

XXI. *On the Genera Heterophyllia, Battersbyia, Palæocyclus, and Asterosmia; the Anatomy of their Species, and their Position in the classification of the Sclerodermic Zoantharia.* By P. MARTIN DUNCAN, F.G.S., Secretary to the Geological Society. Communicated by Professor HUXLEY, F.R.S.

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1. THE admirable classification of the *Zoantharia* by MM. MILNE-EDWARDS and JULES HAIME*, although very elaborate and natural, presents several very decided “breaks” in the continuity of the generic succession. The great distinction between the important families of the *Turbinolidæ* and *Astræidæ*† renders the classification rather more artificial than it really is; and at first sight this classification may appear not very practical, on account of there being several genera which either cannot be placed at all or are arranged provisionally amongst certain divisions or families.

The objects of this communication are to describe the species of a genus which unites the family of the *Turbinolidæ* to that of the *Astræidæ*, to describe some very peculiar *Heterophylliæ* and *Battersbyiæ* and to classify them, and to remove the genus *Palæocyclus* from the family of the *Fungidæ* into that of the *Cyathophyllidæ*.

2. The genus *Heterophyllia* was established by M'COY, who described two species of it from the Carboniferous limestone of Derbyshire. He was so struck with the anatomical peculiarities of the species that he had no hesitation in asserting that they were totally unlike those of any other recent or fossil group.

MM. MILNE-EDWARDS and JULES HAIME placed the genus amongst the “incertæ sedis.”

Several specimens from the Carboniferous beds of Ayrshire, Fifeshire, Lanarkshire, and Stirling have lately been found to contain no less than six well-marked species of the genus *Heterophyllia*; and some of them are more paradoxical in their anatomy than those described by M'COY. Still the generic peculiarities are strongly marked in all the species.

The genus may now be admitted to contain the following species.

* Histoire Naturelle des Coralliaires; Paris, 1860. † Brit. Foss. Corals, 2nd series, p. 34, 1866, pt. 1.

Genus HETEROPHYLLIA, *M'Coy*.

Ann. Nat. Hist. 2nd Series, vol. iii. p. 126; Brit. Palæoz. Foss. plate 3 A. figs. 1 & 2.

1. *Heterophyllia ornata*, M'Coy.
2. — *grandis*, M'Coy.
3. — *mirabilis*, sp. nov.
4. — *granulata*, sp. nov.
5. — *angulata*, sp. nov.
6. — *M'Coyi*, sp. nov.
7. — *Lyelli*, sp. nov.
8. — *Sedgwicki*, sp. nov.

The new species come from highly fossiliferous beds which are very low down in the Carboniferous series.

The generic diagnosis of M'Coy is as follows; and it is proposed to modify it slightly after the description of the new species.

Gen. Char.—"Stem elongate, subcylindrical, irregularly fluted longitudinally; *horizontal section*, few distinct lamellæ, destitute of any order of arrangement, but irregularly branching and coalescing in their passage from the solid external walls towards some indefinite point near the centre where the few main lamellæ irregularly anastomose; *vertical section*, showing about the middle an irregularly flexuous line (the edge of one or two of the radiating vertical lamellæ), from which on each side a row of thin, distant, sigmoidally curved plates extends obliquely upwards and outwards, forming a row of large rhomboidal cells on each side."

According to the terminology now used, the stem is the corallum, the flutings are intercostal spaces, the lamellæ are septa, and the curved and oblique plates are endothecal dissepiments.

Description of the Species.

1. HETEROPHYLLIA GRANDIS*, M'Coy.

The corallum is tall and slightly flexuous. The costæ are few in number, and project as large polygonal unequal ridges. The intercostal spaces are grooves, and are deep as well as unequal. The horizontal section has an irregularly angular outline. The surface of the corallum is smooth. The septa are very irregular in disposition and number. The diameter of the stem is five lines.

The species is an uncommon form in the Mountain-limestone of Derbyshire.

2. HETEROPHYLLIA ORNATA, M'Coy.

The corallum is subcylindrical, long, and flexuous. The costæ are narrow, subequal, and are ornamented with small and rounded tubercles. The costæ are about sixteen in number. The intercostal spaces are flat, and are rather wider than the costæ. The

* These descriptions of M'Coy's species are altered so as to meet the requirements of the terminology of the received classification.

surface of the corallum is finely granular. The septa are fourteen in number. The diameter of the corallum is about $1\frac{1}{2}$ line.

