senonian, Campanian, zone of *B. mucronata*. Rügen.

Type-specimen.—That figured by Marsson, 1887, pl. x, fig. 14, is hereby selected.

Remarks.—*Pachydera grandis* is mainly remarkable for the complication of the intraterminal front-wall, since each costa bears four and sometimes even five pelmata. *P. densa*, to which, presumably, it gave rise, has a secondarily simpler intraterminal front-wall.

Figures.—Text-fig. 121. Orthœcium and its two apertural aviculœcia.

Plate VIII, fig. 6. Specimen **D. 14680**. consisting of five orthœcia. × about 27 diameters.

LIST OF SPECIMENS.

D. 14208. D. 14531–5. D. 14537–9. D. 14659–61. D. 14665. D. 14680. D. 14981. D. 16525. Sixteen asties, of which **D. 14534. D. 14537–9** show the primary pelmata extremely clearly, **D. 14535** and **D. 14659** the three tiers of the secondary aperture, and **D. 14665** well-preserved apertural aviculœcia. Senonian, Campanian, zone of *B. mucronata*. Rügen. Agnes Laur collection. 1906, 1909.

2. Pachydera densa, Lang.

Pachydera densa, sp. n.; Lang, 1916, p. 112; Danian; Faxe, Denmark.
Pachydera densa, Lang; Lang, 1919 [4], pp. 205, 221.

Diagnosis.—*Pachydera* with 4 or 5 costæ, each of which bears large primary and secondary, and small tertiary pelmata.

Description.—Asty unilaminar, incrusting, and generally on a solid cylindrical substratum; œcia dimorphic. Orthœcia about

1 mm. long and about ·5 mm. wide, more-or-less pear-shaped, owing to the oval proximal end tapering to a cylindrical secondary aperture; extraterminal front-wall of very small extent, hardly obscured by a very scanty interœcial secondary tissue; the intraterminal front-wall is well arched and consists of about five widely-spaced costæ, each of which bears a large primary pelma at its extreme proximal end, a large secondary pelma rather nearer the distal than the proximal end, and a very small (pelmatidial) tertiary pelma at the distal end, close to the mid-line; lateral costal fusions occur at the levels of the secondary pelmata; the apertural bar and secondary aperture resemble, apparently, those of *P. grandis.* Aviculœcia, like those of *P. grandis.*

Distribution.—Danian. Faxe, Sjælland, Denmark.

Type-specimen.—D. 28210.

Remarks.—In the original diagnosis of *Pachydera densa* it was stated that the secondary aperture was more tubular than in *P. grandis.* It has since been determined, however, that the secondary aperture of *P. grandis* may be quite as prolonged as that of *P. densa.* The main difference between the two species lies in the intraterminal front-wall, which in *P. densa* is far simpler, and, presumably, secondarily so. The costæ are fewer—about five, instead of from six to nine; there are no quinary pelmata, sometimes present in *P. grandis*; no quaternary pelmata, always present in *P. grandis*; and the tertiary pelmata are minute, whereas in *P. grandis* they are very large. *P. densa* was probably derived from *P. grandis* by the modification of the intraterminal front-wall in these catagenetic directions.

Figures.—Text-fig. 122. Orthœcium and its pair of apertural aviculœcia.

Plate VIII, fig. 7. Part of the type-specimen, showing the whole or parts of four orthœcia. × about 27 diameters.

LIST OF SPECIMENS.

D. 28210. D. 28209. D. 28211–13. Type-specimen and four paratypes. Danian. Faxe, Sjælland, Denmark. Pindborg collection. 1914.

VI. DECURTARIA, Jullien, 1886.

Semiescharipora [partim] ; Beissel, 1865, pp. 11, 58, 90.
Semiescharipora [partim] ; Ubaghs, 1879, pp. 139, 217.
Semiescharipora [partim] ; Mourlon, 1881, p. 116.
Decurtaria ; Jullien, 1886, p. 606.
Semiescharipora ; Jullien, 1886, p. 606.
Prosoporella nov. gen. ; Marsson, 1887, pp. 100, 109.
Prosoporella ; Deecke, 1895, p. 80.
Cribrilina [partim] ; Canu, 1900 [2], p. 441.
Cribrilina (*Decurtaria*); Canu, 1900 [2], p. 446.
Decurtaria ; Lang, 1916, pp. 101, 107.
Prosoporella ; Lang, 1917, p. 172.
Decurtaria ; Lang, 1917, p. 172.
Semiescharipora ; Lang, 1917, p. 172.
Decurtaria ; Lang, 1919, pp. 192, 199, 200, 204–5, 220–1, 223.

