4.—FURTHER PERMIAN CORALS FROM WESTERN AUSTRALIA.

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The corals described in this paper are from the *Cyathaxonia* faunas in the Permian of Western Australia. These faunas are :—

NORTH-WEST.[1]

KIMBERLEY.[2]

[1] The succession here given is that given by Teichert (1939, p. 6) and personal communication.
[2] The succession given here is after Wade in Clarke (1938, p. 426).

IRWIN RIVER.[3]

Species to which no page reference has been given in the above lists have already been described (Hill, 1937a).

The *Cyathaxonia* Fauna of the Palaeozoic consists of small, solitary Rugosa without dissepiments, and of Cladochonids, Favositids, and Palaeacids. It appears very important in the Artinskian of the Urals and Timor, and the Middle Permian of Timor, and it is the only coral fauna known from the Kamilaroi Series (mostly Permian, but possibly in part Uralian) of Australia. Its occurrence in the Lower Carboniferous has already been summarised (Hudson, 1935 ; Hill, 1938a, p. 5). Species belonging to it have recently (Dobrolyubova, 1936) been described from the Moscovian and Uralian of Russia, so that its continuous existence from the Lower Tournaisian to the Middle Permian is proved. Evidence that it was already in existence in the Devonian and even in the Silurian is accumulating. It is characteristic of a particular facies of deposition, described by Hill (1938a, p. 5). The long range of the Tabulate genera in this fauna has long been known, and it may be that morphologically similar Rugose forms from different periods, at present regarded as different generically, are really one and the same genus. These morphologically similar forms have already been indicated (Hill, 1938a, p. 8). This possibility weakens the reliance which may be placed on the genera as indicators of horizon. The species from both the Wandagee Stage and the Callytharra Stage, however, are comparable with Artinskian or Middle Permian-Basleo species, rather than with Uralian or Upper Permian species, and *Euryphyllum* is so far known, outside Australia, only in Artinskian beds. In the absence of species common to the Western Australian faunas and the Timor or Russian faunas, we cannot at present indicate the precise age of our faunas. Two species from the Wandagee Stage, *Euryphyllum reidi* (Hill) and *Thamnopora immensa* (Hill), are associated at Castle Creek, Theodore, Queensland, at an unknown horizon in the Bowen sequence. *Cladochonus nicholsoni* (Etheridge) from the Nooncanbah series, occurs in the Condamine Fault Block and in the Coral Stage of the Bowen Marine Series in the Springsure District, Queensland.

ZOANTHARIA MADREPORARIA RUGOSA
AMPLEXIMORPHS.

Ampleximorphs ; Hill, 1940, p. 390.

These simple, cylindrical, or fasciculate Rugose corals with short, equal lamellar septa, and complete tabulae, and without dissepiments, are common in the Silurian, Devonian, Carboniferous, and Permian, and probably represent the endpoints of trends of simplification in many stocks. In the Permian of

[3] Succession after Teichert (1939, p. 6), and Clarke (1938, p. 429).

Timor a group occurs which differs from the earlier ampleximorphs in having dilated septa usually swollen a little axially, and continuous vertically throughout that outer part of the tabularium where the edges of the tabulae are downturned. Small septal ridges may continue for a short distance over the upper flat surfaces of the tabulae. Usually minor septa are absent. Such are some small specimens in the Sedgwick Museum, Cambridge, and a large form figured as *Amplexus coralloides* by Gerth (1921, p.l cxlvi, figs. 22, 23) from the Upper Artinskian of Bitauni, Timor. Other Permian ampleximorphs, which appear to have been derived from zaphrentoids by the withdrawal of the septa from the axis have been called *Paracaninia* Chi (1937, p. 93) ; but these have thin, unequal septa, not swollen at their axial edges. Others again, which appear to have an aulos, have been called *Amplexocarinia* Soshkina (1928, p. 379). Yet others, with unequal, rhopaloid septa, have been called *Amplexus* by Gerth (1921) and Heritsch (1937).

" **Amplexus** " **pustulosus** Hudleston. (Plate I., fig. 1.)

Amplexus? pustulosus Hudleston ; for references, see Hill, 1937a, p. 45, pl. i, fig. 1 ; text-fig. 1 ; " Fossil range," Gascoyne River, Permian.

Diagnosis : Erect, turbinate Rugose corals with the major septa dilated and laterally contiguous, leaving a wide axial area free of septa.

Remarks : One specimen from the upper part of the Callytharra series near Trig. Station K52, Kennedy Range, near Williambury—Middalya road, W.A., is probably a member of this species, although it is curved rather than erect, and cylindrical rather than turbinate. It is flattened in the plane of the cardinal septum, probably by crushing, as the tabulae seen in a vertical section are somewhat shattered. There are 33 septa at a diameter of 15mm. x 18mm., extending a little over half way to the axis, sub-equal, some with sharp axial edges, and some with swollen axial edges, all dilated so as to be almost in contact laterally. The cardinal septum is shorter than the rest and is on the longest side of the corallum. No minor septa are developed. The tabulae are complete, shallow domes. Etheridge has already mentioned this species from Williambury Station, Minilya River.

" **Amplexus** " sp. (Plate II., fig. 1.)