The species is found with *H. grandis*.

3. *HETEROPHYLLIA GRANULATA*, sp. nov. Plate XXXI. figs. 1 *a*–1 *d*.

The corallum is long, slightly flexuous, and more or less cylindrical; it is rendered irregular in shape from alternate constrictions and swellings of the wall. The costæ are numerous, flexuous, rounded, unequal, and coriaceous; they bifurcate and project but slightly. The intercostal spaces are grooved, shallow, narrow, and wavy: they are narrower than the costæ. The horizontal section is nearly circular. The surface of the corallum is finely granulated. The septa are nineteen in number, thin, and often unite, to form five principal sets. The diameter of the corallum is $\frac{4}{10}$ inch at the swellings and $\frac{3}{10}$ inch at the constrictions.

In the Carboniferous series of Fifeshire.

4. *HETEROPHYLLIA ANGULATA*, sp. nov. Plate XXXI. figs. 2 *a*–2 *d*.

The corallum is long, flexuous, and rather angular in its transverse outline. The costæ are numerous, unequal, projecting, close, faintly granular, and coriaceous; they are usually eighteen in number, are rather sharp at the free edge, and smaller there than at their base. The intercostal spaces are unequal, concave, rather deep, narrow, and coriaceous. The horizontal section of the corallum is angular and irregular. The surface of the corallum is finely granular. The septa are seventeen in number, thirteen large and four small; they are arranged in five groups: the largest septa are nearly straight, and one is solitary and larger than the others. The small septa reach and become united to those nearest to them. The longest septa are joined by a lamina which stretches across the axial space*. The endotheca is very abundant, and stretches across the interseptal spaces, the concavity being outwards. The wall is thin and partly composed of very close endothelial cells. There is some vesicular endotheca. The diameter is $\frac{2}{10}$ inch.

The species is found in the Carboniferous strata of Brockley, Lesmahagow, Lanarkshire.

5. *HETEROPHYLLIA M'COYI*, sp. nov. Plate XXXI. figs. 3 *a*–3 *c*.

The corallum is tall, nearly straight, and is hexagonal in its transverse outline. The costæ are small, projecting, rounded, six in number, without ornamentation, and are grooved here and there. The intercostal spaces are very wide, shallow, slightly concave, nearly equal, and are marked occasionally with faint linear and festoon-shaped depressions. The horizontal section shows the wall to be stout and hexagonal; it is concave between the angles. The surface of the corallum is smooth. There are six septa, which unite centrally to a linear septal columella. The endotheca is very abundant. The diameter of the corallum is $\frac{2}{10}$ inch.

The species is found in the Carboniferous strata of Brockley, Lesmahagow, Lanarkshire.

* See Anatomy of *Sclerenchyma*, Brit. Foss. Corals, 2nd series, pt. 1, P. M. Duncan, Pal. Soc. 1866.

6. *HETEROPHYLLIA LYELLI*, sp. nov. Plate XXXI. figs. 4 *a*-4 *c*.

The corallum is very long, very slender, and is slightly bent. The costæ are large, smooth, and rounded; they project and are marked with occasional tubercles, pits, and grooves. The intercostal spaces are wide, shallow, and equal; they are slightly concave, and are marked with festoon-shaped ridges or lines. The horizontal section of the corallum is hexagonal in outline; the wall is stout and thick, and only very slightly concave between the costæ. The surface of the corallum is smooth and plain. There are six septa, which are united by a linear septal columella. The endotheca is tolerably abundant. The diameter of the corallum is $\frac{1}{10}$ inch or less.

In the Carboniferous limestone of Craigenglen, Stirling, and Brockley, Lesmahagow, Lanarkshire.

7. *HETEROPHYLLIA MIRABILIS*, sp. nov. Plate XXXI. figs. 5 *a*-5 *b*.

The corallum is tall, very slender, and nearly straight. The costæ are narrow, rounded, smooth, and slightly projecting; they have tubercles at regular and frequent intervals. These tubercles are rounded and oblique, and project slightly. To each of them is articulated a curved hook-shaped process, which stands out from the costa and the tubercle, its concavity being directed inwards and downwards. The intercostal spaces are shallow, wide, and usually slightly convex, but occasionally concave; they are marked with three longitudinal delicate shallow grooves with very slightly rounded longitudinal eminences between them. A groove is central. The horizontal section of the corallum is nearly circular; there are projections which correspond with the costæ; and the wall is moderately thick. The surface of the corallum is smooth. There are six septa, which are united by a linear septal columella. The endotheca is scanty, and the dissepiments are wide apart. The diameter of the corallum is rather more than $\frac{1}{20}$ inch.