Diagnosis.—Pelmatoporinæ with only the distal shield of a secondary aperture ; this, however, is very stout, and forms a thick cushion-like collar round the distal two-thirds of the aperture ; it appears to be formed of a collar-like growth of secondary tissue that involves and obliterates both pairs of apertural spines ; vertically directed secondary aviculœcia appear, as in *Pelmatopora*, on the distal rim of the secondary aperture and immediately distal to the apertural spines ; but in *Decurtaria* these are imbedded in the distal face of the distal shield, and do not, as in *Pelmatopora*, stand out freely from it ; the costæ are very few and bear but two or three pelmata.

Genotype.—*Semiescharipora cornuta*, Beissel.

Remarks.—*Decurtaria* may be known from the other Pelmatoporinæ by the collar-like distal shield of the secondary aperture and the absence of any proximal shield. Imbedded in the distal face of the distal shield are two pairs of vertically-directed aviculœcia, comparable in position with the 'secondary aviculœcia' of *Pelmatopora quadrivolucris* ; but, whereas the latter structures are free, those of *Decurtaria* are firmly united by secondary tissue of the distal shield in which they lie imbedded. It is possible that these aviculœcia are the homologues of the 'secondary aviculœcia' of *Pelmatopora*, and that *Decurtaria* is directly derived from advanced species of that genus. Indeed, the co-existence of 'secondary aviculœcia' and distal apertural spines is matched in the type-specimen of *Decurtaria allecta*, where the distal ends of the aviculœcia lie against, and distal to, those of the apertural spines. It differs, moreover, from *Pelmatopora* in the catagenetic development of the intraterminal front-wall, which consists of about six costæ only, and these have but two or three pelmata. It is to be noted that all the high-zonal Pelmatoporine genera, except *Murinopsia* (which is partly high and partly mid-zonal), namely, *Batrachopora*, *Pachydera*, and *Decurtaria*, exhibit catagenesis in the number of costæ and pelmata.

It is remarkable that of the two species of *Decurtaria*—namely, *D. cornuta* from Rügen and *D. allecta* from Maastricht—the latter should be more primitive than the former. Generally speaking, the Maastricht forms are further developments of very similar species from Rügen. But *D. allecta* is certainly more primitive than *D. cornuta*, having a less catagenetic intraterminal front-wall, with more costæ and pelmata, and altogether a less solid skeleton, and cannot be derived from *D. cornuta*. The specimens we know are probably the survivors of a common ancestor, which may yet be found (perhaps low) in the *B. mucronata*-zone at Rügen, while others wandered away to the new environment at Maastricht, and became there the still primitive *D. allecta*.

Key to the Species of *Decurtaria*.

A. Skeleton less massive; costæ eight or ten (fig. 123) ...... 1. *D. allecta*.
B. Skeleton more massive; costæ four to seven (fig. 124) ... 2. *D. cornuta*.

1. Decurtaria allecta*, new species.

Diagnosis.—*Decurtaria* with skeleton less solid than that of *D. cornuta*, and 8 or 9 costæ.

Description.—Asty erect, unilaminar; œcia dimorphic. Orthœcia about ·66 mm. long and ·56 mm. wide, broadly oval to sub-circular; extraterminal front-wall of small extent and but little concealed by a very scanty interœcial secondary tissue; the intraterminal front-wall is well arched and consists of from eight to ten rather widely-spaced costæ, each of which bears proximally

* *allecta*—'enticed,' on the assumption that the species migrated to Maastricht from Rügen.

a long, slot-like, compound pelma, which is constricted in the middle, has a larger proximal and a smaller distal expansion, and is composed of fused primary and secondary pelmata; towards the distal end of each costa is a smaller tertiary pelma (sometimes also united to the compound pelma), and there are lateral costal fusions at the levels of the secondary (that is, the distal end of the compound pelma) and tertiary pelmata; the extreme distal ends of the costæ are united in a median area of fusion, and it is possible in some cases to detect exceedingly minute pelmatidial

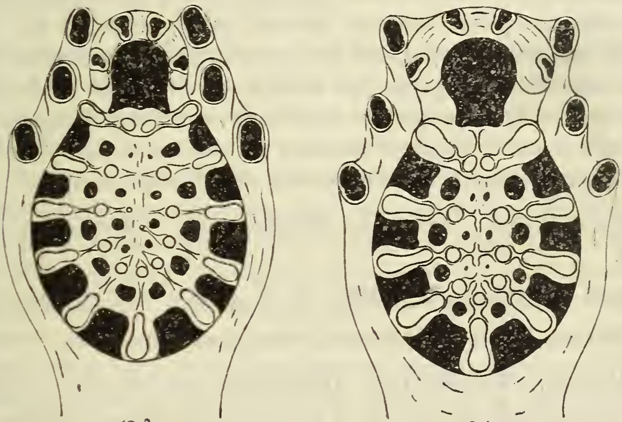

Fig. 123.—*Decurtaria allecta.* Diagram of an orthœcium and three pairs of interœcial aviculœcia, from above, showing the secondary orthœcial aperture, with the distal shield formed of secondary tissue growing up against the distal face of the primary aperture, tending to obliterate the apertural spines, and itself bearing, imbedded in its distal face, two pairs of aviculœcia corresponding in position to the apertural spines. × about 75 diameters.