Material : One specimen from the Permian of Fossil Cliff, Irwin River, in the collection of the University of Western Australia.

Description : The specimen is an obliquely broken fragment 60 mm long, and 32 mm in diameter. There are about 50 slightly dilated major septa, continuous vertically for about 5 mm. from the epitheca, and then extending for a short distance over the upper flat surfaces only of the tabulae as faintly marked ridges. The septa appear to be slightly rhopaloid, *i.e.*, swollen at the inner edge of their vertically continuous portions ; as far as can be seen from the fragment, they are equal, and there are no minor septa. There is a peripheral stereozone about as thick as the septa. The tabulae are complete, unequally distant, up to 3 mm. apart, and with an edge 5 mm. wide, downturned to the stereozone at about 45°. It is in this area of downturning that the septa are vertically continuous.

Remarks : As far as one can ascertain from the fragment, the septa are equal, so that the specimen does not belong to *Paracaninia* ; neither is there an internal wall, so that it is not *Amplexocarinia*, and pending further investigations in Carboniferous and Permian ampleximorphs, it is referred to

"*Amplexus*." It seems close to *Amplexus coralloides* of Gerth *non* Sowerby, from the Upper Artinskian of Bitauni, Timor, but it differs from the Lower Carboniferous *Amplexus coralloides* J. Sowerby in having the septa dilated and not attenuate, and in having the vertically continuous segment of the septum much wider.

ZAPHRENTIMORPHS.

Zaphrentimorphs have been discussed recently (Grabau, 1928 ; Hill, 1938).

Genus **ALLOTROPIOPHYLLUM** Grabau.

Allotropiophyllum Grabau, 1928, p. 130.

Genotype (by designation) : *Amplexus spinosus* de Koninck var. *sinensis* Grabau, 1922, p. 64, pl. i, figs. 22a, 22b, 23. Chihsia Limestone Chihsiashan, Central China (= Artinskian).

Diagnosis : Simple Rugose corals, typically curved, and bearing scattered spines. The septa of the counter quadrants and sometimes the alar and first meta-septa are grouped in a narrow crescentic area embracing the counter side of the corallum ; the remaining septa of the cardinal quadrants are directed towards a point or points on its inner side, which is roughly midway between the axis of the corallum and the epitheca. The septa become amplexoid in late stages. Tabulae are usually far apart, complete and oblique, with a downturned border of the same width as the crescent ; they slope downwards from the convex to the concave side of the corallum. There are no dissepiments, and minor septa are developed very late or not at all.

Remarks : The genus is known in the Tournaisian of Belgium, the Dinantian and Lower Namurian of Scotland, the Artinskian Chihsia limestone of China, and the Upper Permian of Djoulfa in Armenia. Possible synonyms of the genus are discussed in the authors "Carboniferous Rugosa of Scotland, Part III.", in course of publication by the Palaeontographical Society of London.

ALLOTROPIOPHYLLUM, sp. (Plate I., fig. 2.)

Material : One specimen in the collection of the University of Western Australia, from the lowest horizon with large species of *Calceolispongia*, middle *Calceolispongia* stage, east limb of syncline west of Coolkilya Pool, Minilya River.

Description : The specimen is broadly trochoid, with a talon, and a very deep calice. The epitheca is longitudinally ribbed but somewhat weathered, the deep grooves corresponding to the major septa having shallow grooves between then indicating the potential presence of minor septa. Spines were not observed. Six major septa in each counter-quadrant are joined with the counter septum in a crescentic curve on the counter side of the corallum. Six straight metasepta in each cardinal quadrant join at their axial edges at a point on the edge of the crescent, leaving a wide closed fossula expanded axially. The long cardinal septum wanders over the fossula to join it at one side of the crescent. The septa are all slightly and equally dilated, and there is a narrow peripheral stereozone. No minor septa are visible. The arrangement of the tabulae is not known.

Remarks : The one specimen is insufficient for a full specific description or comparison with other species. The age indicated is that of the genus, Carboniferous and Permian.

Genus **EURYPHYLLUM** Hill.

Euryphllum Hill, 1937, p. 150 ; 1937, a, p. 50 ; 1938, p. 25.

Genotype : Euryphyllum reidi Hill, 1937, p. 150 ; 1937, a, p. 50 ; 1938, p. 25 ; Permian (? Artinskian) Bowen Marine series of Queensland.

Diagnosis : Simple, turbinate to ceratoid Rugose corals, erect except at the tip, which is turned aside ; with well-marked interseptal ridges, and typically an oblique calical floor. The major septa, which are never carinate or serrate, extend to the axis and are pinnately grouped about a long, closed fossula, bisected by a long cardinal septum on the concave side of the corallum ; alar fossulae are present. The septa are dilated, and at first are laterally contiguous throughout, but during ontogeny dilatation decreases in a widening zone midway between the periphery and the axis, leaving a wide peripheral stereozone, and an axial structure formed by the conjoined dilated axial ends of the septa. Very short minor septa appear late, and remain buried in the stereozone. Tabulae are distant, usually dilated, complete or incomplete, and there are no dissepiments.

Euryphyllum reidi Hill. (Plate I., fig. 3 ; Plate II., fig 2.)

