

42. OBSERVATIONS on the AFFINITIES of the GENUS *ASTROCCENIA*.

By ROBERT F. TOMES, Esq., F.G.S. (Read June 21st, 1893.)

[PLATE XX.]

RESEARCHES recently made relative to the structure of certain undoubted *Astrocceniæ*, having for their primary object the better understanding of the supposed species of the genus obtained from the Glamorganshire Conglomerate, have been productive of results which are to a great extent unexpected, and which will render imperative a complete modification in the classificatory position of the genus.

Before recording the examinations which have led to these results, it is desirable that I should make a brief survey of some part of the literature relating to the genus. Commencing with its definition by the original describers, MM. Milne-Edwards and Haime, which appeared in the 'Annales des Sciences Naturelles' in 1848,¹ I transcribe in full their own words:—

“Ce genre a un polypier massif, beaucoup plus dense que celui des *Stylocœnies*. Les cloisons sont proportionnellement épaisses, et on ne distingue jamais à l'angle des calices de tubercules columnaires. Enfin, la columelle est en général très peu saillante. Sous tous les autres rapports, les *Astrocceniæ* ne diffèrent pas du genre précédent [*Stylocœnia*]; elles se séparent comme lui des *Stylinæ* par les calices polygonaux; des *Stéphanocœnies*, par l'absence de palis; des *Phyllocœnies*, des *Dichocœnies* et des *Hétérocœnies* par la columelle styloforme.”

After a few words relative to the distribution of the several species constituting the genus, the same authors continue:—“Parmi celles que nous avons pu étudier, de manière à les caractériser suffisamment, les unes présentent des calices en polygones irréguliers et de grandeurs un peu différentes, parce qu'elles se multiplient à la fois par bourgeonnement latéral et par bourgeonnement marginal, tandis que d'autres s'accroissent seulement en surface par le premier mode de bourgeonnement, et n'offrent que des calices de même grandeur et en polygones réguliers.”

Two years later, namely in 1850, the same authors published the first part of their great work on British Fossil Corals, Palæont. Soc. Monogr., at p. xxx. of which is a definition of the genus *Astroccenia* in the following words:—

“Corallum very dense and not bearing columnar processes as in the preceding genus [*Stylocœnia*]. Calices polygonal. Columella styloform, not projecting much. No pali. Septa thick; apparently eight or ten systems, two or four of the secondary septa being as much developed as the six primary ones. Walls thick and united, as in *Stylocœnia*.”

It is not a little remarkable that in the description of *Astroccenia pulchella*,² which appears in the same volume (p. 33) and is of the

¹ 3ème sér. vol. x. p. 296.

² It seems probable that this may prove to be generically distinct from the Cretaceous species.

same date, the following paragraph, which is so contradictory, should appear:—"When the corallites are not crowded together, the calices are circular, and have a distinct though not prominent edge; they are also separated by a pseudo-cœnenchyma, the surface of which is covered with small costal ridges, that are usually denticulated so as to assume the appearance of rows of round, obtuse granulae. When the calices approximate, they become somewhat polygonal, and their margins are separated only by a narrow furrow, or united so as to appear simple." A further definition is given by the same authorities in 1851, of which I need only observe that the walls are described as being thick and directly soldered together.¹

The 'Histoire Naturelle des Corallaires' (Paris, 1857) of the same authors adds nothing to our knowledge of the genus, the corallites being described as prismatic, soldered together by their walls, which are thick and simple; but the somewhat contradictory remarks respecting *Astrocœnia pulchella* are repeated.

Dr. E. de Fromentel, in his 'Introduction à l'Étude des Polypiers Fossiles,' dated 1858-1861, defines the genus in the following words:—"Polypier massif composé d'individus soudés directement par les murailles, qui sont prismatiques; calices polygonaux" (p. 232).