Fig. 124.—*Decurtaria cornuta.* Diagram, from above, of an orthœcium with its two pairs of secondary apertural aviculœcia imbedded in the distal shield of the secondary aperture and its three pairs of primary interœcial aviculœcia. × about 75 diameters.

quaternary pelmata; each half of the apertural bar resembles a normal costa; the apertures are super-normal; the distal shield is not so solid as in *D. cornuta*, and in some instances it is possible to see the primary apertural rim bearing the apertural spines in its distal face, with the secondary apertural rim, as it were, plastered against this distally, bearing in its turn the secondary aviculœcia imbedded in its distal face, and corresponding in position to the apertural spines (see fig. 123); this is exactly comparable with the arrangement of similar structures in *Pelmatopora brydonei* (see pp. 294–5). Aviculœcia: two pairs of secondary aviculœcia on the apertural rim and three pairs of primary aviculœcia accompanying each orthœcium, and lying in the interœcial valleys; the most distal pair of primary aviculœcia is placed at the level of the distal end of the aperture, and lies more medianly and is raised higher than the other two pairs; the most proximal pair is placed at the level of the first pair of costæ, and lies more laterally and is sunk lower than the other two pairs; the median pair is at the level of the proximal part of the aperture, and is intermediate in distance from the mid-line and in height between the other two pairs; all have but slightly elongate apertures—as a rule, directed distally.

Distribution.—Senonian, Maastrichtian. Maastricht, Holland.

Type-specimen.—D. 28305. F. H. Butler. 1918.

Remarks.—See remarks under the genus *Decurtaria*.

Figures.—Text-fig. 123. Orthœcium, two pairs of secondary apertural aviculœcia, and six of primary interœcial aviculœcia.

Plate VIII, fig. 8. The type-specimen, consisting of two complete and two partial orthœcia. × about 27 diameters.

Specimens.—The type-specimen. Distribution and collection as above.

2. Decurtaria cornuta (Beissel).

Semiescharipora cornuta M. 1864; Beissel, 1865, pp. 58, 11, 90, pl. vii, figs. 77–81; Senonian [*A. quadratus*-zone], Kreidemergel ohne Feuerstein, mittlere und obere Pläner; Friedrichberg, Vaels und Schneeberg, near Aachen.

Semiescharipora cornuta, Beissel; Ubaghs, 1879, pp. 139, 217; Sénonien; Craie Marneuse sans silex [zone of *A. quadratus*]; Limbourg.

Semiescharipora cornuta, Beiss.; Mourlon, 1881, p. 116; Sénonien; Limbourg.

Decurtaria cornuta (Beissel); Jullien, 1886, p. 606 [Genotype of *Decurtaria*].

Prosoporella cornuta Beissel sp.; Marsson, 1887, pp. 100, 109; weisse Schreibkreide; Rügen [Genotype of *Prosoporella*].

Prosoporella cornuta Beiss.; Deecke, 1895, p. 80; Senon; Rügen.

Cribrilina (*Decurtaria*) *cornuta* (Beissel); Canu, 1900[2], pp. 441, 446, text-fig. 53 on p. 441 [copy of Beissel, 1865, pl. vii, fig. 80], text-fig. 60 on p. 446 [copy of Beissel, 1865, pl. vii, fig. 77, 78, 81].

Decurtaria cornuta (Beissel); Lang, 1916, p. 107; Maastrichtian; Aachen, Germany.

Decurtaria cornuta (Beissel); Lang, 1917, p. 172.

Decurtaria [*Semieschanipora*] *cornuta* (Beissel); Lang, 1919[4], pp. 200, 205, 221, figs. 15–17 on p. 200.

Diagnosis.—*Decurtaria* with a skeleton more solid than that of *D. allecta*, and but 5 or 6 costæ.

