CORRELATION OF THE CANADIAN MIDDLE DEVONIAN HUME AND NAHANNI FORMATIONS BY TETRACORALS

by A. E. H. PEDDER

ABSTRACT. *Dendrostella trigemme* (Quenstedt), *Grypophyllum graciliseptatum* sp. nov., *Utaratuia laevigata* Crickmay, *Sociophyllum glomerulatum* (Crickmay), and *Radiastraea verrilli* (Meek) are shown to be common to the Hume and Nahanni Formations. In addition *Taimyrophyllum*, a senior synonym of *Eddastraea*, is recognized for the first time in North America, *T. triadorum* sp. nov. is described from the Hume Formation, and a closely related species *T. vescibalteatum* sp. nov. from the Nahanni Formation.

Grypophyllum gracile (McCoy), from the Middle Devonian of Devon, is redescribed and a lectotype chosen.

In some far northern regions there are indications that the lowest part of the Hume Formation may be Eifelian and in the upper Root River area there is evidence that the very uppermost Nahanni Formation is Middle Givetian. Elsewhere, however, the Hume, Nahanni and Headless Formations are believed to be essentially correlatives and early Givetian in the Belgian usage of the stage.

TWO works (Warren and Stelck 1962; McLaren 1962) have recently appeared, almost simultaneously, containing correlations and stage assignments of the Hume, Headless, and Nahanni Formations of north-western Canada. Copies of these were received by the writer after he had completed his part of yet another work (House and Pedder 1963) touching on the correlation of these same formations. Since Warren and Stelck's views differ considerably, and McLaren's slightly, from the author's, further evidence and considerations which have helped shape his opinions are now published.

The Eifelian and Givetian Stages. Although European geologists recognize two stages in the Middle Devonian, there are differences of opinion as to where the division should be made and also on the appropriate name for the earlier stage (Lecompte 1955). Throughout most of the first half of this century the Middle Devonian in Belgium was divided into the Couvinian and Givetian. During the same period in Germany, however, it was more frequently divided into lower, middle, and upper divisions. Gignoux (1950, p. 141, fig. 27) and a few others before him, carried the term Givetian into the Rhineland and drew the base of the stage at, or near, the base of the middle Middle Devonian of the earlier German classification. This resulted in the Givetian in Belgium and Germany being about coeval and also in the virtual correspondence between the range of the stage and that of the one fossil which overseas workers had long regarded as being entirely characteristic and indeed diagnostic of it, namely *Stringocephalus*.

The Eifelian–Givetian boundary was taken to occur at this level in the author's previously published correlation chart (House and Pedder 1963, text-fig. 2). With reference to the Blankenheimer and Hillesheimer sequences of the Rhineland this is approximately at the base of the Freilinger Schichten (Ochs and Wolfart 1961, p. 68). Contrarily the recent trend in Germany has been to elevate the lower Givetian boundary to the base of the Loogher Schichten of the Hillesheimer sequence. This, of course, validates Warren and Stelck's (1962, p. 273) statement that 'it has long been known that *Stringocephalus* sensu lato appears first in the Eifelian', but the statement is true only provided the high placement of the stage's upper limit is maintained. McLaren (1962,

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p. 12) referred to Schmidt (1960) and stated that *Stringocephalus* occurs only in the middle and upper Givetian in Germany. However, Schmidt was considering only the hercynischen Facies, and *Stringocephalus* has been reported in early Givetian beds of the rheinischen Facies by a number of workers.

The writer has not found *Stringocephalus* associated with the coral faunas described in this paper, but has been shown collections from the Nahanni equivalent in north-eastern British Columbia, which included *Dendrostella trigemme* and *Stringocephalus*. Furthermore, Warren and Stelck (1962) report the presence of *Stringocephalus* in the Hume Formation, and McLaren (1962) records its presence in the Pine Point Formation, a correlative of the Hume, Headless, and Nahanni Formations. There are thus several reasons for believing that the age of the coral faunas is approximately the same as the earliest occurrences of *Stringocephalus* in western Canada.

The relationships of the Hume and Nahanni faunas to others. The corals under consideration are part of a fauna that invariably underlies beds containing *Leiorhynchus castanea* (Meek). Over most of the region drained by the Mackenzie and Anderson Rivers the corals range to the top of the Hume Formation, and *L. castanea* occurs in beds immediately above this formation. However, on Root River the corals occur throughout most of the Nahanni Formation, but are absent in its very highest beds, which contain abundant *L. castanea*. For this reason the upper limit of the Nahanni Formation, in at least some localities, is believed to be just younger than that of the Hume Formation. Most Canadian workers (Warren and Stelck 1962; McLaren 1962; House and Pedder 1963) now agree that these earliest occurrences of *L. castanea* in western Canada are at about the middle of the Givetian. This is supported by a goniatite suite accompanying one occurrence on Francis Creek, near Norman Wells. It contains *Agoniatites sp.* cf. *A. vanuxemi* (Hall), *Cabrieroceras karpinskyi* (Holzapfel) and *Tornoceras* (*T.*) *sp.* cf. *T. westfalicum* Holzapfel (House and Pedder 1963).

In most areas the Hume, Headless, and Nahanni Formations are underlain by unfossiliferous dolomites. But in some of the western ranges of the Mackenzie Mountains, in the extreme south-western part of the Northwest Territories, these dolomites are replaced by rusty-weathering argillaceous limestones comprising the Funeral Formation. The latter is up to 2,000 feet thick and has yielded *Agoniatites sp.* and *Gyroceratites* (*Lamelloceras*) *sp.* near the base, and *Anarcestes* (*Latanarcestes*) *sp.* cf. *A. praecursor* Frech 469 feet below the top (House and Pedder 1963). The lower part of the formation, therefore, is probably of early or middle Eifelian age and the formation remains Eifelian at least to within 469 feet of its top.

House regards the goniatite *Teicherticeras lenzi* as Emsian rather than Eifelian. On Ogilvie River it occurs only 296 feet below beds correlated with the Hume Formation by Lenz. This, and the fact that the lowest few feet of the Hume Formation on Anderson River contain, in addition to normal Hume species, others not known in higher beds, suggest that in the north the lowest Hume may represent a slightly older and presumably Eifelian zone.

Composition and analysis of the tetracoral faunas. Table 1 indicates the distribution of the corals described in this paper. It strongly suggests that the Nahanni, Headless, and Hume Formations are essentially the same age, excepting (as mentioned above) the uppermost beds of the Nahanni.

The Digonophyllidae are omitted since they are the subject of a thesis by O. Miedema, which is to be published. Despite the conflicting evidence gleaned by most palaeontologists from this family, Miedema is firmly in favour of an early Givetian age for the digonophyllids of the Hume Formation.

SPECIES	FORMATION		
	HUME	HEADLESS	NAHANNI
Dendrostella trigemme	x	x	x
Taimyrophyllum triadorum	x		
T. vesciballeatum		x	x
Grypophyllum graciliseptatum	x		x
Utaratuia laevigata	x	cf	cf
Sociophyllum glomerulatum	x	x	x
Radiastraea verrilli	x	x	x

TABLE 1. Known distribution of the tetracorals, described in this paper, in the Hume, Headless, and Nahanni Formations (Middle Devonian, Canada).

Dendrostella occurs rarely in the Eifelian of Germany, and probably also in beds of this age in Russia and eastern Australia. However, as a result of a surge in its distribution and numbers at the start of the Givetian, the Givetian occurrences greatly outnumber those of the Eifelian. The species *D. trigemme* was extraordinarily widely distributed in Givetian times and its abundance in the Hume, Nahanni, and Headless Formations is a strong indication of the age of these formations.