From the Carboniferous limestone of Craigenglen and Brockley.

8. *HETEROPHYLLIA SEDGWICKI*, sp. nov. Plate XXXI. figs. 6 *a*-6 *e*.

The corallum is tall, thin, and very flexuous, except near the calice, where it becomes straight. The costæ are numerous, small, very slightly projecting, rounded, unequal, distant, and flexuous; they are grooved, and vary in number, eighteen or nineteen being the maximum. The intercostal spaces are shallow, rather wide (but occasionally narrow), slightly convex, and grooved longitudinally; and the appearance of false costæ is thus produced. The horizontal section of the corallum is nearly circular in outline; the wall is thin, and the costæ project very slightly. The surface near to the calicular end is coriaceous, and over the rest of the corallum it is smooth. The septa are twenty in number. There are ten large and ten small septa in the calice. In sections there are eighteen or nineteen very irregular septa; all the larger radiate to the centre. The calice is regular, and there is a small columella (a septal). The reproduction is partly by gemmation around the calice at the end of the stem-like corallum. The buds have many septa. The endotheca is very abundant, and the wall is thin. The diameter of the corallum is from $\frac{1}{10}$ to $\frac{2}{10}$ inch; and the calicular end, with its buds, measures in diameter $\frac{4}{10}$ inch.

In the Carboniferous limestone of Brockley, Lesmahagow, Lanarkshire.

It will be very readily observed that the stout wall, the costæ, and the absence of epitheca render this genus rather exceptional amongst those of the Palæozoic fauna. The irregular septal arrangement of some of the species, and the presence of one septum larger than the others in certain forms, are *rugose* peculiarities; but the scanty and simple dissepimental endotheca is very differential.

In *Heterophyllia mirabilis* the endotheca is very sparingly seen, and it exists in the form of simple dissepiments very wide apart, which, as in the *Astræidæ*, close more or less the interocular spaces. They do not close in the whole of the visceral, axial, and interocular cavities in a horizontal plane, and they are not tabulæ in the strict acceptation of the term. In other species the dissepiments are closer, and, although curved, simulate tabulæ. True vesicular endotheca is rare, but it exists in most of the specimens. The columellary lamina, curved in some species, but straight in others, is probably produced by the soldering of the septal ends, and is not really a true lamellar columella. In the specimen of *Heterophyllia Sedgwicki*, whose calice is preserved, the formation of the septal columella can be seen. The costæ, so variable in their structure, afford admirable specific distinctions; and those of *H. mirabilis* are totally unlike any others from any madreporarian family. The septa, irregular in number in some species, are then rather numerous; but when they are regular in their arrangement they never number more than six.

The species may be distinguished by comparing the specimens with the following Table:—

<i>Heterophyllia grandis</i>	{ Costæ few, large, as polygonal ridges. Septa very irregular in number.
— <i>ornata</i>	{ Costæ 16 in number, narrow with round tubercles. Septa 14 in number.
— <i>granulata</i>	{ Costæ numerous, flexuous, rounded, bifurcate, granular. Septa 19 in number, grouped in 5 series.
— <i>angulata</i>	{ Costæ projecting, sharp, unequal. Septa 17 in number, in 5 series and 1 large septum.
— <i>M^cCoyi</i>	{ Costæ 6 in number, small, rounded, grooved. Septa 6 in number.
— <i>Lyelli</i>	{ Costæ large, smooth, rounded, projecting, tuberculate. Septa 6 in number.
— <i>mirabilis</i>	{ Costæ narrow, rounded, tuberculate and spined. Septa 6 in number.
— <i>Sedgwicki</i>	{ Costæ 18 in number, distant, flexuous, small, grooved. Septa 18 to 20 in number.

The genus may be subdivided into a group with numerous septa and a group with six septa.

In the first subdivision the *rugose* type is faintly, and in the second the hexamerall

arrangement is well observed. The dense wall and the dissepimental endotheca prove that the type of the mesozoic coral-fauna was foreshown.