Euryphyllum reidi Hill, 1937, p. 150 ; 1937a, p. 50 ; 1938, p. 25, pl. i. Permian (? Artinskian) of Queensland.

Holotype : F3243, University of Queensland collection, from the ?Artinskian Upper Dilly Stage of Cabbage Creek, Springsure District.

Diagnosis : Euryphyllum with oblique calice, the cardinal quadrants being wider than the counter ; the peripheral stereozone is irregular and very wide, and septal dilatation does not decrease until very late.

Remarks on North-Western Australian Specimens : There are in the Collection of the University of Western Australia, 5 specimens from the *Strophalosia-Calceolispongia* horizon, just below the horizon with *Allotriophyllum,* sp., middle *Calceolispongia* stage, 1 specimen from the horizon just below the *Dictyoclostus gratiosus* zone, upper *Calceolispongia* stage, 6 specimens from just above the " worm track " horizon, upper Calceolispongia stage, all from the east limb of the syncline west of Coolkilya Pool, Minilya River, and 1 specimen from the main *Calceolispongia* horizon, 6 specimens from the *Cleiothyridina-Calceolispongia* horizon, all from the upper *Calceolispongia* stage, west limb of the same syncline. The specimens on the whole are rather larger than those from the Springsure area, but those from the first named horizon are identical in size with Queensland specimens from Castle Creek, Theodore. The species may prove divisible. I have not yet made a detailed study of zaphrentimorphs from the Upper Marine of New South Wales, but from Etheridge's figures none appears to be *E. reidi*, though *Z. gregoriana* is possibly a member of the genus.

Thirteen specimens from the highest *Calceolispongia* horizon, at the top of the Wandagee series, are identified as *Euryphyllum reidi* Hill. They are of the morphology of that sub-group from Castle Creek, Queensland, and from the locality J3, in the middle or upper parts of the *Calceolispongia* zone in the Wandagee Series, west or south-west of Coolkliya Pool, Minilya River. The localities of these 13 thirteen specimens are :—

south-west side of Wandagee Hill, near mouth of South-West Creek ;
near south-east corner of Wandagee Hill, at crossing of Wandagee Wool-
shed—Middalya road over highest *Calceolispongia* horizon ;
north-east corner of Wandagee Hill.

Two specimens from the uppermost *Pseudogastrioceras* horizon of *Linoproductus-Fenestella* stage of Wandagee series, are identified as *Euryphyllum reidi* Hill, but they may represent a variant from the morphology characteristic of the *Calceolispongia* zone, for their septa are without any curvature. Nevertheless, a similar morphology is known in specimens from Castle Creek, Queensland.

? **EURYPHYLLUM**, sp. (Plate I., fig. 4.)

Material : One specimen from locality H_4E, in the Collection of the University of Western Australia from the lowest horizon with a species of large *Calceolispongia*, middle *Calceolispongia* stage, east limb of syncline west of Coolkilya Pool, Minilya River.

Description : The specimen is small and trochoid, the diameter at the upper edge of the calice being 18 mm, with a deep calice and strong longitudinal ribbing. One side of the corallum, about an alar fossula, is excavate, but whether from injury or attachment it is impossible to say. Major septa only are developed, and they are considerably dilated ; there are 7 in each cardinal quadrant and 7 in each counter quadrant ; the axial edges of those in the cardinal quadrants all meet the axial edge of the short counter septum, or join the two parallel septa about the cardinal fossula. There is a lozenge-shaped gap filled with matrix in the middle of the coral, where the septa of the cardinal and counter quadrants are parted, the greatest width being in the plane of the alar fossulæ, and the opposite diameter being between the axial edges of the cardinal septum and the counter septum.

Remarks : Whether this gap is a specific character or a pathological condition cannot be determined without further specimens. In the meantime the specimen is placed doubtfully in *Euryphyllum*. It might, however, be an aberrant *Allotropiophyllum*.

Genus **PLEROPHYLLUM** Hinde.

Plerophyllum Hinde, 1890, p. 195 ; for references, etc., see Hill, 1937, a, p. 47.

Genolectotype (chosen Grabau) *: Plerophyllum australe* Hinde, 1890, p. 196, pl. viiiA, figs 1a-f ; Permian. Gascoyne River ; Irwin River ; Western Australia.

Diagnosis : Small, curved, ceratoid Rugose corals in which the two counter-lateral septa, both alar septa and the cardinal septum (and sometimes the counter septum also) are larger and more dilated than the others, but equally developed among themselves, and are swollen near their axial edges. Septal insertion is accelerated in the counter quadrants.

Plerophyllum sp. (Plate II., fig. 3).

Material : One specimen from the Cundlego Series, in the fossiliferous horizon above Coolkilya Pool, Minilya River.

Description : The specimen is cylindrical and very small, being the calical end (8 mm.) of a specimen, with a constant diameter of 3 mm. Longitudinal and growth striations are well-marked. The two counter-lateral septa, the alar septa and the cardinal septum are dilated and meet at the axis, and are almost equally spaced. Shorter septa can be distinguished between them, the counter septum clearly, but others less clearly. There is a stereozone about 0·75 mm. wide at the periphery.