Taimyrophyllum was proposed for a species said to occur at the base of the Lower Devonian in south-west Taimir, but just how low this is in the Lower Devonian is not known. Elsewhere in the Soviet Union the genus has been described from beds of supposed Eifelian age (Bulvanker 1958; Spasskiy 1960). In Australia *Taimyrophyllum* occurs in the Loomberah and Broken River Formations of New South Wales and Queensland respectively. The Loomberah Formation has yet to yield truly diagnostic fossils, but contains a species very close to the European Givetian *Endophyllum abditum* Edwards and Haime (Hill 1942*b*). The Broken River Formation is about 7,000 feet thick (Hill and Denmead 1960, pp. 149, 151) and contains several faunas. The one with *Taimyrophyllum* includes *Stringocephalus* as well as many other corals, and is evidently early Givetian. The age assigned to the Canadian species of *Taimyrophyllum*, therefore, is compatible with the known range of the genus elsewhere, which is Lower Devonian to early Givetian.

Although *Grypophyllum* has been described from Lower Devonian and Eifelian deposits, several of the species referred to it would be better accommodated in *Lyrielasma* or other genera, and in fact species of the *G. graciliseptatum* group are far more characteristic of the Givetian than earlier stages.

In Europe, Asia, North Africa, and Australia the closely related genera *Stringophyllum*, *Neospongophyllum*, and *Sociophyllum* are predominantly Givetian. The Canadian *S. glomerulatum* closely resembles *S. elongatum* (Schlüter), which is common in the

Givetian Loogher Schichten and has also been reported in the slightly younger Ermberg Schichten by Ochs and Wolfart (1961, p. 46).

Before the range of *Radiastraea* can be regarded as established, research is necessary on the relationship of its type species to others currently referred to *Billingsastraea* and even *Phillipsastrea* (e.g. the Frasnian '*P.*' *whittakeri* Smith). Regardless of the outcome of such research the similarity between the Emsian *R. arachne* Stumm and *R. verrilli* (Meek) argues against regarding the latter as Givetian.

The previously given evidence, however, outweighs that provided by *Radiastraea*, and the corals described in this paper are best regarded as being about the age of the Freilinger or Fleringen Schichten in the German Blankenheimer Mulde sequence. This is about the same age as Kayser's (1871) Crinoiden Schichten, or the base of the middle Middle Devonian.

Summary. The Hume, Headless, and Nahanni Formations have sufficient tetracorals in common to justify their correlation, at least in part. *Stringocephalus* occurs with one of the corals in north-eastern British Columbia and is reported in the Hume as well as in the correlative Pine Point Formation. It probably first occurs in Canada and Germany at about the same time.

Analysed in the absence of other considerations the corals appear to be approximately the same age as the base of the German middle Middle Devonian, or Freilinger Schichten. The corals are overlain by a middle Givetian ammonoid fauna in one region and in another overlie 469 feet of undated beds, which in turn overlie at least 1,000 feet of beds containing Eifelian ammonoids.

It is possible that in the north the lowest part of the Hume Formation is Eifelian. Otherwise it is concluded that the Hume, Headless, and the major part of the Nahanni Formations are about the same age as the base of the middle Middle Devonian. This is early Givetian in the Belgian concept of the stage.

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SYSTEMATIC PALAEONTOLOGY

The following abbreviations are used for the names of collections containing type specimens to which reference is made:

- BM British Museum (Natural History), London.
- CGM Central Geological Museum, Leningrad.
- GSC Geological Survey of Canada, Ottawa.
- SM Sedgwick Museum, Cambridge.
- TOCL Triad Oil Co. Ltd., Calgary.
- USNM United States National Museum, Washington.

The Northwest Territories are also abbreviated to NWT.

Family STAURIIDAE Edwards and Haime, sensu lato
Genus DENDROSTELLA Glinski 1957

Type species (original designation). Cyathophyllum rhenanum Frech 1886, p. 207 (93), pl. 15 (3), figs. 19, 19*a*. Büchleler Schichten, 'Schichten mit *Uncites gryphus*' of Meyer 1879, (Givetian), near Paffrath, Germany. The original types of this species are lost. A neotype (designated by Glinski 1957, p. 88) is illustrated in text-figs. 16*a*, *b* of Glinski's work and is also from the Bücheler Schichten, Schladetal, Paffrather Mulde, Germany.

Diagnosis. Loosely fasciculate tetracorals with subcylindrical corallites. The epitheca is thick and composed of greatly expanded septal ends embedded in lamellar tissue. The septa are thin, smooth, subradially arranged and differentiated into two orders; typically several of the major septa are especially long, but these are not definitely identifiable with any of the protosepta. The peripheral ends of the septa are greatly expanded and as seen in transverse section bear a dark median line in the outer part of the expanded region. Dissepiments and tabellae are absent. The tabulae are broad and some are quite complete.

Remarks. Glinski proposed *Dendrostella* as a subgenus of *Favistella*, but the type species of *Dendrostella*, together with a few others, form a compact species group worthy of full generic rank. Flower (1961, pp. 76–9) outlined the problems involved in the recognition of *Favistella* and proposed *Favistina* for the Ordovician corals previously assigned to *Favistella*. The Middle Devonian species of *Dendrostella* are distinguished from them by their highly characteristic epitheca and by their tabulae, which are not peripherally downturned.

Dendrostella trigemme (Quenstedt 1879)

Plate 62, figs. 1–11

?1852 *Cyathophyllum caespitosum* Goldfuss; Quenstedt (*partim*, Bensberg specimens only), p. 664, pl. 59, figs. 40*a*, *b* (not fig. 41, which shows dissepiments).
?1867 *Cyathophyllum caespitosum* Goldfuss; Quenstedt, p. 797, pl. 76, fig. 40. Teste Flügel.
?1879 *Cyathophyllum caespitosum* Goldfuss; Quenstedt (*partim*, Bensberg specimens only), pp. 516–18.
1879 *Cyathophyllum caespitosum trigemme* Goldfuss; Quenstedt, p. 518.
?1881 *Cyathophyllum caespitosum* Goldfuss; Quenstedt (*partim*) pl. 162, figs. 1, 2 only.
1881 *Cyathophyllum caespitosum trigemme* Goldfuss; Quenstedt, pl. 162, figs. 5–8.
1885 *Cyathophyllum caespitosum* Goldfuss; Quenstedt (*partim*, Bensberg specimens only), pp. 1023, 1024, pl. 83, fig. 6, (not fig. 7, which shows dissepiments).
1886 *Cyathophylloides rhenanum* Frech, p. 207 (93), pl. 15(3), figs. 19, 19*a*.
1894 *Cyathophylloides* (*Densiphyllum*) *rhenanus* Frech; Weissermel, p. 621.
1897 *Columnaria* (*Pycnophyllum*) *rhenana* (Frech); Weissermel, pp. 872, 873.
1900 *Cyathophyllum caespitosum* Goldfuss; Lotz, p. 235. Teste Flügel.
1912 *Metriophyllum poshiense* Mansuy, pp. 47, 48, pl. 7, figs. 8*a*-*d*.
1922 *Metriophyllum* (?) *poshiense* Mansuy; Grabau, p. 67.
1922 *Columnaria* (*Pycnophyllum*) *rhenana* (Frech); Paeckelmann, pp. 74, 75.
1923 *Cyathophylloides rhenanum* (Frech); Fliegel, p. 370.
1942*a* *Favistella rhenana* (Frech); Hill, p. 253, pl. 9, figs. 2*a*, *b*, 3*a*, *b*.
1945 '*Columnaria*' cf. *disjuncta* Whiteaves; Wilson, A. E. *in* Hage, p. 6.
?1948 *Columnaria sp.*; Wang, p. 28, pl. 4, fig. 23.
1949 *Columnaria vulgaris* Soshkina; Soshkina, p. 107, pl. 43, figs. 5, 6.
1952 *Columnaria vulgaris* Soshkina; Soshkina, p. 92, pl. 26, fig. 102.
1955 *Columnaria rhenana* (Frech); Kraevskaya, pp. 216, 217, pl. 41, fig. 2*a*.