The generic characteristics may be admitted to be as follows.

Genus *Heterophyllia*, M'Coy.

The corallum is simple, long, and slender. The gemmation takes place around the calicular margin, and is extracalicular. The septa are either irregular in number and arrangement, or else are six in number and regular. The costæ are well developed, and may be tubercular, spined, and flexuous. The wall is thick, there is no epitheca, and the endotheca is dissepimental.

The position of *Heterophyllia* in the classification of the Madreporaria will be more easily comprehended after the following examination of the genus *Battersbyia*.

3. GENUS BATTERSBYIA.

The genus *Battersbyia* was founded by MM. MILNE-EDWARDS and JULES HAIME in order to include a very anomalous species which is very plentiful in the Devonian limestones of Torquay.

Since that species was described I have discovered two others, whose anatomy renders the generic determination of MM. MILNE-EDWARDS and JULES HAIME capable of some extension, and the position of the genus in the classification of the Madreporaria more decided. The great French zoophytologists at first considered the species *Battersbyia inæqualis* so anomalous as to form the type of a new division of fossil corals; but subsequently they classified it amongst the *Milleporidæ*, but evidently only provisionally. The study of the new species proves that the genus cannot be retained amongst the *Milleporidæ*, and that the first suggestion of MM. MILNE-EDWARDS and JULES HAIME was correct.

The reproduction of *Battersbyia* can be studied in the new specimens, and its peculiar character, and the evident absence of a cœnenchyma around the corallites, prove that the so-called cœnenchyma of *Battersbyia inæqualis* is of *stromatoparous* origin and is parasitic.

“Genus *Battersbyia*, Milne-Edwards and Jules Haime*.”

“The corallum is massive, and the gemmation is lateral. The walls are thick. The septa are small but well developed. The ‘planchers’ are vesicular. The cœnenchyma is very lax and spongy.”

1. BATTERSBYIA INÆQUALIS, Ed. and H.*

The corallum is massive; the corallites are very unequal, they have thick but non-cos-tulate walls. The calices are circular. The septa are readily seen, but they are small and unequal. They are twenty six in number in the largest calices. The “planchers” are vesicular and fill up the visceral chamber. The cœnenchyma is scanty and spongy.

* Monogr. des Polyp. des terr. Palæoz. 1851, p. 151.

† Hist. Nat. des Corall. vol. iii. p. 244. Brit. Foss. Corals, Pal. Soc. p. 213. pl. 47, fig. 2.

The specific determination is given more fully in the Monograph of the Devonian Corals (p. 213). Thus the septa are said to be somewhat unequal in size alternately, to be rather thick towards the wall, but very thin inwardly. The diameter of the largest corallite is pronounced to be above $1\frac{1}{2}$ line.

2. *BATTERSBYIA GRANDIS*, sp. nov. Plate XXXII. figs. 1 *a*–1 *d*.

The corallum is in fasciculate masses; and the corallites are tall, and very close in some parts of it and rather distant in others; they are very unequal in size. The calices are wanting; but transverse sections prove the corallites to be generally circular in outline; but they are often deformed, oval, and elliptical. The outline of the larger corallites is rendered irregular by the pressure of the growing buds; and where the wall of the bud and that of the parent corallite touch, one is often absorbed. The wall is dense and not costulated, but it is thin in comparison with the diameter of the largest corallites. The septa are very thin, are alternately long and short, and are often wavy or curved; they spring from the wall by wide wedge-shaped processes, and none of them reach the centre of the calice. The septa vary in number; in the smallest corallites there is a confused tissue formed of vesicular endotheca, and a few rudimentary septa; in other corallites, and as they increase in length, there are 12 to 16, 36 to 40, 46 to 52 septa. The wedge-shaped origins of the septa are equal in perfect corallites; and the axial space varies in diameter. The endotheca is greatly developed; it is often as stout as the septa, and it forms a series of small vesicles placed one over the other, and side by side in the interocular space. Each interseptal loculus contains many vesicles, so that a transverse section which cuts across the vesicles presents a series of concentric lines. There are no horizontal tabulæ, nor do the vesicles cut off all below them on the same plane. There is no columella, and its space is occupied by a vesicular endotheca. There is no cœnenchyma. The diameter of the largest corallites is $\frac{1}{2}$ inch, and of the smallest, with 12 to 16 septa, $\frac{3}{20}$ inch. The height of the corallites is several inches.