Description.—Asty erect, unilaminar; œcia dimorphic. Orthœcia about ·66 mm. long and ·56 mm. wide, broadly oval to subcircular; extraterminal front-wall of considerable extent, and hardly, if at all, concealed by interœcial secondary tissue, which is very scanty, if not entirely absent; the intraterminal front-wall is well arched, somewhat flat above, and consists of five to seven well-spaced costæ, each of which bears proximally a very large, somewhat medianly constricted, slot-shaped pelma composed of fused primary and secondary pelmata, and distally small tertiary pelmata; there are lateral costal fusions at the distal ends of the constricted, slot-like, compound pelmata; each half of the apertural bar resembles one of the normal costæ; the aperture is super-cribriline in shape; the distal shield is formed on the plan already described for the genus, but is more solid than that of *Decurtaria allecta*, and the apertural spines are more completely obliterated. Aviculœcia of two kinds, (1) primary and (2) secondary; each orthœcium has eight or ten aviculœcia accompanying it, two or three pairs of primary and two of secondary. (1) The primary aviculœcia lie in the interœcial valleys, but on the orthœcium which each accompanies; they comprise a higher, more distally and more medianly placed pair lying alongside the distal part of the aperture, a middle less raised pair lying alongside the proximal part of the aperture, and a proximal low-lying and more outwardly placed pair lying at about the level of the first pair of costæ; or there may be only two pairs; the apertures of all three pairs are constricted, but little elongated, and are generally directed distally. (2) The secondary aviculœcia have already been described as being vertically directed and consisting of two pairs, imbedded in the distal face of the distal shield and generally corresponding in position with the apertural spines; they have large, nearly circular, proximal portions, divided by a constriction from smaller, somewhat elongate rostra.

Distribution.—Senonian, Campanian, zone[s] of [*A. quadratus* and] *B. mucronata*. Holland and Northern Germany.

Type-specimen.—That figured by Beissel, 1865, pl. vii, fig. 77, is hereby selected.

Remarks.—See remarks under the genus *Decurtaria*.

Figures.—Text-fig. 124. Orthœcium, two pairs of secondary apertural aviculœcia, and three of primary interœcial aviculœcia.

Plate VIII, fig. 9. Part of specimen **D. 15000**, showing four orthœcia. × about 27 diameters.

LIST OF SPECIMENS.

D. 14168–70. D. 14172–75. D. 14177–82. D. 14484. D. 14993. D. 15000. D. 15025. D. 15031. D. 15083. D. 16524. D. 29033–35. Twenty-three asties, of which **D. 15000** shows a fusion of all the pelmata on each costa. Senonian, Campanian, zone of *B. mucronata*. Rügen. Agnes Laur collection. 1906, 1909.

VII. MURINOPSIA, Jullien, 1886.

Multescharipora [partim]; d'Orbigny, 1853, p. 497, 1854, p. 1098.
Multescharipora [partim]; Pictet, 1857, p. 112.
Semiescharipora [partim]; Beissel, 1865, pp. 11, 55, 90.
Semiescharipora [partim]; Ubaghs, 1879, pp. 139, 217.
Semiescharipora [partim]; Mourlon, 1881, p. 116.
Murinopsia; Jullien, 1886, p. 608.
Lagodiopsis nov. gen.; Marsson, 1887, pp. 99, 100.
Lagodiopsis; Deecke, 1895, p. 80.
Murinopsia; Canu, 1900 [2], p. 452.
? *Semiescharipora*; Jukes-Browne, 1904, pp. 268, 492.
Murinopsia; Lang, 1916, pp. 101, 107.
Lagodiopsis [partim]; Lang, 1917, p. 171.
Murinopsia; Lang, 1917, p. 171.
Murinopsia; Lang, 1919 [4], pp. 192, 199, 200, 204–5, 220–1, 223.
Multescharipora; Lang, 1919 [4], p. 205.
Semiescharipora; Lang, 1919 [4], p. 205.

Diagnosis.—Pelmatoporinæ in which the secondary aperture has a distal shield only, or a proximal shield, if present, is represented only by a flattening of the apertural bar in the vertical plane; the distal shield is formed of a rim of secondary tissue involving the apertural spines, but does not embrace either primary or (as in *Decurtaria*) secondary aviculœcia; on the other hand, one or more pairs of aviculœcia project distally beyond the secondary aperture, but are not fused with it.

Distribution.—Senonian, Campanian. North-western Europe.

Genotype.—*Semiescharipora galeata*, Beissel.

Remarks.—*Murinopsia*, like *Decurtaria*, probably was derived directly from *Pelmatopora*, but, unlike *Decurtaria*, from a species of *Pelmatopora* which had not yet acquired secondary aviculœcia. For the distal shield of *Murinopsia* is formed of a rim of secondary tissue involving the apertural spines, but not bearing secondary aviculœcia. And those aviculœcia of *Murinopsia* which project distally beyond the secondary aperture appear rather to be comparable with the primary aviculœcia of *Decurtaria* than with the secondary aviculœcia of that genus and of *Pelmatopora*. Moreover, *Murinopsia* has a more primitive intraterminal front-wall than has *Decurtaria*. That is to say, catagenesis, though it may have set in, has not proceeded far, since the costæ are more numerous and the pelmata as numerous as, and less specialised than, those of *Decurtaria*; there are no fusions between the primary and secondary pelmata.