1957 *Favistella (Dendrostella) rhenana* (Frech); Glinski, pp. 88–90, text-figs. 1–4, 16.
1958 *Favistella rhenana* (Frech); Bulvanker, pp. 110–12, pl. 42, figs. 3, 4; pl. 43; fig. 2.
1958 *Favistella (Dendrostella) rhenana* (Frech); Flügel, pp. 49, 50.
1959 *Columnaria rhenana* (Frech); Middleton, pp. 150, 151, text-figs. 5*f–h*, pl. 27, figs. 6*a*, *b*, 7.
1959 *Favistella (Dendrostella) trigemme trigemme* (Quenstedt 1881); Flügel, pp. 113–17.
1961 *Dendrostella rhenana* (Frech); Fontaine, pp. 156, 157, pl. 28, figs. 6–8.
1961 *Columnaria rhenana* (Frech); Lenz, p. 506, pl. 1, figs. 5–10.
1962 *Dendrostella rhenana* (Frech); McLaren, Norris and McGregor, pl. 2, figs. 1, 2.
non 1826 *Lithodendron caespitosum*; Goldfuss, p. 44, pl. 13, fig. 4 (lectotype = *Phacellophyllum*).
non 1935 *Disphyllum (Phacellophyllum) trigemme* (Quenstedt); Lang and Smith, p. 575, text-figs. 30, 31 (= *Thamnophyllum trigeminum* (Penecke), teste Flügel).
non 1936 *Columnaria vulgaris*; Soshkina, p. 22, text-figs. 1–3 (= *Dendrostella vulgaris*).

Types. The *lectotype* is in the Museum für Geologie und Paläontologie der Universität, Tübingen, where it is numbered Coe 5/162/5. It is the specimen figured by Quenstedt 1881, pl. 162, fig. 5, and came from the Schwelmer Kalk (Givetian) at Hand, near Paffrath, Germany. Flügel (1959, p. 114) actually designated the specimen in fig. 5 of Quenstedt's pl. 182, but there is no doubt from the study of his synonymy, the museum label, and Quenstedt's plates, that he really meant pl. 162. When seen by the writer the specimen consisted of two small fragments.

Hypotype 1, GSC 16984 (Plate 62, fig. 10), previously TOCL D141*d*, upper part of the Hume Formation, east end of Carcajou Ridge, NWT, about 65° 30′ N., 128° 30′ W.; collected by E. W. Best and D. L. Barss, 1961. *Hypotype* 2, GSC 16985 (Plate 62, fig. 11), previously TOCL D141*k*, as above. *Hypotype* 3, GSC 16986 (Plate 62, figs. 1–9) previously TOCL G1425*a*, 140 to 150 feet below the top of the Nahanni Formation, north side of Bluefish Lake in the Nahanni Range, NWT, 61° 11′ 30″ N., 123° 19′ 30″ W.; collected by A. E. H. Pedder, 1960.

Additional material. In all, more than 100 specimens from 62 localities in the NWT and Yukon have been studied.

Description of hypotypes. A loosely dendroid tetracoral occurring commonly in huge masses, which presumably represent many intergrown coralla. The lateral offsets are mostly at a marked angle to the original corallite, so that the corallites, which are cylindrical and typically very straight, tend to grow in various directions.

Transverse sections. The adult corallites are approximately circular and vary between 4·5 and 8·5 mm. in diameter. Owing to the coral's growth form they are rarely in contact and are commonly 5·0 to 15·0 mm. apart. The epitheca is continuous and about 0·5 mm. thick; it is composed of exceptionally expanded septal ends embedded in lamellar tissue. The septa number between 30 and 40 per adult corallite; they are differentiated into two orders and are roughly radially arranged. The major septa extend almost to, or beyond the axes; Glinski termed the longest 'Richtsepten' (directive septa) but they are not homologous with the Richtsepten of the Digonophyllidae. The minor septa, although variable, are approximately half as long as the major. The peripheral ends of the septa are characteristically greatly expanded in the epitheca and in transverse section the outer half of the expanded regions bears a dark median line. In the tabularium the septa are thin and smooth along their entire length.

Longitudinal sections. The sides of the epitheca are subparallel in adult corallites. There are neither dissepiments nor tabellae. The tabulae, which are typically depressed axially, are moderately spaced and abut against the epitheca; they are broad and some appear complete, but most are disrupted by septa.

Remarks. Through the kindness of Professor Hölder, the writer was able to study the lectotype of this species and supports Flügel's contention that Frech's *Cyathophylloides* *rhenanus* is a junior synonym of it. The lectotype, which is a small fragment of a corallite, is about 7·2 mm. in diameter and has 36 septa; it closely resembles the hypotypes in all respects, except that its epitheca is more pronounced, being about 1·0 mm. thick. Fontaine has shown that *Metriophyllum poshiense* Mansuy is another junior synonym of this species. The holotype is said to be at l'École des Mines, Paris, and came from the Givetian of Yunnan. Although Wang's (1948) fragments were described as having short major septa, which number only 16 in corallites averaging as much as 8·0 mm. in diameter, it is possible that they should be referred to this species.

In Canada this species occurs in the Nahanni Formation of north-eastern British Columbia, southern Yukon, and south-western NWT, and in the Headless and Hume Formations of the NWT; it is also said to occur in the Givetian of the arctic islands, but the writer has not studied specimens from there. Elsewhere it occurs in Givetian limestones in Germany, the Plöken Pass region of Austria, south-western England, the Urals, Kuznets, and Novaya Zemla regions of Russia, southern China, northern Vietnam, and in northern Queensland, Australia. It is also reported in the late Eifelian of the Kuznets Basin.

Family SPONGOPHYLLIDAE Dybowski

Remarks. Most workers have accepted the Ptenophyllidae as a family distinct from the Spongophyllidae. This is difficult to justify when one considers the obvious gradation from *Xystriphyllum*, an accepted ptenophyllid, through *Pseudospongophyllum* to *Spongophyllum*, and in this work Ptenophyllidae is regarded as synonymous with Spongophyllidae.

The tabularium in early species of *Smithiphyllum* are more suggestive of the Endophyllidae than either the Spongophyllidae or Disphyllidae, and the genus should probably be transferred to that family.

Genus TAIMYROPHYLLUM Chernychev 1941

Type species (original designation). T. speciosum Chernychev 1941, pp. 12, 13, text-fig. 1, pl. 1, figs. 1–3; pl. 2, figs. 1–3; pl. 5, fig. 5. Lower Devonian, Tareia River, 40 km. from the mouth, south-west Taimir, U.S.S.R.

Diagnosis. Massive thamnasterioid to aphroid tetracorals. The calices are shallow and their rims most commonly flush with the nearly flat calicular platforms. In some species slight thickening of the dissepiments and septa produces rudimentary intracorallite walls, in others these are entirely absent and the genus is never truly cerioid. In the thamnasterioid species the septa are either continuous with those of neighbouring corallites or abut against them. The septa in the dissepimentarium are normally thin, smooth, and either undifferentiated or are poorly so. In the tabularium, however, they

EXPLANATION OF PLATE 62

All figures × 3.