Remarks : This small specimen may be only a young individual of *Plerophyllum australe*, and so pending the discovery of more material it is left unnamed. No adult *P. australe* are known from the Wandagee Series.

Genus **VERBEEKIELLA** Gerth.

Verbeekiella Gerth, 1921, p. 81 ; nom. nov. for *Verbeekia* Penecke, in Verbeek, 1908, p. 673 ; *Verbeekia* was pre-occupied by Fritsch, 1877, for a Tertiary echinoid.

Verbeekia ; Hill, 1937, a, p. 54.

Genotype : *Verbeekia permica* Penecke *loc. cit.* = *Clisiophyllum australe* Beyrich.

Diagnosis : Simple Rugose corals typically with much dilated vertical skeletal elements ; with a clisiophylloid axial column, with domed tabulae, and without dissepiments.

Remarks : The genus is reported from the Moscovian and Artinskian of Russia and the Permian of Timor, and *V. talboti* (Hosking) occurs in the Callytharra Stage of the North-West of Western Australia. *Zeliaphyllum* Heritsch (1936, p. 130, genotype *Z. suessi* Heritsch, *id.*, text-fig. 34, pl. xviii., fig. 24) from the Lower *Schwagerina* limestone of the Carnic Alps may be synonymous. *Cravenia* Hudson (1928, p. 252, genotype *rhytoides* Hudson, *id.*, pl. i., figs. 1a-g), a Tournaisian form of England, may be related or synonymous. It is difficult to know whether genera of solitary coralla with axial columns but without dissepiments should be considered as members of the family Clisiophyllidae or not ; and for the present they are left as Rugosa incertae sedis.

Verbeekiella mersa sp. nov. (Plate I., figs. 5, 6 ; plate II., fig. 4).

Holotype : From *Linoproductus-Calceolispongia* horizon, just below lowest *Propinacoceras* zone, lower *Calceolispongia* stage, east limb of syncline west of Coolkilya Pool, Minilya River. Four other specimens from just above the " worm track " horizon, upper *Calceolispongia* stage, same locality. Another is from the fossiliferous Cundlego horizon above Coolkilya Pool.

Diagnosis : *Verbeekiella* with septa greatly dilated at first, without minor septa, with the axial structure quite dense, of dilated lamellae attached to the counterseptum.

Description : Trochoid coralla, about 40 mm. tall with a slightly irregular curvature and a calical diameter of 20 mm. The diameter is longer along the cardinal-counter line than at right angles to it. The epitheca is without longitudinal striation, but shows growth annulation. The cardinal septum is on the longer side, but is not necessarily in any plane of symmetry of the corallum. When the epitheca is weathered away, slender grooves are seen up the middle of each septum. The distal edges of the septa are curved, rising up slightly from the epitheca, and then descending a little in a long curve towards the axial edge ; when the corallum is broken vertically down a septum, lines of growth are seen parallel to this curve of the distal edge. The axial structure projects as an elongate boss, which may show lateral ridges. Only major septa are developed, 20 at a diameter of 12 mm., up to 26 at greater diameters. There is always at least one more septum in each counter quadrant than in each cardinal quadrant, so that the alar fossulae tend to be on the cardinal side of the corallum. The septa are dilated so as to be in contact throughout the young stages, but as the corallum grows the dilatation lessens somewhat ; a narrow peripheral stereozone is always left, and the thinnest part of a septum is just inside this stereozone, so that the septa tend to be rhopaloid. The counter septum is joined with the axial structure, which is made up of a median lamella and a few lateral lamellae so dilated as to be in contact ; very occasionally spaces may be seen between the lamellae ; the sides of the structure may be smooth, so that it is oval in section, or ridged by the outer edges of the lateral lamellae ; it is always joined to the counter septum, but is not a continuation of the counter septum. The tabulae are thin, complete and incomplete, and domed. No dissepiments are developed.

Remarks : The oval section of the axial structure and its confluence with the counter septum suggests that this species should be placed in *Lophophyllum* or *Lophophyllidium*, or other genera with a columella formed simply by dilatation of the axial end of the counter septum. But sections show that this axial structure is really compound, an axial column formed by dilatation of its constituent medial and lateral lamellae, so that the affinities of the species are with *Verbeekiella* or *Sinophyllum* Grabau. In *Sinophyllum* the formation of the compound axial structure by the association of the dilated axial ends of the other major septa with the prolonged, swollen axial end of the counter septum is evident, but in *Verbeekiella* the compound axial structure is dissociated from the axial ends of the septa (except the counter and cardinal septa in some species) throughout the corallum. *V. mersa* has this dissociated type of structure. It is the only species of the genus which is homeomorphic with *Lophophyllum*. It differs from *V. talboti* from the Callytharra Series (somewhat lower than the Wandagee Series) of the North-West, chiefly in the general absence of spaces in its axial structure and in the absence of irregularity in dilatation.

Verbeekiella talboti (Hosking) (Plate I., fig. 7).

Clisiophyllum talboti Hosking ; for references, etc., see Hill, 1937, a, p. 55, pl. i., figs. 13–17 ; text-figs. 6, 7 ; Permian, Callytharra Series, creek half a mile west of Callytharra Springs, Wooramel R.