Locality. Devonian limestones, Torquay.

3. *BATTERSBYIA GEMMANS*, sp. nov. Plate XXXII. figs. 2 *a*–2 *d*.

The corallum is fasciculate, and the corallites are tall, very close and crowded; they are very unequal in size. The wall is thin, and not always double when two corallites impinge, but in the buds and young corallites it is very thick; in transverse outline the wall is oval, circular, and even polygonal. The septa are very thin, wavy, and arise from small wedge-shaped processes; the septa are alternately very long and short, and they vary in number. In the largest calices there are thirty-two, and in the smallest there are six. The endotheca is highly developed; the vesicles are small, and their tissue is thicker than the septa. The budding is of two kinds:—1. From the walls of corallites. These buds have either five septa or more; and in the first instance budding takes place as follows. 2. From the interseptal spaces, so that five buds arise from each lateral bud whose septa are not more than six in number. The septa and the wall of each interocular space develop other septa, and thus a very rapid budding is

completed. When the first kind of bud has more than five septa the resulting corallite grows like the parent. Diameter of corallites from $\frac{1}{10}$ inch to $\frac{1}{4}$ inch.

Locality. Teignmouth. Devonian limestones.

The generic characters of *Battersbyia* may be altered in consequence of the specific characteristics of the new forms:—

Corallum fasciculate and branching. Corallites tall, cylindrical, unequal in size and distance. Septa numerous and following no apparent cyclical order.

Endotheca very abundant; it is vesicular, and there are no tabulæ. Epitheca, costæ, and cœnenchyma wanting. The wall is stout; and the septa spring from wedge-shaped processes. The columellary space is occupied by vesicular endotheca. Gemmation extracalicular, and calicular from buds having only five septa.

Being satisfied that there is no cœnenchyma in *Battersbyia grandis* and *Battersbyia gemmans*, and that it is simulated in *Battersbyia inæqualis*, Ed. & H., by an investing and incrusting *Stromatopora*, the removal of the genus from the *Milleporidæ*, where it had been placed somewhat provisionally by MM. MILNE-EDWARDS and JULES HAIME, is absolutely necessary.

The corallum in every species is fasciculate; and the unequal size of the corallites is determined by the method of gemmation. In the case of *Battersbyia gemmans* the difference in the size of the corallites is excessive; and it is very probable that its peculiar gemmation is witnessed in the other species. The buds which develop more than five septa appear to grow into corallites, which are destined to bud again from the external wall; and the buds which develop five septa soon produce other buds from their interseptal loculi, the buds thus developed resembling the multiseptate corallites. This curious alternation of gemmation has not been observed in any other genus; but it is remarkable that the *Heterophylliæ* with six septa should be related to *Heterophylliæ* with numerous septa.

The genera *Heterophyllia* and *Battersbyia* have much in common. They have a stout wall, a vesicular and dissepimental endotheca, delicate septa, very irregular in their number, and neither tabulæ, epitheca, nor a quaternary septal arrangement. The genus *Battersbyia* has nothing to ally it to the *Rugosa*; and *Heterophyllia* has in some of its species the solitary large septum or a vacancy where a septum should be, which is so often observed in the *Cyathophyllidæ*. Its costæ and endotheca connect the genus with the mesozoic and recent *Astræidæ*; and that this family, unrepresented in palæozoic strata, is foreshadowed by the genera now under consideration is very evident.

The costæ of *Heterophyllia mirabilis* are the most extraordinary ever recorded, and they are unlike those of any other species of coral.

There is nothing unusual in the irregular septal development of *Battersbyia*; for it is noticed in the Liassic fasciculate *Astræidæ*; and whilst this genus points to the genera *Pentacœnia*, *Calamophyllia*, and *Thecosmilia*, *Heterophyllia* may be likened, faintly it is true, to *Rhabdophyllia*.

It would appear necessary to associate the genera *Battersbyia* and *Heterophyllia*

together in a division of the *Astræidæ*, and to place it near the above-mentioned mesozoic genera under the name of *Palastræaceæ*.