Figs. 1–11. *Dendrostella trigemme* (Quenstedt). 1–6, Transverse; 7–9, longitudinal sections of hypotype 3, GSC 16986, Nahanni Formation. 10, Transverse section of hypotype 1, GSC 16984, Hume Formation. 11, Longitudinal section of hypotype 2, GSC 16985, Hume Formation.

Figs. 12, 13. *Taimyrophyllum triadorum* sp. nov. 12, 13, Longitudinal and transverse sections of holotype, GSC 16987, Hume Formation.

are clearly differentiated into two orders and commonly bear zigzag carinae. The minor septa only just protrude into the tabularium, but the major are long and typically form a weak axial vortex and may show minor rhopaloid thickening. The septa are not thickened at the margin of the tabularium. The trabeculae, in the few specimens in which they have been observed, are almost vertical throughout much of the dissepimentarium, but in and close to the tabularium they are inwardly and upwardly directed. The dissepiments grade from ones of moderate size and approximate horizontal disposition in most of the dissepimentarium to smaller and more steeply inclined ones at the margin of the tabularium. Lateral or cystose dissepiments occur in some species. Tabellae are rare or absent. The tabulae are closely spaced and commonly much disrupted by the major septa.

Remarks. The genus *Eddastraea* (Hill 1942*b*, pp. 147, 148) is a synonym of *Taimyrophyllum*. The type species of the former is, by original designation, *Phillipsastraea grandis* Dun (*in* Benson 1918, p. 379, pl. 35, figs. 4, 5). The type material was collected from the Loomberah Limestone (Eifelian or Givetian) near Loomberah, New South Wales, Australia. In 1942 the whereabouts of this material was unknown, but later the original slides came to light at Otago University and were forwarded to Professor Hill in time for her to prepare new figures of the species for the *Treatise on Invertebrate Palaeontology*, Part F. The extant part of the original specimen of *T. grande* consists of two transverse and two longitudinal sections. Search for the remaining unsectioned part has been unsuccessful. To facilitate comparison the types of *T. grande* and *T. speciosum* are figured in this paper on Plates 63 and 64.

Taimyrophyllum triadorum sp. nov.

Plate 62, figs. 12, 13; Plate 64, fig. 5; Plate 65, figs. 1, 2

Name derivation. Patronym for the geologists of Triad Oil Co. Ltd.

Holotype, GSC 16987 (Plate 62, figs. 12, 13; Plate 64, fig. 5), previously TOCL D23*a*, Hume Formation, Anderson River, NWT, about 68° 30′ N., 127° 25′ W.; collected by A. E. H. Pedder, 1959. *Paratype*, GSC 16988 (Plate 65, figs. 1, 2), previously TOCL D15*a*, Hume Formation, Anderson River, NWT, about 68° 32′ N., 127° 12′ W.; collected by A. E. H. Pedder, 1959. Neither of the outcrops is sufficient to indicate their level in the formation.

Diagnosis. A species of *Taimyrophyllum* having from 24 to 28 septa and a tabularium from 2·0 to 4·0 mm. wide.

Description. A thamnasterioid tetracoral. Both the types are incomplete specimens, the holotype was at least 13 cm. in diameter and 42 cm. high; the paratype was smaller. The calices are shallow and saucer-shaped, typically about 1·0 mm. deep and between 2·0 and 4·0 mm. in diameter. The axes of adjacent corallites are mostly between 8·0 and 12·0 mm. apart. The calicular rims are either flush with the general surface of the corallum, or are just exsert. The septa are prominently elevated on the surface of the corallum.

Transverse sections. The septa are differentiated only in the tabularium and number from 24 to 28 per adult corallite. They are either confluent with those of adjacent corallites, or abut against them. The major septa are thin, smooth, and typically only very gently sinuous in the dissepimentarium, but in the tabularium they are carinate and twisted, forming loose axial vortices; some have slight rhopaloid thickening. The minor septa are smooth and thin throughout, and are either confined to the dissepimentarium, or just protrude into the tabularium. The dissepiments are abundant, particularly near the tabularium, where owing to their greater inclination, they appear to be especially abundant. They are commonly chevron-shaped and in extreme cases both ends of the same dissepiment abut against the same septum.

Longitudinal sections. Throughout most of the dissepimentarium, the dissepiments are broadly arched and horizontally disposed. In the holotype their average length is about 1·0 mm., but in the paratype it is about 1·2 mm.; the largest seen is 4·0 mm. long. Close to the tabularium they become progressively more steeply inclined, so that in many places the tabulae are perpendicular to the dissepiments; thus the demarcation between the tabularium and dissepimentarium is abrupt and distinct. The tabulae are closely set and invariably incomplete, especially as they are much disrupted by the septa. There are no tabellae. As far as can be seen in the prepared sections of the types, the trabeculae are parallel and upwardly directed throughout most of the dissepimentarium, but are inwardly inclined near, and in, the tabularium.

Remarks. This species has been found only in two collections from the Hume Formation. It is distinguished from *T. vescibalteatum* by its lack of intracorallite walls and by its more widely spaced tabularia. *T. grande* is a much larger species with considerably more septa. *T. speciosum* is also larger and is less consistently thamnasterioid.

Taimyrophyllum vescibalteatum sp. nov.

Plate 65, fig. 3; Plate 66, figs. 1–6

Name derivation. Latin, *vescus* = weak, *balteatus* = belted.

Holotype. GSC 16989 (Plate 65, fig. 3; Plate 66, figs. 3, 4), previously TOCL G5067*a*, 227 to 237 feet below the top of the Nahanni Formation, northern Funeral Range, NWT, 61° 41′ 30″ N., 125° 05′ 00″ W.; collected by A. E. H. Pedder, 1960. *Paratype* 1, GSC 16991 (Plate 66, figs. 5, 6), previously TOCL G7051*a*, 320 to 330 feet below the top of the Nahanni Formation, upper Prairie Creek, NWT, 61° 42′ 00″ N., 124° 58′ 00″ W.; collected by L. F. Cote, 1960. *Paratypes* 2, 3, GSC 16990 (Plate 66, figs. 1, 2),

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EXPLANATION OF PLATE 63

All figures ×3.

Figs. 1, 2. *Taimyrophyllum grande* (Dun). 1, Transverse section of holotype (at present in the keeping of Professor D. Hill, Brisbane), Loomberah Limestone, near Loomberah, New South Wales. 2, Transverse section, probably also of the holotype, at present in the keeping of Professor D. Hill.

Figs. 3, 4. *Taimyrophyllum speciosum* Chernychev. Lower Devonian, Tareia River Basin; after Chernychev 1941. 3, Transverse section of holotype, CGM 3/5958. 4, Transverse section of a paratype, repository unpublished.

EXPLANATION OF PLATE 64

Figures 1–4, ×3, figures 5, 6, ×1.

Figs. 1, 2, 6. *Taimyrophyllum speciosum* Chernychev. Lower Devonian, Tareia River Basin; after Chernychev 1941. 1, 6, Longitudinal section and exterior of holotype, CGM 3/5958. 2, Longitudinal section of a paratype, repository unpublished.

Figs. 3, 4. *Taimyrophyllum grande* (Dun). 3, 4, Longitudinal sections of holotype (at present in the keeping of Professor D. Hill, Brisbane), Loomberah Limestone, near Loomberah, New South Wales.

Fig. 5. *Taimyrophyllum triadorum* sp. nov. Part of the exterior of holotype, GSC 16987, Hume Formation.

GSC 16992, previously TOCL G5021*b*, *c*, respectively, 176 to 186 feet below the top of the Nahanni Formation, same locality and collector as the holotype.

Additional material. Eleven specimens from nine localities in the Nahanni Formation have been studied.