The two species of *Murinopsia* are to be distinguished by the number of pairs of aviculœcia that accompany each orthœcium; these aviculœcia are placed distally in the neighbourhood of the orthœcial apertures, and consist of a single pair in *M. francqana* and of at least two pairs in *M. galeata*. Without the actual specimens, it is difficult to compare the relative developments of their intraterminal front-walls, so as to determine which is the more primitive; but it is likely that *Murinopsia galeata*, with its larger number of primary aviculœcia, is the more primitive. This species out-ranges *M. francqana* both in an upward and downward direction, since it is found in the *A. quadratus*-zone at Aix and (presumably high) in the *B. mucronata*-zone at Rügen; while *M. francqana* occurs only in the Meudon chalk, in the zone of *B. mucronata*, probably in the lower and middle parts.

Key to the Species of *Murinopsia*.

A. More than one pair of aviculœcia accompany each orthœcium at its distal end .... 1. *M. galeata*.

B. A single pair of aviculœcia accompanies each orthœcium at its distal end (fig. 125) .... 2. *M. francqana*.

1. Murinopsia galeata (Beissel).

Semiescharipora galeata m.; Beissel, 1865, pp. 55, 11, 90, pl. vi, figs. 70–75, pl. vii, fig. 76; Senonian [*A. quadratus*-zone], Kreidemergel ohne Feuerstein, mittlere und obere Pläner; Friedrichberg, Vaels and Schneeberg, near Aachen.

Semiescharipora galeata, Beissel, 1865; Ubaghs, 1879, pp. 139, 217; Sénonien, Craie Marneuse sans silex [zone of *A. quadratus*]; Limbourg.

Semiescharipora galeata, Beissel, 1865; Mourlon, 1881, p. 116; Sénonien; Limbourg.

Murinopsia galeata (Beissel); Jullien, 1886, pp. 608–9; terrains crétacés; genotype of *Murinopsia*.

Semiescharipora galeata Beissel; Marsson, 1887, p. 100.

Non=*Multescharipora francqana*, d'Orbigny; as stated by Marsson, 1887, p. 100.

Semiescharipora galeata Beissel; Canu, 1900[2], p. 452, and figured as *M. francqana* (d'Orb.), text-fig. 64 *a–d* on p. 452 [copy of Beissel, 1865, pl. vi, figs. 72–4–3, pl. vii, fig. 76].

Non=*Murinopsia francqana* (d'Orbigny); as stated by Canu, 1900[2], p. 452.

? *Semiescharipora galeata*, Beiss.; Jukes-Browne, 1904, pp. 268, 492; zone of *Ostrea lunata*; Trimingham.

Murinopsia galeata (Beissel); Lang, 1916, p. 107; Maastrichtian; Aachen, Germany.

Semiescharipora galeata Beissel; Lang, 1917, p. 171.

Murinopsia [*Semiescharipora*] *galeata* (Beissel); Lang, 1919[4], pp. 205–221.

Diagnosis.—*Murinopsia* in which two or more pairs of aviculœcia accompany the aperture of every orthœcium.

Distribution.—Senonian, Campanian, zone of *A. quadratus* and *B. mucronata*. Aachen (Aix-la-Chapelle) and Rügen.

Type-specimen.—That figured by Beissel, 1865, pl. vi, fig. 75, is hereby selected.

Remarks.—See remarks under the genus *Murinopsia*.

Specimens.—None in the Collection.

2. Murinopsia francqana (d'Orbigny).

Multescharipora francqana, d'Orb.; d'Orbigny, 1852, pl. 734, figs. 6–8; 1853, p. 497; 1854, p. 1098; Sénonien; Meudon, près de Paris.

Multescharipora Francquana [sic], d'Orb.; Pictet, 1857, p. 112; craie blanche.

Murinopsia Francqana (d'Orbigny); Jullien, 1886, pp. 608, 609; craie de Meudon.

Lagodiopsis Francquana [sic] d'Orbigny sp.; Marsson, 1887, pp. 100, 109; weisse Schreibkreide; Rügen; genotype of *Lagodiopsis*.

Non=*Semiescharipora galeata* Beissel, as stated by Marsson, 1887, p. 100.

Lagodiopsis Francquana [sic] d'Orb.; Deecke, 1895, p. 80; Senon; Rügen.

Murinopsia Francqana d'Orb.; Canu, 1900 [2], p. 452; Senonian.

Non=*Semiescharipora galeata* Beissel; as stated by Canu, 1900 [2], p. 452 and figured text-fig. 64 *a–d* on p. 452 [a copy of Beissel, 1865, pl. vi, figs. 72–4–3, and pl. vii, fig. 76].

Murinopsia francqana (d'Orbigny); Lang, 1916, p. 107; [Campanian]; Meudon, France.

Multescharipora francqana d'Orbigny; Lang, 1917, p. 171.

Murinopsia [*Multescharipora*] *francqana* (d'Orbigny); Lang, 1919 [4], pp. 200, 205, 221, figs. 18–20 on p. 200.

Diagnosis.—*Murinopsia* in which a single pair of aviculœcia accompanies the aperture of every orthœcium.