4. Genus PALÆOCYCLUS*. Plate XXXII. figs. 6 a-6 e.

This genus of Silurian corals has hitherto been regarded as belonging to the *Fungidæ*, and as the only representative of that great family in the palæozoic rocks. It is rather anomalous that a number of species of a highly organized coral genus should be found in the Silurian rocks of Dudley, Wenlock, and of Gothland, and that not a species of any other genus of the family of the *Fungidæ* should have been found in the Devonian or in the Carboniferous and Permian strata. The doubt whether *Palæocyclus* could belong to the *Fungidæ* was rendered more worthy of consideration by the discovery in the Australian tertiaries of a simple fungoid coral which had all the generic attributes of the Palæozoic genus†.

Careful sections of specimens of *Palæocyclus porpita*, Linnæus, sp., and *Palæocyclus rugosus*, MILNE-EDWARDS and JULES HAIME, were made, and it became evident that, although the external characteristics of the corals were those of the simple *Fungidæ*, the internal structure was analogous to that of the Palæozoic family of the *Cyathophyllidæ*.

The generic diagnosis of *Palæocyclus* is as follows.

The corallite is simple, short, and in general discoid, it is free and subpedicellate. The wall is covered with a complete epitheca. The calice is circular, and has a well-marked central fossa. The columella is rudimentary. The septa are moderately numerous, stout, straight, slightly exsert, and free internally. They are granular laterally, and dentate superiorly.

In order to admit the genus into the family of the *Fungidæ*, the septa of all its species must have synapticulæ upon them, and the corallites should not possess curved dissepiments or tabulæ.

Transverse and longitudinal sections of *Palæocyclus porpita* and *Palæocyclus rugosus* were prepared, and the absence of synapticulæ was proved, as was also the presence of an inclined dissepimental endotheca at the sides, and of tabulæ in the centre of the corallites.

The taller the specimen the more numerous were the tabulæ, and the uppermost of them formed the base of the septal fossa. In the discoidal species no tabulæ could be distinguished, but there were some marked rugose peculiarities and no synapticulæ. The septa of *Palæocyclus* are ornamented laterally with ascending rows of granules or blunt dentations. When the septa are worn from above downwards, these ornamentations stand out on either side of the laminæ and give the appearance of synapticulæ. Transverse sections through the corallites show the adhesion of the dissepiments to the septa; but the cross-bar-like appearance is produced by the section passing through a

* MILNE-EDWARDS et JULES HAIME, Compt. Rend. de l'Acad. des Sc. t. xxix. p. 71, 1849. HISINGER's *Cyclolites*.

† Ann. and Mag. of Nat. Hist. Sept. 1864, plate vi. fig. 2.

dissepiment. In the longitudinal sections the obliquity of the dissepiments is seen, and it explains the appearance in the transverse view. The dissepiments are numerous and curved, and they unite with the central tabulæ. There is no columella in the species. The septa of some of the specimens of the discoidal species are not of the same size on both halves of the calices, and very often one septum is longer than the others. The cyclical arrangement of the septa in six or in four systems is never distinguishable. It must be remembered that the discoidal species may be in some instances (for there are several new discoidal species) the young of the taller and tabulate corallites.

The removal of the genus *Palæocyclus* from the family of the *Fungidæ* is necessary, and it is very evident that the species classified under it belong to two divisions of the family *Cyathophyllidæ*. The *Cyathophyllidæ* with large tabulæ and short septa have been separated from the genus *Cyathophyllum*, whose species have the septa passing to the axis of the corallum, and have been arranged under the genus *Campophyllum*, Ed. et H.; but it is too specific a distinction to be of generic value. It is therefore proposed to place all the species of *Palæocyclus* in the genus *Cyathophyllum*, which, like the genus *Montlivaltia*, now possesses simple corallites of every form.

The genus *Palæocyclus* may therefore be abolished altogether, and its species will be named as follows:—

1. *Cyathophyllum porpita*, Linnæus, sp.
2. — *præacutus*, Lonsdale, sp.
3. — *Fletcheri*, Ed. et H., sp.
4. — *Edwardsi*, the *rugosus* of Ed. et H.

5. Genus ASTEROSMILIA.

Whilst investigating the fossil corals of the Nivajé shale* of San Domingo, my attention was strongly attracted by the very unusual combination of structural elements presented by a species named *Trochocyathus abnormalis*, nobis. Mr. Lonsdale had noticed the peculiarities of the specimens in his manuscript notes, and had proposed to include the species in a new genus.

Lately other specimens have been examined, and the necessity of forming a new generic division which will include these species has become evident.