Diagnosis. A species of *Taimyrophyllum* with narrow corallites (averaging about 9·0 mm. in width) separated by weak intracorallite walls.

Description. A partly cerioid to astreoid tetracoral. The types are all incomplete; the largest specimens seen in the field by the writer are about 35 cm. in diameter and 10 cm. high. The calices are moderately shallow and subconical. The calicular rims are flush with the general surface of the corallum and are surrounded by broad calicular platforms. The adult corallites are delimited by weak zigzag walls and are between 6·0 and 11·0 mm. across.

Transverse sections. The septa number from 22 to 30 per adult corallite and are either confluent with those of adjacent corallites or abut against them. They are smooth in the dissepimentarium, but in the tabularium faint traces of carinae can be seen on some. Their length varies in the tabularium, but differentiation into major and minor septa is irregular. In the tabularium they tend to show a rudimentary bilateral symmetry and form an axial vortex. They are typically thin, although in places thickening occurs, especially in the tabularium and near the periphery of some corallites; some have minor rhopaloid thickening. The intracorallite walls are indistinct and absent in places. They appear as thick dissepiment-like bars between some of the septa, which may be thickened and augment the wall. The walls are secondary to the septa since they do not interrupt their continuity from one corallite to another. The dissepiments, which are either arcuate or chevron-shaped, appear to be especially abundant near the tabularium; this is due to their greater inclination there than elsewhere.

Longitudinal sections. The intracorallite walls are mostly thin and continuous in the holotype and paratype 2; in paratype 1, however, they are discontinuous. The peripheral dissepiments abut against the wall where it is present, but where it is absent the peripheral dissepiments of adjacent corallites are continuous. The dissepiments are arched and mostly vary in length between 0·5 and 2·0 mm. Peripherally they are horizontally disposed or nearly so; axially they become progressively more steeply inclined so that the innermost ones commonly lie perpendicular to the tabulae and the boundary between the dissepimentarium and tabularium is abrupt and distinct. The tabulae are closely set, incomplete, and much disrupted by septa. There are no tabellae. Trabeculae cannot be seen in the type material.

Remarks. The species does not closely resemble any other yet described. It differs from *T. triadorum* in its more closely set tabularia and weak intracorallite walls.

Genus GRYPOPHYLLUM Wedekind 1922

Type species (original designation). *G. denckmanni* Wedekind 1922, pp. 13–15, text-figs. 13, 14; figures reproduced by Stumm 1949, pl. 12, figs. 13, 14; Hill 1956, text-fig. 207, 1*c*, *d*. Bücheler Schichten (Givetian), Bergisch–Gladbach, Germany. Wedekind's (1925, p. 14) subsequent designation of *G. isactis* Frech is invalid.

Diagnosis. See Middleton 1959, p. 143.

Remarks. Taylor (1951, pp. 173, 174) restricted *Grypophyllum* to those forms in which the septa are thin and peripherally withdrawn, leaving a lonsdaleoid dissepimentarium, and assigned forms with completely developed and peripherally thickened septa to a new genus, *Hooeiophyllum*. The peripheral withdrawal of septa is variable in several species of *Grypophyllum* and the writer follows most subsequent workers in not accepting *Hooeiphyllum*.

Birenheide (1961, pp. 114–16) merged *Leptoinophyllum* in *Grypophyllum* and relegated the latter to a subgenus of *Acanthophyllum*. These genera and also *Lyrielasma* are certainly closely related, but it seems preferable to regard them as distinct. *Grypophyllum* is distinguished from *Leptoinophyllum* and *Acanthophyllum* by its colonial form, smooth non-rhopaloid and generally thinner septa, and by its typically more strongly developed epitheca. *Lyrielasma* is distinguished from *Grypophyllum* by its epitheca, which is almost entirely composed of dilated septal ends, and its well developed minor septa, which are never so reduced as to give rise to a herringbone dissepimentarium. The acme of *Grypophyllum* occurred in the Givetian, whereas that of the others was in either the Lower Devonian or Eifelian.

Grypophyllum gracile (McCoy 1850)

Plate 68, figs. 1, 2

1850 *Strephodes gracilis* McCoy (*partim*), p. 378.
1851 *Strephodes gracilis* McCoy; McCoy (*partim*) *in* Sedgwick and McCoy, pp. 72, 73.
1853 *Strephodes gracilis* [= *Cyathophyllum* or *Ptychophyllum*] McCoy; Edwards and Haime, p. 232.
1855 *Strephodes gracilis* McCoy; McCoy (*partim*) *in* Sedgwick and McCoy, pl. 2A, figs. 5*a*, *b* only (fig. 5 is indeterminate).
1891 *Strephodes gracilis* McCoy; Woods, p. 28.
1950 *Cyathophyllum gracile* (McCoy); Bassler, p. 80.
?1959 *Grypophyllum sp.* cf. *G. normale* Wedekind; Middleton (*partim*?), p. 146, text-figs. 4*e*, *f*.
non 1925 *Grypophyllum gracile* (McCoy); Wedekind, p. 20, pl. 5, figs. 28, 29 (= *G. wedekindi* Middleton).

Types. Two syntypes in the Sedgwick Museum numbered H175 and H176. McCoy's figures (1855, pl. 2A, figs. 5–5*b*) are synthetic and suggest that the polished faces figured in 5*a* and 5*b* are from the same coral as shown in fig. 5. However, comparison of the figures with the extant types strongly suggests that fig. 5 is based on H176 and that figs. 5*a* and 5*b* are based on H175.

On the legend of pl. 2A, the specimens are said to have come from the Devonian limestone of Plymouth, but McCoy's earlier works (1850, p. 378; 1851, p. 73) state that the type locality is Newton Bushel. The original label was written by W. Farren, McCoy's assistant, and states that the specimens

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EXPLANATION OF PLATE 65

All figures ×3.

Figs. 1, 2. *Taimyrophyllum triadorum* sp. nov. 1, 2, Transverse and longitudinal sections of paratype, GSC 16988, Hume Formation.

Fig. 3. *Taimyrophyllum vescibalteatum* sp. nov. Transverse section of holotype, GSC 16989, Nahanni Formation.

EXPLANATION OF PLATE 66

All figures ×3.

Figs. 1–6. *Taimyrophyllum vescibalteatum* sp. nov. 1, 2, Transverse and longitudinal sections of paratype 2, GSC 16990, Nahanni Formation. 3, 4, Longitudinal sections of holotype, GSC 16989, Nahanni Formation. 5, 6, Longitudinal and transverse sections of paratype 1, GSC 16991, Nahanni Formation.

came from 'Devonian Limestone, Newton Bushel?' The two specimens are not conspecific, nor are they similarly preserved—H175 is grey whereas H176 is red stained. There are therefore several indications that the types may have originated from different localities.

Through the kindness of Dr. C. L. Forbes, the types have now been sectioned. H176 (Plate 68, fig. 3) is generically indeterminate, but may be close to *Neospongophyllum*. Axially it appears to have traces of monacanths, but the septa are not differentiated into two orders. No trace of the peripheral region now remains. H175 is a much more adequately preserved specimen and is *here chosen as lectotype* (Plate 68, figs. 1, 2).

Description of lectotype. The lectotype is a subcylindrical fragment about 65 mm. long and 17 mm. in greatest width. It may be part of an originally fasciculate corallum.

Transverse section. That part of the epitheca which is preserved is from 0·2 to 0·5 mm. thick between the septal ends. The septa are smooth and roughly radially arranged and only the major, which number 27, are well developed; they are mostly thin but in places are thickened by a thin investment of sclerenchymal tissue; some extend beyond the axis, others fall short of it and a few are axially contratingent. The minor septa are mostly represented by mere ridges on the interior of the epitheca, a few are more fully developed and three are about half as long as their adjacent major septa. The dissepiments are arcuate or chevron-shaped and in places, where the minor septa are absent, abut against each other forming a herringbone pattern.