Description.—Asty incrusting, unilaminar; œcia dimorphic. Orthœcia about ·67 mm. long and ·4 mm. wide, elliptical, but broader proximally; the intraterminal front-wall is well arched and consists of about ten fairly widely-spaced costæ, each bearing rather small primary, secondary, tertiary, and generally quaternary pelmata, and having lateral fusions at the levels of these; the apertural bar is wide and flattened proximo-distally, so as to form a minute proximal shield; apertures sub-normal; the distal shield is a thick collar-like rim of secondary tissue encircling the distal three-quarters of the aperture, and enveloping the four apertural spines, which, however, are not obliterated, but emerge above the rim. The apertural aviculœcia of the single pair project beyond the distal shield and are quite separate from it.

Distribution.—Senonian, Campanian, zone of *B. mucronata*, probably in the lower or middle part of the zone. Meudon, S.W. of Paris.

Remarks.—The above description of *Murinopsia francqana* is founded upon a specimen labelled "*Murinopsia* [*Multescharipora*] *francqana*" in Mr. Canu's collection. A photograph of this specimen is in the British Museum. For further remarks see under the genus *Murinopsia*.

Figures.—Text-fig. 125. Diagram of an orthœcium and its two attendant aviculœcia.

Fig. 125.—*Murinopsia francqana*. Diagram of an orthœcium and two distally-placed aviculœcia, from above. × about 75 diameters.

Specimens.—Only a photograph of a topotype in Mr. Canu's collection.

INDEX TO SYSTEMATIC NAMES OF POLYZOA.

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GENERAL INDEX.

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All × about 27 diameters.

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Plate I

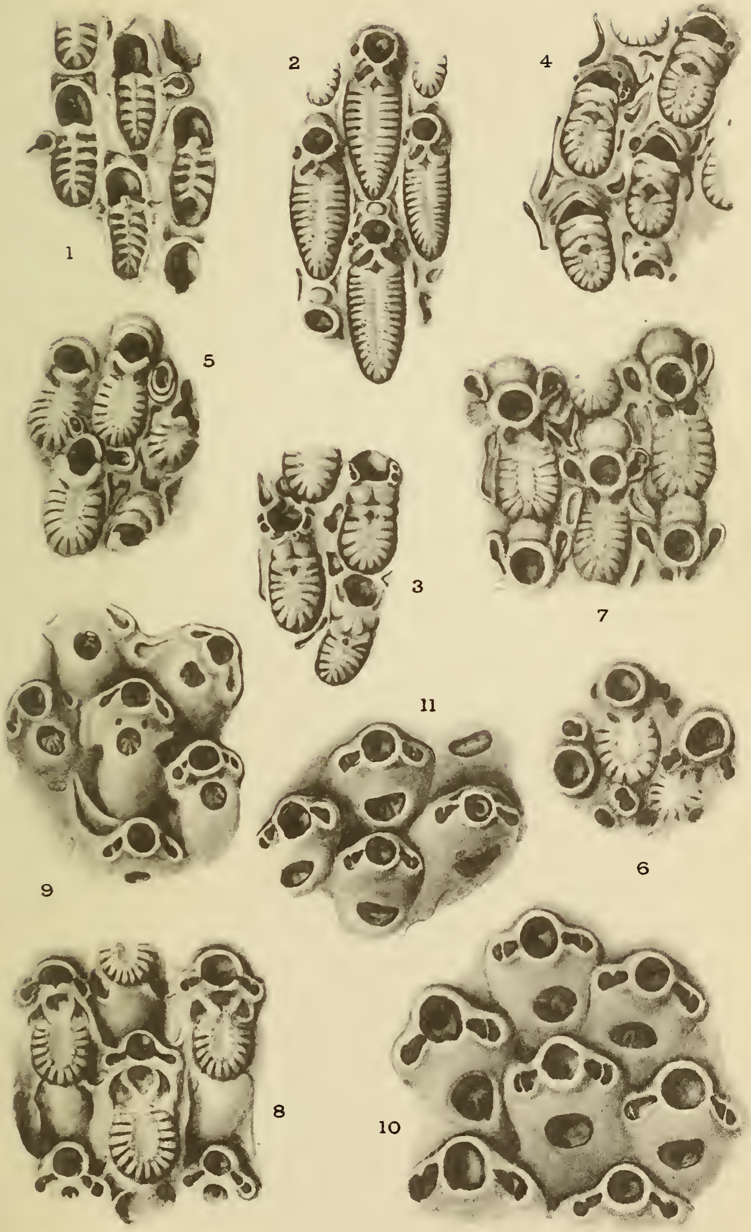

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PLATE II.

All × about 27 diameters.

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Plate II.