The new genus unites the great families *Turbinolidæ* and *Astræidæ*, between which a great break had existed previously. It allies the *Trochocyathi*, *Placocyathi*, and the *Paracyathi* with the simple *Troschosmiliaceæ*, and contains simple corals with endothecal structures, columellæ, and pali.

The correct position of the new genus *Asterosmilium* will be comprehended after the study of the characteristics of the families it allies.

The *Madreporaria aporosa* are divided into two great groups. In the first, which includes the great family of the *Turbinolidæ*, the interseptal loculi, and the visceral cavities, generally speaking, are open from the base to the calice; and in the last, which

* Foss. Corals of the West Indies, Proc. Geol. Soc. 1863.

includes amongst others the family of the *Astræidæ*, the interseptal loculi and visceral cavities are not open from the base to the calice, but are more or less completely shut off from below upwards by endotheal dissepiments.

This endotheca is absent in the *Turbinolidæ*, although it is very faintly foreshadowed in the well-known *Paracyathi* of the London clay, and it is invariably present in the *Astræidæ*. There are two divisions amongst the *Turbinolidæ*: in one the septa reach inwards from the wall and have no appendages between their inner ends and the columella; and in the other these appendages or pali always exist before certain definite septa. The first division, the *Turbinolinæ*, has, then, neither pali nor endotheca; and the second division, the *Caryophyllinæ*, has pali but no endotheca.

The second great group of the *Madreporaria* has endotheal structures but no pali.

The new genus *Asterosmilias* has species which possess pali and endotheca.

Endotheal dissepiments are secreted by the innermost of the tissues which line the visceral cavity of recent corals; and the portion of the corallum shut off by the formation of the dissepiment is no longer filled with any of the soft parts, but is dead to all intents and purposes. As the coral grows in height, these dissepiments are formed, so that the soft tissues are really restricted to a space a very little lower than the calice. Where there are no dissepiments the visceral cavity reaches to the base of the corallum.

The pali are structures which spring from the base of the corallum, are secreted by the soft tissues, and determine the existence of a row of tentacles between the mouth and the innermost of the rows of the tentacles of the septal part of the disk.

The corals contained in the *Turbinolidæ* are simple and not aggregate. The species of the new genus are simple; and it is interesting to observe that the form of the corallites closely resembles that of the elongate *Trochocyathi*. The position of *Asterosmilias* in the classificatory scale is between the *Turbinolidæ* and the simple *Astræidæ*.

Description of the Species.

1. ASTEROSMILIA ANOMALA, Duncan. Plate XXXII. figs. 3 a-3 d.

Trochocyathus abnormalis, Proc. Geol. Soc. 1863, p. 26.

2. ASTEROSMILIA CORNUTA, sp. nov. Plate XXXII. fig. 4.

The corallum resembles *Asterosmilias anomala* in shape, but is often longer. The costæ are wavy and are slightly prominent, especially those of the principal septa. There are crests inferiorly. The endotheca is abundant. Height of corallum $1\frac{1}{2}$ inch.

Locality. Nivajé shale. In the collection of the Geological Society.

3. ASTEROSMILIA EXARATA, sp. nov. Plate XXXII. fig. 5.

The corallum is small, pedunculate, nearly straight, and it enlarges suddenly. All the costæ are prominent and nearly equal. There are no crests. Height $\frac{3}{4}$ inch.

Locality. Nivajé shale. In the collection of the Geological Society.

From the characteristics of the species the generic diagnosis may be thus given.

Asterosmilias.—The corallum is simple, long, and more or less cornute. The costæ are

irregular in their development, and crests are occasionally present. The septa are numerous and exsert. The columella is more or less solid, essential, and compressed. Pali exist. The endothecal dissepiments are distinct, tolerably numerous, and are curved.

The genus forms the link in the classificatory chain between the genera *Placosmilia*, *Parasmilia*, and *Trochoscilia* and the genera *Placocyathus*, *Paracyathus*, and *Trochocyathus*. As it cannot be correctly associated either with the *Turbinolidae* or the *Trochosmiliaceae*, it must be included in a new division—the *Asterosmiliaceae*.

6. It has been attempted to prove the necessity of classifying the genera, the anatomy of whose species has been described in this communication, as follows.

Heterophyllia, M'Coy, must be associated with *Battersbyia*, Ed. et H., in a division of the *Astræidae*—the *Palastræaceae*.