Longitudinal section. On one side in the lower part of the section there are indications of a rejuvenation; this is most unusual for the genus. The dissepiments are from 3 to 7 deep on each side of the dissepimentarium; some are globose, others long without being fully lonsdaleoid. The tabularium is clearly distinguished from the dissepimentarium and is about 3·0 mm. wide. The tabulae are closely spaced and sag axially; they invariably appear incomplete owing to interruptions by the long major septa.

Remarks. Middleton (1959, p. 146) correctly noted that this species is a *Grypophyllum*, and was therefore justified in proposing *G. wedekindi* for its junior homonym *G. gracile* Wedekind 1925. Since *G. gracile* (McCoy) is the earliest described member of the genus, its revision naturally raises the question of whether there are any subsequently proposed names which might be suppressed as synonyms. Engel and Schouppé (1958, pp. 103–7, pl. 9, figs. 18–25) grouped four of Wedekind's species from the Givetian of Hand, Germany, under the name *G. denckmanni*. Thus interpreted the species is extremely variable and in most respects morphologically encompasses *G. gracile*. However, for the present at least, it is recommended that *G. denckmanni* be recognized as a distinct species, because of the great thickness of its epitheca. Taylor (1951) and Middleton (1959) have figured several specimens of *Grypophyllum* from Devon; of these, only the specimen figured by Middleton as *G. sp.* cf. *G. normale* Wedekind is close enough to be regarded as a possible example of *G. gracile*. Its largest corallite is slightly smaller than the lectotype of *G. gracile* and has only 24 major septa; its minor septa are also slightly more developed.

Grypophyllum graciliseptatum sp. nov.

Plate 67, figs. 1–19

?1962 *Lyrielasma* cf. *sperabilis* Crickmay, p. 8.

Name derivation. Latin *gracilis* = slender; *septatus* = septate.

Holotype, GSC 17003 (Plate 67, figs. 1–3, 14, 15), previously TOCL G6944*a*, 500 to 510 feet below the top of the Nahanni Formation, north-east part of Nahanni Plateau, NWT, 61° 53′ N., 124° 25′ W.; collected by D. Mason, 1960. *Paratype* 1, GSC 17004 (Plate 67, figs. 4–10, 18, 19), previously TOCL G6905*a*, 112 to 122 feet below the top of the Nahanni Formation, same locality and collector as the holotype. *Paratype* 2, GSC 17005 (Plate 67, figs. 11–13, 16, 17), previously TOCL D136*f*, 115 to 130 feet below the top of the Hume Formation, Schooner Creek, NWT, about 64° 18′ N., 126° 34′ W.; collected by A. E. H. Pedder, 1959.

Additional material. Specimens from three other localities have also been studied.

Diagnosis. A loosely fasciculate species of *Grypophyllum* with a corallite diameter of from 8·0 to 14·0 mm. The major septa number from 24 to 28 per adult corallite and the minor are almost completely suppressed. The species is also characterized by its narrow tabularium.

Description. A loosely fasciculate tetracoral. The holotype was incompletely collected and before sectioning measured about 100×70×50 mm.; the paratypes were also incomplete, but were slightly larger. Lateral offsets are moderately abundant and typically grow at a marked angle to the parent corallite. The paratypes are invested by stromatoporoid growths.

Transverse sections. The corallites are subcircular, or just elliptical and their adult diameter is between 8·0 and 14·0 mm.; adjacent corallites are up to about 25·0 mm. apart. The epitheca, which is composed of septal ends embedded in lamellar tissue, is very thin in paratype 1, but is about 0·5 mm. thick in the holotype and paratype 2. The septa are subradially arranged and highly differentiated into two orders. The major number from 24 to 28 per adult corallite; they are smooth, very long and thin, but are expanded and fusiform in section at the periphery of the corallite; axially they are commonly slightly twisted, forming a weak vortex. The minor septa consist solely of the peripheral fusiform part and only just protrude from the interior of the epitheca. The dissepimentarium is broad. Some of the dissepiments are arcuate between septa, others are arranged in herringbone fashion.

Longitudinal sections. The two sides of the epitheca are approximately parallel. The dissepiments are variable; some are relatively small and globose, others are much larger and more steeply inclined; in paratype 1 some are upturned at their lower end.

EXPLANATION OF PLATE 67

All figures ×3.

Figs. 1–19. *Grypophyllum graciliseptatum* sp. nov. 1–3, Transverse; 14, 15, longitudinal sections of holotype, GSC 17003, Nahanni Formation. 4–10, Transverse; 18, 19, longitudinal sections of paratype 1, GSC 17004, Nahanni Formation. 11–13, Transverse; 16, 17, longitudinal sections of paratype 2, GSC 17005, Hume Formation.

EXPLANATION OF PLATE 68

All figures ×3.

Figs. 1, 2. *Grypophyllum gracile* (McCoy). Longitudinal and transverse sections of lectotype, SM H175, Middle Devonian.

Fig. 3. Stringophyllid ?, transverse section of the other syntype of *Strephodes gracilis* McCoy, SM H176, Middle Devonian.

Figs. 4, 5. *Utaratuia sp.* cf. *U. laevigata* Crickmay. Longitudinal and transverse sections of hypotype 2, GSC 17540, Nahanni Formation.

Figs. 6, 7. *Utaratuia laevigata* Crickmay. Longitudinal and transverse sections of hypotype 1, GSC 17539, Hume Formation.

The transition from dissepimentarium to tabularium is gradational in most specimens. The tabularium is narrow and the mostly incomplete tabulae are much dissected by septa.

Remarks. Crickmay's *Lyrielasma sperabilis* is closer to *Grypophyllum* than *Lyrielasma*, and it is possible that the specimens he called *L.* cf. *sperabilis* will prove to be examples of *G. graciliseptatum*. They come from the Hume Formation on Houston River.

From *G. praecursor* (Frech), occurring in the 'Crinoiden Schichten' at Sötenich, Germany, this species is distinguished by its longer and slightly more numerous major septa, its almost completely suppressed minor septa, and by its narrower tabularium.

From *G. robustum* (Maurer), an unadjusted primary homonym, occurring in the Waldgirmes Formation of Germany, this species is distinguished by its slightly smaller size, longer major and almost completely suppressed minor septa.

From *G.* ? *sperabile* (Crickmay) occurring in the 'Ramparts Limestone' of the Redstone area, NWT, this species is distinguished by its tabulae, which are not axially elevated and form a much narrower tabularium, and by its less phaceloid growth form.

From *G. wedekindi* Middleton, occurring in various Givetian limestones in Germany, Belgium, and Russia, this species is distinguished by its slightly smaller size, longer major and more suppressed minor septa.

Genus UTARATUIA Crickmay 1960

Type species (original designation). U. laevigata Crickmay. See below.

Diagnosis. 'Cerioid Spongophyllidae with greatly shortened septa of one order; thickened walls; dissepiments, of discrepant sizes, in several series; tabulae, close, both complete and incomplete, some arched, some sagging' (Crickmay).

Remarks. The question of the relationship between this genus, which is at present known only from the early Givetian of western Canada, and *Tabellaephyllum*, which occurs in the Frasnian of Nevada and the Urals, was not raised by Crickmay. This is to be regretted as most coral specialists have regarded *Tabellaephyllum* as Crickmay regarded *Utaratuia*, that is, as a spongophyllid with greatly, or totally, reduced septa. At present the writer accepts both as homoeomorphic genera. *Utaratuia* is thought to lie phylogenetically closest to such species as '*Cystiphyllum*' *caespitosum* Schlüter, which form a group in great need of revision, whereas *Tabellaephyllum* appears to have been derived from either an endophyllid such as *Smithiphyllum*, or a disphyllid such as *Donia*.