Diagnosis : Verbeekiella with dibunophylloid axial structure containing few septal lamellae.

Remarks on a specimen from Callytharra Springs : A large specimen with a height of 50 mm., and a calical diameter of 25 mm. differs from previously described specimens of this species not only in these larger dimensions, but also in having near the calice a clisiophylloid rather than a dibunophylloid section of the axial column. Instead of there being a maximum of nine lamellae on each side of the median lamella, there are in one transverse section eighteen, nine shorter lamellae alternating with the nine long ones touching the axial lamella ; but in a transverse section about 3 mm. below, most of these shorter lamellae are not present. It is not thought that this difference from the earlier described species is specific, although the boss in the calice also shows the eighteen lamellae on either side of the median lamella. This large number of lamellae is that characteristic of *V. rothpletzi* (Gerth, 1921, pl. cxlvii, figs. 10, 11) from the Lower and Middle Permian of Bitauni, Mandeo and Basleo, Timor.

ZOANTHARIA MADREPORARIA TABULATA.

FAMILY **FAVOSITIDAE**.

Genus **FAVOSITES** Lamarck.

Favosites Lamarck, 1816, p. 204 ; for references, etc., see Jones, 1936, p. 2.

Genolectotype (see Edwards and Haime, 1850, p. lx) *: F. gothlandicus* Lamarck, 1816, p. 206, Silurian, Gotland.

Diagnosis : Cerioid tabulate corals forming massive or ramose colonies, in which the contiguous corallites have thin or moderately thin walls, spinose or obsolete septa, and complete or mainly complete horizontal tabulae.

Remarks : The genus is widespread, from the Upper Ordovician to the end of the Devonian ; forms like *Favosites* in the Carboniferous have usually been referred to *Emmonsia*, but Gerth (1921) has described as *Favosites* three Permian species from Mandeo and the Middle Permian of Basleo, Timor.

FAVOSITES, sp. (Plate II., fig. 5.)

Material : Two specimens from the base of the *Linoproductus* stage of the Wandagee series, centre of syncline west of Coolkilya Pool, Minilya River (one near Station 4A, the other 12 chains from Station f of 1939 survey).

Description : The corallum is tuberose, 30 to 40 mm. in diameter, and 50 mm. or more long. The individual corallites diverge outwards from the axis, each being about 1·5 to 2 mm. in diameter, though smaller ones occur. Owing to the processes of fossilisation, neither specimen is worth sectioning. Neither mural pores nor septal spines were proved, but one surface suggests a single vertical row of pores per wall. Tabulae are thin, slightly domed, and rather distant, 3 in 2 mm.

Remarks : The specimens do not appear to be conspecific with the species described by Gerth from Timor, or with any other species known to me.

Genus **THAMNOPORA** Steininger.

Thamnopora Steininger, 1831, p. 10 ; 1834, p. 337 ; for references, etc., see Hill, 1937 a, p. 56.

Genolectotype : *Thamnopora madreporacea* Steininger = *Alveolites cervicornia* de Blainville, 1830.

Diagnosis : Ramose Tabulate corals in which the cylindrical branches may be flattened and coalesced ; the corallites are typically polygonal, they diverge from the axis of the branch and usually open normal to the surface ; the corallite walls are dilated throughout, and the dilatation increases distally ; typically the growth lamination in the sclerenchyme of the wall is obvious, while its fibrous nature is not ; septal spines are usually obsolete, and mural pores are large.

Range : Silurian, Devonian, Permian, and rare in the Trias.

Thamnopora immensa Hill (Plate I., fig. 8 ; Plate II., fig. 6).

Thamnopora immensa Hill, 1937a, p. 58, pl. i., figs. 21, 22, text-fig. 9 ; Permian, two miles East of Christmas Creek Homestead, south of Rough Range, Kimberley.

Holotype : H 25, Geological Survey of Western Australia.

Diagnosis : Large *Thamnopora*, in which the corallites have calices of two sizes opening at right angles to the surface of a branch, excessively dilated walls, thin tabulae, and numerous large, regular mural pores, frequently further excavated by boring organisms.

Remarks : Additional specimens, from Boolgadoo Pool, Minilya River, and from Coolkilya Flat, south of the Minilya River, probably from the lower part of the *Linoproductus* stage of the Wandagee series, were sent by Dr. Teichert. They have allowed an expansion of the diagnosis given in 1937. The specimen from Boolgadoo is unweathered, and large corallites are seen between smaller ones on the calical surface. The calices show eight or nine coarse radial ridges, somewhat as in *Striatopora* Hall ; the ridges are without spines. In all specimens the corallites open at right angles to the surface, thus differing from *T. marmionensis*, where they open obliquely. In the M 16 specimen, dilatation is not so excessive as in the others, and thin tabulae can be seen. Individual septal spines or trabeculae have not been distinguished, though the sclerenchyme is fibrous. Etheridge may have included some specimens of *T. immensa* in his *T. marmionensis*, as his description of the latter covers coralla with corallites opening at right angles to the direction of growth as well as those with corallites opening obliquely. The only two syntypes of *T. marmionensis* which I have seen, however, had their corallites opening obliquely. *T. immensa* or a very closely similar form occurs in association with *Euryphyllum reidi* at Castle Creek, Theodore, in an unknown horizon in the Queensland Bowen succession.