In 1854 appeared the fine work by Reuss on the Anthozoa of the Cretaceous deposits of the Eastern Alps,² in which are beautiful figures of the *Astrocœnia* from the well-known locality of Gosau. In that work the talented author made known what had not before been noticed—namely, that there are denticulations in the edges of the septa.

The late Prof. Duncan, in his 'Monograph of the British Fossil Corals, Second Series,' Palæont. Soc. 1872 (part iv. No. 1, p. 24), after accepting the description of the genus by MM. Milne-Edwards and Haime, with the modification made by Reuss, follows the former authors in their remarks on *Astrocœnia pulchella*, but states that the cœnenchyma between the corallites in that species arises "from an hypertrophied condition of the adjacent corallite-walls." This is followed by some statements relating to the nature of the gemmation in *Astrocœnia*; but it is perhaps necessary to observe that this immediately precedes the description of the supposed *Astrocœnie* from the deposits at the bottom of the Lias in South Wales, twelve in number, in every one of which the cœnenchyma is either definitely stated to exist, or its presence alluded to.

There is a further description of the genus by the same author in his 'Revision of the Families and Genera of the Sclerodermic Zoantharia,' Journ. Linn. Soc. vol. xviii. (1884), which, as it does not appear in immediate connexion with doubtful forms, deserves a fuller mention, and is as follows:—"Colony variable in shape, massive, gibbous, lamellar, dendroid or discoid, compact, sometimes encrusting. Corallites prismatic or cylindrical, uniting by their walls, which

¹ 'Monogr. des Polyp. Foss. Terr. Paléoz.' Arch. Mus. Hist. Nat. Paris, vol. v. p. 64.

² 'Beitr. zur Charakt. der Kreid. i. d. Ostalpen,' Denkschr. kais. Akad. Wissensch. Wien, vol. vii. p. 73.

are thick and simple; cœnenchyma rare between them. The calices are polygonal, irregular or regular in shape and size, and their margins are ordinarily simple." After defining the columella and septa, he concludes thus:—"Gemmation marginal and lateral, or marginal and circumferential only" (p. 120).

In a paper on the so-called *Astroccœnia* from the South Wales Conglomerate, by the same author, which was published in this Journal in 1886,¹ are many scattered remarks on the characteristics of the genus, to which reference must be made. These are the most recent observations which have come to my knowledge, but their value is unfortunately much lessened by the highly controversial nature of the paper in which they occur. The polygonal form of the corallites is strongly insisted upon, and the greater number of species are specially mentioned as having no structure whatever between the walls, which are united. The concluding remarks I transcribe *verbatim*:—"It appears that, owing to greater or less vigour of growth and to the influence of crowding, the corallites may be perfect hexagonal prisms, or irregularly polygonal in transverse section, and that the walls of corallites in the same corallum may be very thin at the calicular surface and thick lower down, or thick at the calicular surface and forming with their joined neighbours a mural or intercalicular cœnenchyma of varying width" (p. 110). Then follows a footnote in which it is stated that the cœnenchyma "resembles that of *Pocillopora* and some of the *Oculinidæ*, especially of the base of *Amphihelia* and the stem of *Astrohelia*," and "is totally distinct from the intermural cœnenchyma of such forms as the *Stylinacœ*."

With such great discrepancies in generic definition as appear in the foregoing, there need be no surprise if a somewhat mixed assemblage of forms are found accumulated under one name, and it was with a view to clear up the confusion that the following investigations were made.

I much regret that I have been unable to examine specimens of the type species, *Astroccœnia d'Orbigny*, but with the kind aid of my friend Mr. R. Etheridge, F.R.S., who has had sections prepared for me, and otherwise afforded me valuable assistance, I have examined the internal structure of *Astroccœnia decaphylla*, *A. reticulata*, *A. tuberculata*, *A. ramosa*, and *A. tourtiensis*, Bölsche. Only very partial success attended my efforts at first, the Gosau specimens not showing their structure very clearly. But the last-named species has proved to be in a very satisfactory state of preservation, and the details of its structure could be examined with certainty. I commence therefore with that species, and speak of the others afterwards.