Utaratuia laevigata Crickmay 1960

Plate 68, figs. 4–7

1960 *Utaratuia laevigata* Crickmay, p. 5, pl. 1, figs. 6–9; pl. 8, fig. 1.
cf. 1962 *Utaratuia laevigata* Crickmay; McLaren, Norris and McGregor, pl. 2, figs. 5, 6.

Types. The *holotype* is in the collection of Imperial Oil Limited, Calgary. It was collected from the Hume Formation, 'low Middle Devonian Limestone', at Rainbow Arch, Carcajou River, NWT, 62° 27′ N., 128° 13′ W. *Hypotype* 1, GSC 17539 (Plate 68, figs. 6, 7), previously TOCL G3446*a*, Nahanni Butte, NWT, 65° 05′ N., 123° 21′ W.; collected by D. Mason. 1960. *Hypotype* 2, GSC 17540 (Plate 68, figs. 4, 5), previously TOCL D141*l*, east end of Carcajou Ridge, NWT, about 65° 30′ N., 128° 30′ W.; collected by E. W. Best and D. L. Barss, 1961.

Additional material. Three specimens from the Hume Formation and fifteen, comparable with this species, from the Nahanni or Headless Formations have been studied.

Remarks. Specimens of *Utaratuia* are moderately common in both the Hume and Nahanni Formations. The almost total reduction of their septa and the considerable variation in their size render them particularly difficult to separate into species. The forms from the Nahanni and Headless Formations have a smaller average corallite width than those from the Hume Formation; the largest corallites in the latter are about 22·0 mm. across, whereas those in the former are about 16·0 mm. Further distinctions are found in the walls, which are thicker and have a less sinuous dark central line in the Hume forms. More material will be required before a decision can be made on whether these distinctions merit taxonomic recognition; in the meantime the Nahanni and Headless forms are identified as *Utaratuia* cf. *U. laevigata* Crickmay.

Family STRINGOPHYLLIDAE Wedekind

Genus SOCIOPHYLLUM Birenheide 1962

Type species (original designation). Spongophyllum elongatum Schlüter 1880, p. 147; 1881, pp. 94, 95 (213, 214), pl. 10(7), figs. 1–3. Primary types and topotypes redescribed by Birenheide 1962, pp. 54–58, pl. 7, figs. 1*a*, *b*. Loogher Schichten, 'Crinoiden Schichten' (early Givetian), Berndorf, Hillesheimer Mulde, Germany.

Diagnosis. Fasciculate tetracorals with subcylindrical corallites. Epitheca relatively thick, composed of septal ends embedded in lamellar tissue. Septa typically essentially bilaterally disposed and irregularly differentiated into two orders. Major septa within the dissepimentarium either continuous, or discontinuous forming fusiform strands or dots, as seen in transverse section. Minor septa typically very reduced, commonly represented merely by single monacanths and in some cases completely absent. Trabeculae monacanthine. Dissepiments lonsdaleoid. Tabulae either complete, or incomplete, concave, generally with a marked axial sag.

Remarks. Birenheide proposed this as a subgenus of *Stringophyllum* for fasciculate species similar to *Neospongophyllum*, which he also recognized as a subgenus of *Stringophyllum*. Growth form has generally been held a valid criterion for generic distinction among tetracorals and therefore *Sociophyllum* is here raised to generic rank.

EXPLANATION OF PLATE 69

All figures × 3.

Figs. 1–13. *Sociophyllum glomerulatum* (Crickmay). Transverse sections. 1–5, Hypotype 9, GSC 17002, Nahanni Formation. 6–13, Hume Formation. 6, 12, Hypotype 1, GSC 16994. 7, Hypotype 5, GSC 16998. 8, Hypotype 7, GSC 17000. 9, Hypotype 3, GSC 16996. 10, Hypotype 4, GSC 16997. 11, Hypotype 2, GSC 16995. 13, Hypotype 6, GSC 16999.

EXPLANATION OF PLATE 70

All figures × 3.

Figs. 1–12. *Sociophyllum glomerulatum* (Crickmay). longitudinal sections. 1, Hypotype 7, GSC 17000, Hume Formation. 2, 7, Hypotype 1, GSC 16994, Hume Formation. 3, Hypotype 4, GSC 16997, Hume Formation. 4, Hypotype 6, GSC 16999, Hume Formation. 5, Hypotype 3, GSC 16996, Hume Formation. 6, 9, 11, 12, Hypotype 9, GSC 17002, Nahanni Formation. 8, Hypotype 2, GSC 16995, Hume Formation. 10, Hypotype 5, GSC 16998, Hume Formation.

Sociophyllum glomerulatum (Crickmay 1962)

Plate 69, figs. 1–13; Plate 70, figs. 1–12

1961 *Spongophyllum elongatum* Schlüter; Lenz (*non* Schlüter), pp. 506, 507, pl. 1, figs. 19–22.
1962 *Stringophyllum* (*Neospongophyllum*?) sp. J; McLaren, Norris and McGregor, pl. 1, figs. 7, 8.
1962 *Stringophyllum glomerulatum* Crickmay, pp. 7, 8, pl. 1, fig. 15; pl. 2, figs. 6, 7; pl. 4, figs. 8, 9.

Types. The *holotype* and *paratype* are in the collection of Imperial Oil Limited, Calgary. Both were collected from the Hume Formation, 'Norman Wells formation' on Houston River, NWT, 65° 30′ N., 131° 15′ W.

Hypotype 1, GSC 16994 (Plate 69, figs. 6, 12; Plate 70, figs. 2, 7), previously TOCL D141*b*, upper part of the Hume Formation, east end of Carcajou Ridge, NWT, about 65° 30′ N., 128° 30′ W.; collected by E. W. Best and D. L. Barss, 1961. *Hypotypes* 2–8, GSC 16995–17001 (see Plates 69 and 70), previously TOCL D101*h*, *i*, *k–n*, *z*, top 30 feet of the exposed part of the Hume Formation, East Mountain, NWT, about 65° 41′ N.; 128° 42′ W.; collected by A. E. H. Pedder, 1959. *Hypotype* 9, GSC 17002 (Plate 69, figs. 1–5; Plate 70, figs. 11, 12), previously TOCL G10097*b*, 40 to 65 feet below the top of the Nahanni Formation, south-west Mackenzie Plain, NWT, 62° 06′ N., 124° 39′ W., collected by D. Mason, 1960.

Additional material. Eighteen specimens from nine localities in either the Hume, Nahanni, or Headless Formations in the NWT have been studied.

Description of hypotypes. All the available specimens are parts of large fasciculate coralla; the largest examples seen in the field were about 50 cm. in diameter and more than 40 cm. high. The exteriors of the hypotypes are concealed by matrix.

Transverse sections. The adult corallites are subcircular and between 9·0 and 17·0 mm. in diameter. Adjacent corallites are either up to about 10·0 mm. apart, or in contact, but the coral never approaches a cerioid form. In well preserved specimens the epitheca is continuous and is from 0·4 to 0·7 mm. thick; it is composed of septal ends embedded in lamellar tissue. The septa are either subradially arranged, or more typically tend to be bilaterally symmetrical; they are much reduced and although there are major and minor septa, the differentiation is irregular, not alternate. Typically the septa are withdrawn both axially and peripherally; some are reduced to fusiform or beaded strands (as seen in transverse sections), others are represented by single monacanths; in extreme cases individual septa consist merely of ridges on the interior of the epitheca. Some septa appear to be rhopaloid, but this is due to the sections cutting obliquely across the monacanths. Where developed the septa are moderately thick. There are normally between 28 and 42 septa in the central part of adult corallites. The peripheral traces of the septa in the epitheca are more numerous than the septa in the central region, but are not present around the entire lumen of any of the corallites in the hypotypes. The dissepiments are large and some bear monacanths.