Thamnopora marmionensis (Etheridge).

Favosites marmionensis Etheridge, 1914, p. 13, pl. i., fig. 1 ; pl. ii., figs 2–4 ; pl. viii., fig. 2. Permian, Mt. Marmion, Kimberley District, Western Australia.

Diagnosis : *Thamnopora* forming large lobate masses, with corallite of two sizes opening obliquely to the surface, calices frequently with lower lip semi-circular, and with corallite walls becoming very thick distally ; with large irregular pores, frequent tabulae, and without septal spines.

Remarks : The species differs from the eastern Australian *T. wilkinsoni* (Etheridge) in being lobate rather than ramose, and in having the calices closer, while the projection of the calical rim is low compared with that of *T. wilkinsoni*.

Thamnopora *aff.* **marmionensis** (Etheridge) (Plate II., fig. 7).

Material : A fragment in limonite (g) from the lower part of the *Linoproductus* stage somewhat east of the *Heliocoprion* locality of Coolkilya Flat ; only the calical surface can be studied, and this shows corallites of two sizes, most of the openings have one-half of their outline semicircular, representing the lower lip, which, however, does not project, and the upper half polygonal, two or three short edges meeting at angles. This specimen is probably *T. marmionensis*, but the internal structure is obscured. A small lobate fragment (i) from high in the *Calceolispongia* stage at Station 25A, " Upper worm track " horizon north of Minilya River, with thin walls and oblique calices, which is probably *T. marmionensis*, but the calices are not clearly distinguishable into two sizes, and vary between 1 mm. and 1·5 mm. A worn, lobate fragment (b) from the highest beds exposed north-west of Station 23, in the lower part of the *Linoproductus* stage, Minilya River, which is probably *T. marmionensis*, although the corallite walls are thicker than in the syntypes, being 1 mm. or nearly 1 mm. throughout, and the septa appear to have denticulations resembling spines on their inner edges. A cylindrical fragment (d) from the lower part of the *Linoproductus* stage near Station 4A, north of Minilya River, whose internal structure is similar to that of (b). A cylindrical fragment (c) from the same horizon at Station 4A, north of Minilya River, closely resembling (b) and (d). All these are from the Wandagee beds.

Remarks : One cannot be certain that these specimens, which are probably conspecific, are *T. marmionensis*, because of their fragmentary nature, and because our knowledge of syntypes is very limited ; but the small, oblique corallites suggest that they are. I have seen nothing similar from eastern Australia.

Thamnopora insculpta sp. nov. (Plate I., figs 9 a-d ; Plate II., figs. 8 and 9).

Type material : Eleven fragments, possibly from one specimen, from the Callytharra beds near Callytharra Springs, W.A., collected by C. Teichert.

Diagnosis : Slender branching *Thamnopora* with the corallites opening a little obliquely to the surface, dilatation of the walls increasing greatly towards the surface, so that the openings are distant, and sunken into the unridged, faintly tuberculated wall tissue.

Description : The diameter of the cylindrical branching fragments varies between 3 mm. and 10 mm. The calical openings are unequal, the largest being 1·5 mm., some being 1 mm., and a few 0·5 mm. in diameter. They are unequally spaced, the smaller being in the angles between the larger, which tend to be arranged in vertical rows. The openings are occasionally surrounded by a raised rim, especially near the growing tips of the branches, its height being greatest on the under side of the opening, but in the older branches there is usually only a very faint trace of this rim, and that on the under side of the opening. Between the openings there is instead from 0·5 to 3 mm. of dense sclerenchyme, which is lightly tuberculate, and no trace of the junction between the walls of neighbouring corallites can be seen. Faint septal ridges are obse vable in one or two calices, twelve being counted. The corallites are almost vertical in the axial parts of the branch, and very small, being from 0·1 to 0·5 mm. in diameter, with but slightly thickened walls. Outside this axial part of diameter about 2 mm., the corallites bend rather rapidly outwards, opening to the surface at less than 30° to the horizontal. As they proceed to the surface they increase in diameter, but the greatest part of this increase is due to an increase in the thickness of the walls, the lumen never becoming wider than 1·5 mm. The walls may be very thick, from the dark line representing the junction of two corallites to the inner edges of the septa may be as much as 1·5 mm. The fibrous structure of this thickened tissue shows that it consists of twelve equal septa so dilated as to be in contact laterally. The vertical sections suggest that they have denticulate inner edges ; but individual trabeculae are not distinguishable in the fibrous tissue, as septal spines. Mural pores are fairly frequent, small and regular. Tabulae are thin and distant.