ASTROCCENIA TOURTIENSIS, Bölsche.

A large piece of a specimen from Plauen, for which I am indebted to the original describer, Dr. Bölsche, was cut into thin slices and examined by transmitted light, and its details of structure were then seen most beautifully. The first thing observable is that the walls of the prismatic corallites are invariably thin, sometimes rudimentary

¹ Vol. xlii. pp. 101-111.

and without a trace of interval between them in which cœnenchyma could exist. There are neither dissepiments, tabulæ, nor pseudosynapticules in the interseptal loculi, but the inside of the corallites is greatly reduced in diameter and rendered more or less cylindrical by the deposition of an excessive quantity of stereoplasm, which really constitutes a great deal of the bulk of the corallum, and makes it solid and strong. No such tissue, however, is added to either the septa or columella. (See Pl. XX. fig. 3.)

All the larger septa run into the columella. They are of medium thickness, straight, and without any kind of lateral ornamentation.

ASTROCENIA DECAPHYLLA.

Examples of this species from the Cretaceous formation at Gosau, when well preserved, have the thickened walls and ornamental calicular surface shown in the figure by Reuss ('Beiträge, etc.,' Denkschr. kais. Akad. Wissensch. Wien, vol. vii. 1854, pl. viii.). If figs. 5 and 6 of pl. viii. in his work be examined, it will be seen that the calices are bounded by a double row of tubercles. Between them is a very narrow space, the position of the true wall. Polished sections do not, however, add much to our knowledge of the wall-structure. The rows of tubercles are really the ornamentation of the stereoplasm; the wall itself, represented by the space between them, is obviously not very thick, and indeed in one specimen now before me there is an extremely fine depressed line representing the position and thickness of the wall. Another specimen, having an approach to an elevated pyramidal form, shows satisfactorily the corallites at and near the axis, seen in section. They have thin and closely-applied walls, and there is no stereoplasm. The nearer the corallites are to the outside of the corallum, the more are they loaded by stereoplasm, and their original structure hidden.

ASTROCENIA RETICULATA.

Of this species I have the advantage of one specimen only for examination, but it is a very instructive one. A few calices had been weathered before fossilization, and the thickened wall, standing up in bold relief, has a central thin portion which is still more prominent. This is the true wall, and is not only thin, but in some places merely rudimentary.

ASTROCENIA RAMOSA.

Transverse sections of this species are very instructive, for, as in *A. decaphylla*, the central corallites (those which are more or less vertical and run up the centre of the corallum) have thin, well-defined walls, closely applied to each other, and not in the least obscured by any secondary deposit. The outer ones, on the contrary, are very much altered by such an addition, and the walls of the corallites are with difficulty distinguished. (See Pl. XX. fig. 5.)

ASTROCENIA TUBERCULATA, Reuss.

Of all the species which I have examined, this proves the least instructive. The corallum seems to be almost wholly made up of secondary material; but, as I have no section showing the state of

the central corallites, they may probably, as in the foregoing species, be free from stereoplasm.

It is obvious that all the definitions of the genus *Astroccenia* are defective, because the internal structure has not been studied by means of sections, and that they are superseded by the results of the foregoing investigations. Under those circumstances a new definition of the genus becomes imperative. I define it as follows, but I may observe that I do not at present include in it any species of earlier date than the Cretaceous period, having concluded that all the so-called Jurassic *Astroccenice* are referable to other and quite distinct genera.