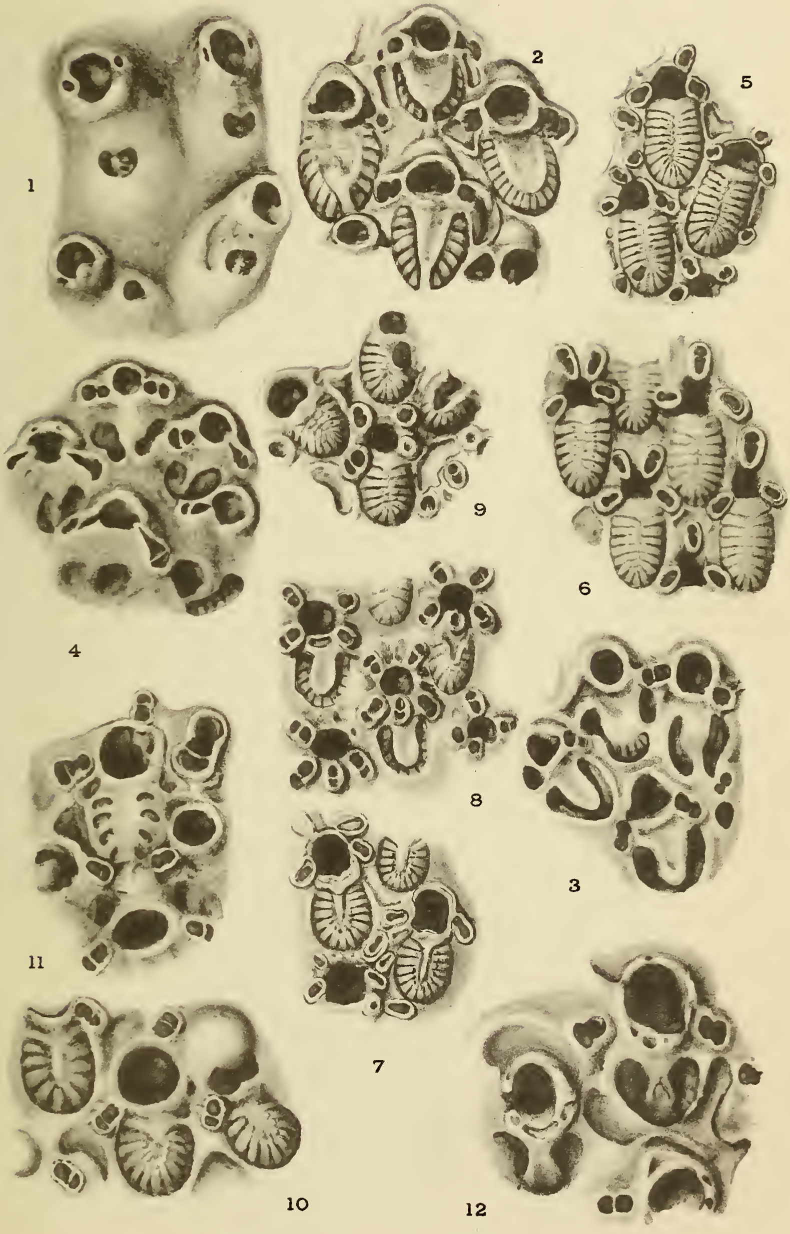

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PLATE III.

All × about 27 diameters.

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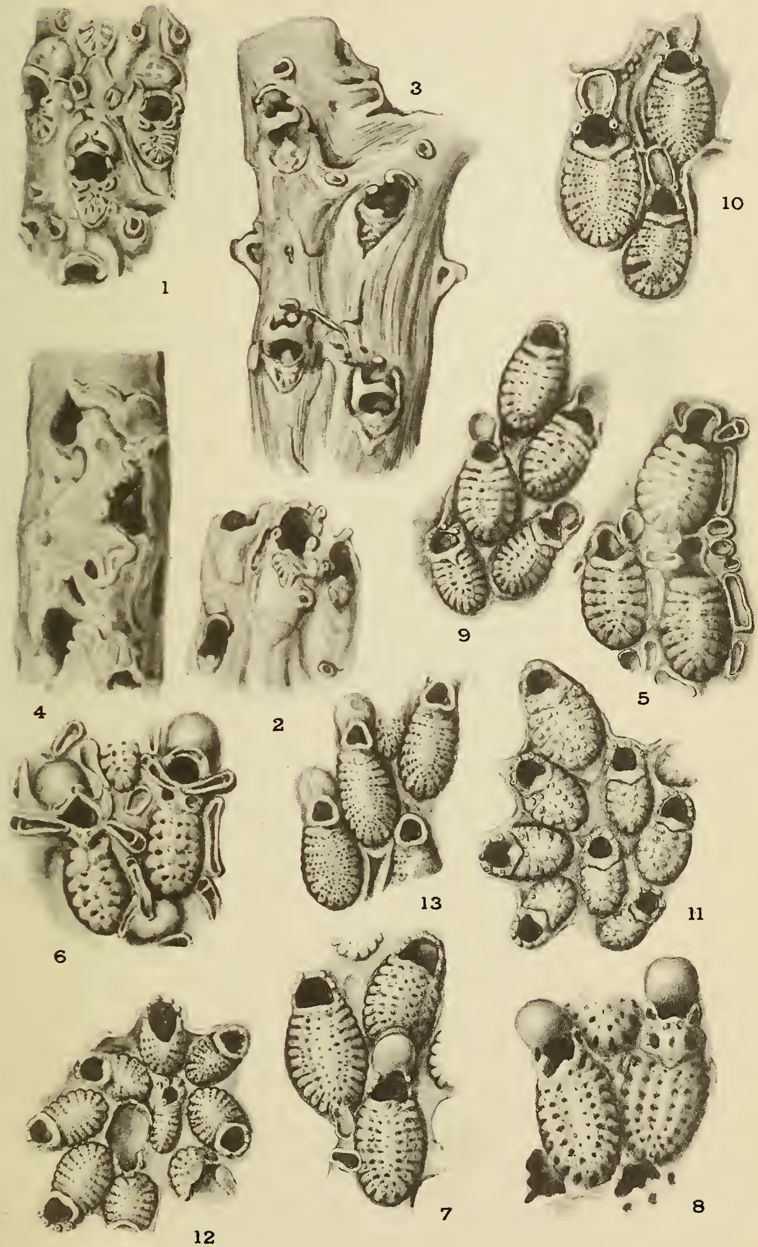