Remarks : The generic position of this species is doubtful. The occurrence of twelve equal septa is a character suggestive of generic difference from *Thamnopora cervicornis*, since neither septa nor septal spines are known in the types of *T. cervicornis*. Species with septal spines have been included in *Thamnopora*, but possibly this Western Australian species with lamellar septa should be placed in a separate genus with the eastern Australian *Trachypora wilkinsoni* Etheridge, to which it is very close. *T. wilkinsoni* has the twelve lamellar septa much more clearly developed, and in it the outer boundaries of the individual corallites are distinguishable by ridges on the surface. *T. wilkinsoni* occurs in the Upper Marine of Mulbring, and of Ellalong, N.S.W., in the Coral Stage of the Bowen Marine of the Springsure Basin, Queensland, and in the Condamine Fault block, near Silverwood, Queensland. I have not seen it from Western Australia, but *T. insculpta* appears to me to be a related form. *Favosites permica* Gerth (1921, p. 101, pl. cxlix., figs. 1, 2, 3, pl. cl., fig. 1) from the Basleo Beds, also has twelve septa, lamellar in the upper part of the calice, but this form is encrusting. Its septa consists of spines fused together at their bases, forming a series of stripes on the calical floor, but with separate spine ends in the lumen. Twelve septa, sometimes acanthine, but frequently with the spines fused at their bases to form lamellar septa, in the form of stripes on the corallite walls, appears to be the highest number possible in *Pseudofavosites stylifer* var. *septosa* Gerth (1921, p. 104, pl. cxlviii., figs. 7, 8) from Basleo, and this number is usually attained. But this genus is without tabulae.

? **Thamnopora** sp. (Plate I., fig. 10 ; Plate II., fig. 10).

Material : One specimen, collected by C. Teichert, from Callytharra Springs.

Description : The corallum is partly encrusting, extensi orm but of crumpled growth, with stumpy branches on the upper surface, which has been pitted by rain weathering. Its size is 60 x 60 x 15 mm., the branches being mostly broken off at a height of 5 to 10 mm., and being about 8 mm. in diameter. The corallites are unequal, up to 2 or 2·5 mm. in diameter. The walls of the corallites in the branches are much dilated, but those in the basal layers and in the parts in which the branches are set are thin. The walls of the corallites in the axes of the branches are also thin. When analysed microscopically, the dilatation is seen to be septal in origin ; the individual trabeculae of each septum are dilated and in contact so that lamellar septa are formed, from the axial edges of which denticulations may nevertheless arise ; and the dilatation is so great that neighbouring septa are in contact laterally, to form a dense wall. The number of the septa per corallite is unknown. The calices probably open obliquely to the surface of the branch, but this is unproved. Mural pores are numerous, and occur both between and piercing the septa. Tabulae are distant and very thin.

Remarks : In its manner of growth this specimen resembles some of the Devonian *Alveolites*, but the weathering does not permit us to study the outline of the calices. It may perhaps represent the basal portion of the branching *Thamnopora insculpta*, but further knowledge of the number of septa and obliquity of corallites is needed before this may be regarded as more or less than a possibility.

FAMILY **CLADOCHONIDAE**.

Genus **CLADOCHONUS** M'Coy.

Cladochonus M'Coy, 1847, p. 227.

Monilopora Nicholson and Etheridge, 1879, p. 293, genotype *Jania crassa* M'Coy, 1844, p. 197, Lower Carboniferous of Ireland.

Cladochonus ; Hill and Smyth, 1938, p. 126.

Genolectotype (chosen Edwards and Haime) : *Cladochonus tenuicollis* M'Coy, 1847, p. 227, pl. xi., figs. 8, Lower Carboniferous of New South Wales.

Diagnosis : Corallum compound, with a reptant ring of corallites proximally, from which free branches arise ; individual corallites are trumpet or pipe-shaped, and in contact only at the point of origin, each giving rise to another by lateral increase through the wall of the expanded calice ; each has a thick peripheral stereozone of laminar, sometimes reticulated sclerenchyme ; neither tabulae nor septal spines are seen in the narrow lumen, but longitudinal (? septal) ridges may appear in the calices.

Remarks : Hill and Smyth (*loc. cit.*) have shown that the genotype of *Monilopora* was but the reptant portion of a coral whose free branches are *Jania bacillaria* M'Coy, a species of *Cladochonus*, and that *Cladochonus* has priority over *Monilopora*. The genus extends from the Devonian through the Carboniferous to the Permian, and characterises the *Cyathaxonia* phase of sedimentation.

Cladochonus nicholsoni (Etheridge).

Monilopora nicholsoni Etheridge, 1914, p. 14, pl. i., figs. 2–4 ; pl. vii., fig. 4 ; Permian (? Upper Artinskian), Mt. Marmion, Kimberley, W.A.

Monilopora nicholsoni ; Etheridge, 1918, pl. xxxix., figs. 2, 3, Permian, Balmaningarra, Mt. Marmion, W.A.

non Monilopora ? nicholsoni ; Hill, 1937. a, p. 59, pl. i., figs. 23, 24, text-figs. 10, 11, from Callytharra, which is *Cladochonus striatus* sp. nov.

Type Material : Of the syntypes, only a fragment, Australian Museum F16418, has so far been found. From it was cut the section figured Etheridge, 1914, pl. vii., fig. 4. The specimens figured Etheridge, 1918, pl. xxxix., figs. 2, 3, are Australian Museum F16820 and F16712 respectively from Balmaningarra, Mt. Marmion. These are conspecific with the type material, and are described below.

Diagnosis : Bifurcating, free branches, 4·5 to 7 mm. thick, with successive corallites on opposite sides of a branch, the diameter at the edge of the calice being constantly 4·5 mm.