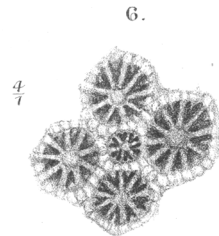
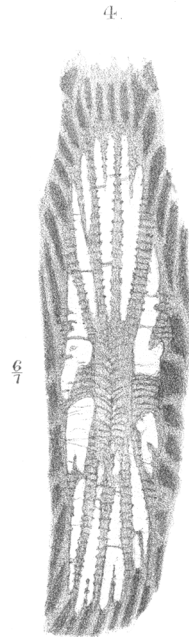
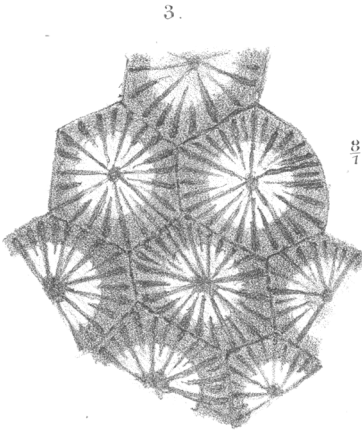
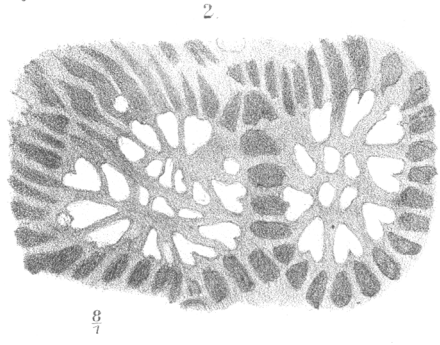
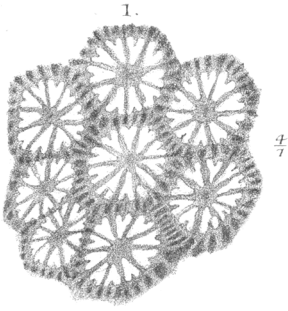
Definition of the Genus *ASTROCCENIA*.

Corallum compact, spreading or dendroid, and composed of prismatic corallites intimately united by their walls, which are thin and sometimes rudimentary. Corallites greatly lessened, and rendered more or less cylindrical internally by a considerable deposit of stereoplasm. Septa straight, alternately long and short, denticulated, the longer ones blending with the columella. The sides of the septa are without growth of any kind. There are no dissepiments, but the loculi are probably filled up inferiorly by stereoplasm. Columella variable in size, but not prominent.

Of the mode of increase I am unable to speak definitely, but should suppose that gemmation must take place on the top of the greatly thickened wall.

At present I refrain from a precise opinion on the classificatory position of this very peculiar genus, but that it will be removed from the place it has hitherto held there can be no doubt. *Stylocœnia*, with which it was associated by M. Milne-Edwards, has few characters in common with it, and neither have any of the genera with which it has been associated by Dr. de Fromentel. The late Prof. Duncan made of it an 'alliance' in which he also included *Cyathocœnia*, *Stephanocœnia*, *Narcissastrœa*, *Haldonia*, and *Bathycœnia*, to none of which is it at all nearly related.

In conclusion, I may offer a few remarks on the apparent discrepancies relative to the thickness of the walls enclosing the corallites. As I have shown, both M. Milne-Edwards and Prof. Duncan have made what appear to be most contradictory statements on the subject. The explanation of their apparently (but not really) inconsistent assertions is, however, perfectly simple and easy. In many calices the attenuated wall has become rudimentary, while in some it has wholly disappeared. When this is the case, the stereoplasm takes its place, though always, so far as I have been able to ascertain, with some remaining indication of its proper position, and the contracted and circular calices, being defined by it, appear to possess what MM. Milne-Edwards and Haime, and the late Prof. Duncan, respectively designated 'pseudo-cœnenchyma' and 'dense cœnenchyma.' The stereoplasm in *Astroccenia* is not unlike dermic cœnenchyma in appearance, from which, however, it differs radically, being wholly within the walls of the corallites.



R.F. Tomes del. F.H. Michael lith.

Mintern Bros. imp.

ASTROCCENIA AND STELIDIOSERIS.