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PLATE IV.

All × about 27 diameters.

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PLATE V.

All × about 27 diameters.

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PLATE VI.

All × about 27 diameters.

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PLATE VII.

All × about 27 diameters.

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Plate VII.

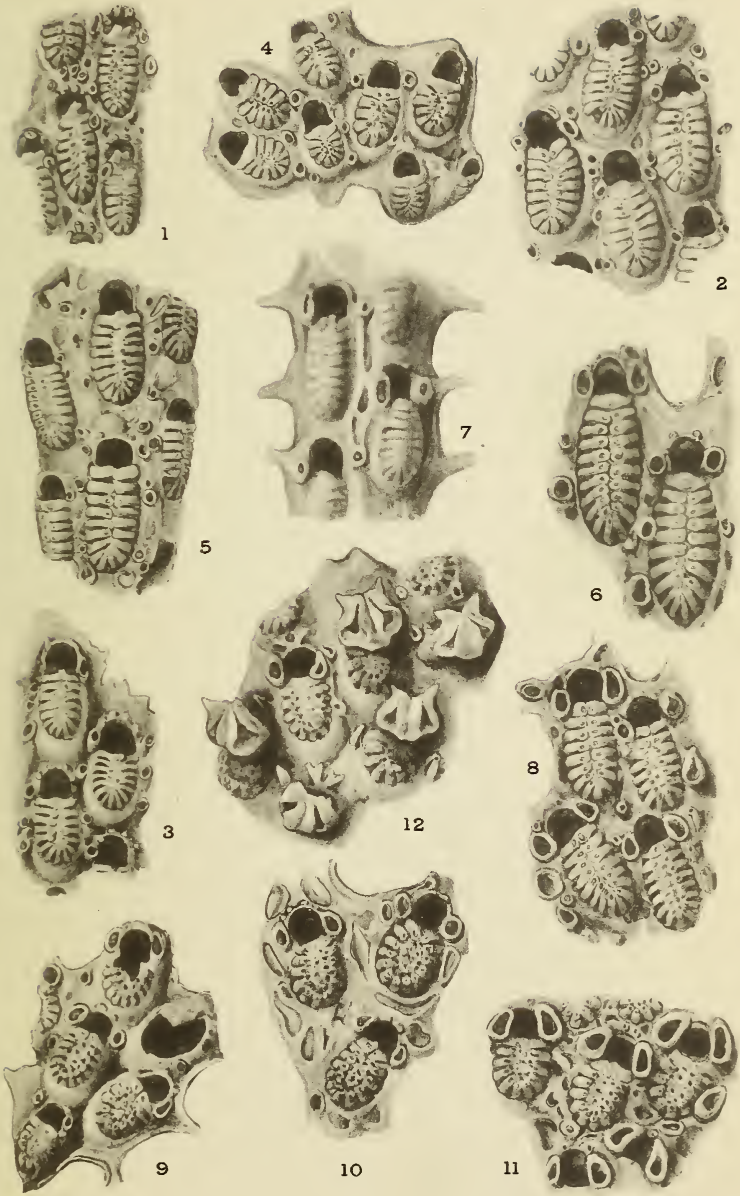

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PLATE VIII.

All × about 27 diameters.

Fig. 1. *Batrachopora ranunculus* (pp. 362–4). Zone of *B. mucronata.* Rügen.

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