Description (of specimens from Balmaningarra) : The diameter of the free branches, measured at right angles to the plane of the calices, is from 4·5 mm. to 7 mm., most fragments having approximately the same diameter top and bottom, except at the point where bifurcation occurs ; a branch of 7 mm. average diameter expanded to 8·5 mm. at such a point. The angle between the products of bifurcation is about 30° ; the distance between bifurcations varies, and new branches are in a plane at right angles to the plane of the calical openings. Calical openings are circular, and fairly regularly 4·5 mm. in diameter, even when the branches are slender. They are also fairly regularly spaced, there being from 8 mm. to 10 mm. between the edge of the lower lip of one corallite to that of the next above. The lower lip of the calice is sharp, but not continued into a ledge, the sharpness being due to the obliquity of the lumen to the branch, which is about 45°. The calices alternate on opposite sides of a branch, each branch usually having two vertical rows of calices, though just before bifurcation there may be irregularity. Each calice arises from the upper part of the base of the one below. The calical opening extends inwards with a very gradual and regular decrease in diameter for at least 4 mm., and there are signs of septal ridges in its upper parts. Etheridge's thin section shows reticular tissue lining its lower parts.

Remarks : The reptant parts of the corallum from which these free branches are presumed to have arisen, are as yet unknown. In the Condamine fault block, near Silverwood, Queensland, and in the Coral Stage of the Springsure District, Queensland, fragments whose dimensions correspond to those of the Balmaningarra specimens except that the calical edges may be 5 mm. in diameter rather than 4·5 mm. occur, associated with other Cladochonid fragments of different proportions, but which yet may prove to be this species, and with *Thamnopora wilkinsoni* (Etheridge). In view of the abundance of specimens of different proportions with those with characteristic proportions at these two Queensland localities, it is important to obtain more syntypes of *C. nicholsoni*, in order to define the range of variation possible in the species. *Cladochonus beecheri* (Grabau, Gerth, 1921, pl. cxlix., fig. 12) and *C. magnus* Gerth (*id.* figs. 10, 11) from the Middle Permian of Basleo, Timor, are even larger than this Australian species, but their dimensions are attained by a specimen in the University of Queensland from Cressbrook Creek, near Esk.

Cladochonus striatus sp. nov. (Plate II., fig. 11).

Monilopora ? *nicholsoni* Etheridge, Hill, 1937, a, p. 59, pl. i., figs. 23, 24, text-figs. 10, 11, Permian, Callytharra, W.A.

Holotype : Specimen figured Hill, *loc. cit.*, text-fig. 10, in the Collection of the University of Western Australia, from the Permian of the creek half a mile west of Callytharra Spring, Wooramel River, W.A.

Diagnosis : Slender *Cladochonus*, with corallites widest at the calical rim, which is 3 or 4 mm. in diameter, and with 18–20 faint longitudinal striations on the epitheca.

Remarks : The specimens previously described were reptant portions of coralla, but I now have fragments of erect branches from the Callytharra beds near Callytharra Springs. The species has much slenderer proportions than the later *C. nicholsoni*, and the longitudinal striation on its epitheca has not been noted in any other species.

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EXPLANATION OF PLATES.

Plate I.

Permian Corals from Western Australia.

All specimens are in the Collection of the University of Western Australia.

All figures by 2 diameters, approximately.

Fig. 1 "*Amplexus*" *pustulosus* Hudleston. Transverse section. Upper part of Callytharra Series near Trig. Station K52, Kennedy Range, near Williambury-Middalya road. No. 41071.

Fig. 2. *Allotropiophyllum*, sp. Transverse section. Middle part of the *Calceolispongia* Stage in the Wandagee Series, near Coolkilya Pool, Minilya R. No. 41072.

Fig. 3. *Euryphyllum reidi* Hill. Transverse section. Upper part of the *Calceolispongia* Stage in the Wandagee Series, north side, Minilya R., W. of Coolkilya Pool. No. 41073.

Fig. 4. ? *Euryphyllum*, sp. Transverse section. Locality and horizon as for fig. 2. No. 41074.

Fig. 5. **Verbeekiella mersa**, sp. nov. Transverse section of holotype. Lower part of the *Calceolispongia* Stage in the Wandagee Series, north side, Minilya R., W. of Coolkilya Pool. No. 41075.

Fig. 6. **Verbeekiella mersa**, sp. nov. Vertical section. Upper part of the *Calceolispongia* Stage in the Wandagee Series, north side Minilya R., W. of Coolkilya Pool. No. 41076.

Fig. 7. *Verbeekia talboti* (Hosking). Transverse section. Callytharra Series, Callytharra Springs. No. 41077.

Fig. 8. *Thamnopora immensa* Hill. Vertical section. Bulgadoo Pool, Minilya R. No. 41069 (= 20204).

Fig. 9. **Thamnopora insculpta**, sp. nov. Type material. Callytharra Series near Callytharra Springs, a, b, transverse section; c, tangential and d, median vertical section. No. 41078 a, b, c, d.

Fig. 10. *Thamnopora* sp. Section. Callytharra Stage, Callytharra Springs. No. 41079.