The genus *Palæocyclus*, Ed. et H., must be abolished and its species added to the genus *Cyathophyllum*, Goldfuss.

The genus *Asterosmilia*, nobis, forming the link between the simple *Astræidae* and the *Turbinolidae*, should form the division *Asterosmiliaceae*, and should be placed between the *Trochosmiliae*, *Placosmiliae*, and *Parasmiliae* and the *Trochocyathi*, *Placocyathi*, and *Paracyathi*.

By the absorption of the genus *Palæocyclus* a representative of the tertiary coral-fauna is removed from the Palæozoic; and by the separation of *Battersbyia* from the *Milleporidae*, and its association with *Heterophyllia*, formerly a genus incertæ sedis, in a division of the *Astræidae*, two genera with mesozoic affinities are introduced into the Palæozoic coral-fauna.

March 1867.

On April 20, 1867, the author added the genus *Pentacænia* to those allied to *Battersbyia*, and corrected the description of the gemmation of *Battersbyia gemmans*.

EXPLANATION OF THE PLATES.

PLATE XXXI.

- Fig. 1 *a*. A portion of the corallum of *Heterophyllia granulata*, sp. nov.
b. Magnified view of a transverse section, showing the septa and the wall.
c. Magnified view of the granular costæ.
d. The wall magnified, with a septum and an endothecal dissepiment.
e. The curved arrangement of the costæ.
- Fig. 2 *a*. A portion of the corallum of *Heterophyllia angulata*, sp. nov.
b. A transverse section: magnified.
c. The wall, septa, and dissepiments: magnified.
d. A longitudinal section showing the dissepiments: magnified.

- Fig. 3 *a.* A portion of the corallum of *Heterophyllia M'Coyi*, sp. nov.: magnified.
b. A transverse section: magnified.
c. The wall, septa, and dissepiments: magnified.
- Fig. 4 *a.* A portion of the corallum of *Heterophyllia Lyelli*, sp. nov.: magnified.
b. A transverse section: magnified.
c. A portion of the wall and some costæ: magnified.
- Fig. 5 *a.* A portion of the corallum of *Heterophyllia mirabilis*, sp. nov.: magnified.
b. A transverse section: magnified.
c. The costæ without the spines: magnified.
d. Side view of the costæ with the spines: magnified.
e. Magnified view of the process of the costæ which supports a spine.
f. The intercostal line: magnified.
g. Longitudinal section: magnified.
h. Restoration of the corallum (diagram).
- Fig. 6 *a.* A portion of the upper part of the corallum of *Heterophyllia Sedgwicki*, sp. nov.
b. A transverse section: magnified.
c. A magnified view of the upper part of a corallum.
d. A longitudinal section: magnified.
e. Magnified calice.

PLATE XXXII.

- Fig. 1 *a.* A transverse section of part of the corallum of *Battersbyia grandis*, sp. nov.: natural size.
b. A corallite, magnified, transverse section.
c. A young corallite, magnified, transverse section.
d. A portion of a large corallite: magnified.
- Fig. 2 *a.* A transverse section of part of the corallum of *Battersbyia gemmans*, sp. nov.
b. A group of buds, transverse section: magnified.
c. A bud commencing to develop five buds, each of which will resemble the original corallum or parent stock, transverse section: magnified.
d. Magnified view of a transverse section of a corallite, the result of one of a series of five buds. Such corallites produce buds like unto themselves, as well as others which develop five buds.
- Fig. 3 *a.* The corallum of *Asterosmilium anomala*, Duncan.
b. A corallum with the wall partially removed, showing the endothecal dissepiments, slightly magnified.
c. A dissepiment: magnified.
d. A view of a worn calice, showing the central columella, the pali attached to it, and the septa.
- Fig. 4. The corallum of *Asterosmilium cornuta*, sp. nov.

Fig. 5. The corallum of *Asterosmilia exarata*, sp. nov.: slightly magnified.

Fig. 6 *a.* Magnified view of the calice of a species of the genus *Palæocyclus* (*Cyathophyllum*).

b. Magnified view of the septa: transverse section, showing the absence of synapticulæ.

c. Magnified view of the dissepiments between the septa.

d. A magnified longitudinal section of a discoid species.

e. Magnified view of a longitudinal section, showing tabulæ and a vesicular endotheca, proving the genus to belong to the *Cyathophyllidæ*.