Longitudinal sections. In some specimens the epitheca is subparallel, but in others it is markedly bent over constrictions and expansions of the corallite. The dissepiments are lonsdaleoid and are from one to about four deep in the dissepimentarium. The tabulae are moderately closely spaced and may, or may not, be complete. At the periphery of the tabularium some of the dissepiments are steeply inclined, but true tabellae are absent. Most of the tabulae sag axially. Monacanths are present in both the dissepimentarium and tabularium and can be seen projecting from the inner side of the epitheca; they are upwardly and inwardly directed at a low angle to the horizontal.

Remarks. As Lenz's identification suggests, this species is very close to *Sociophyllum elongatum* (Schlüter); in fact some of the Canadian specimens are almost indistinguishable from the Pelm examples of *S. elongatum* figured by Ma (1937, pl. 6, figs. 2*a*, *b*; 1956, pl. 8, figs. 3*a*, *b*). The average diameter of the corallites and the number of septa are less in *S. elongatum*, but in these respects there is considerable overlap, and more reliable distinctions appear to lie in the more crowded and more obviously bilateral arrangement of the septa in *S. elongatum* and in the more continuous development of the septa in *S. elongatum*, especially in the tabularium.

There are some resemblances between *S. glomerulatum* and *S. longiseptatum* (Bulvanker), which occurs in the Mamontovo, Kerlegesh, and Safonova Beds (Eifelian-Givetian) of the Kuznets Basin, but the Russian species has well-developed septa and a much narrower dissepimentarium with smaller dissepiments.

The species is transferred to *Sociophyllum* because it is a fasciculate species of the Stringophyllidae.

Family DISPHYLLIDAE Hill

Genus RADIASTRAEA Stumm 1937

Type species (*original designation*). *R. arachne* Stumm 1937, pp. 439, 440, pl. 53, fig. 13; pl. 55, figs. 8*a*, *b*; figures reproduced by Stumm 1949, pl. 16, figs. 9–11; 1955, card 232. Nevada Limestone, in beds now referred to the *pinyonensis* Zone (Emsian), Lone Mountain, 18 miles north-west of Eureka, Nevada.

Diagnosis. Massive asteroid to thamnasterioid tetracorals. The calices are shallow and normally lack exsert rims. The calicular platforms are almost flat, although the upper edges of the septa are slightly elevated at their peripheral extremity, so that the limits of the individual corallites are distinct even though the coral is not cerioid. The septa are thin to moderately thick and may, or may not, bear zigzag carinae. They are undifferentiated in the dissepimentarium, but in the tabularium there is a clear differentiation into major and minor septa; the latter extend only a short distance into the tabularium; the former terminate near the axis. The trabeculae are directed upwardly and inwardly in the tabularium and inner part of the dissepimentarium, but towards the outer part of the dissepimentarium they become almost vertical. The dissepiments are globose and generally of moderate size, becoming smaller and more steeply inclined at the margin of the tabularium. Tabellae are present and the tabulae are commonly very incomplete and tend to be axially domed.

Remarks. Stumm proposed the genus principally because he originally believed its type

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EXPLANATION OF PLATE 71

All figures ×3.

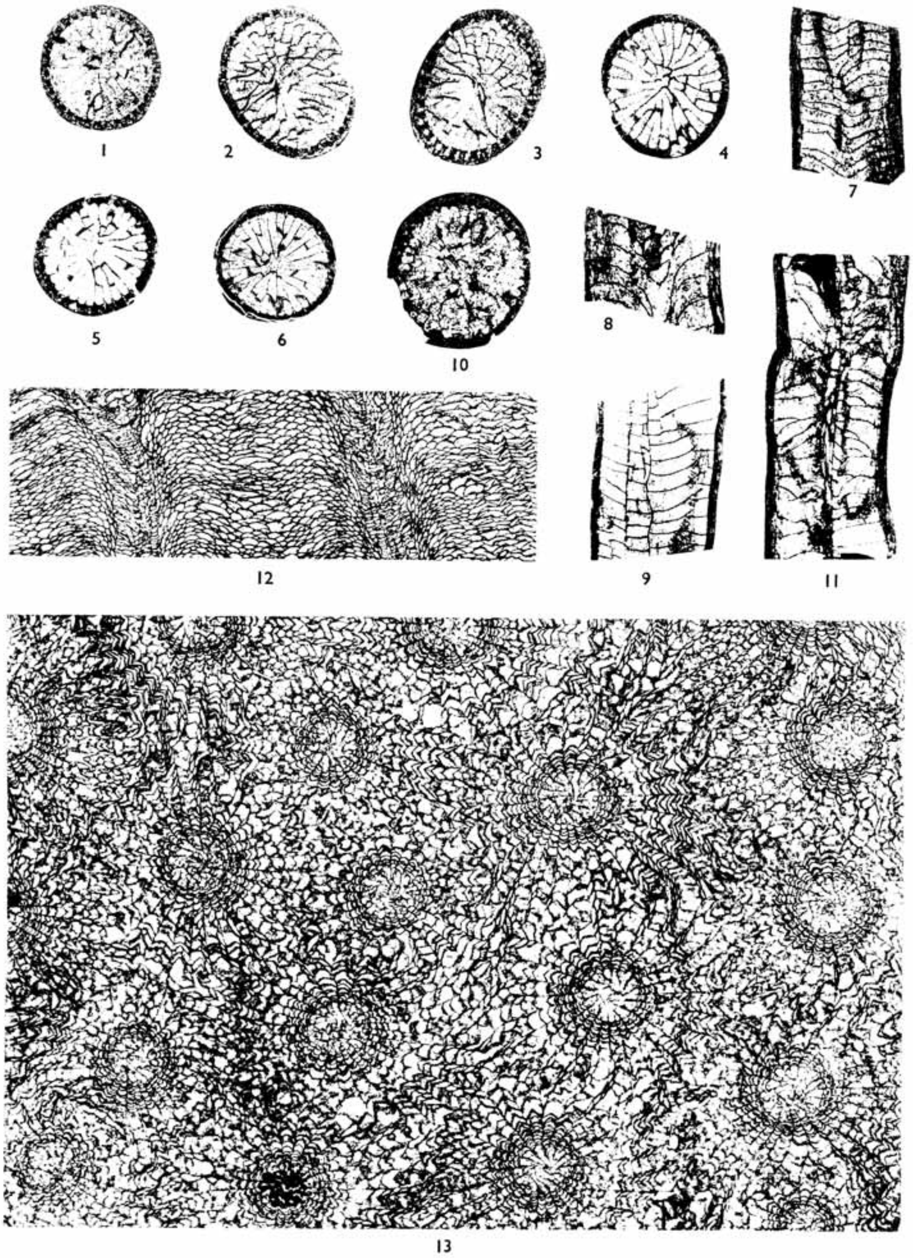
Figs. 1–5. *Radiastraea verrilli* (Meek). 1, 2, Transverse; 3, longitudinal sections of hypotype 3, GSC 16981, Nahanni Formation. 4, 5, Longitudinal and transverse sections of hypotype 2 (also topotype), GSC 16983, Hume Formation.

EXPLANATION OF PLATE 72

All figures ×3.

Figs. 1–3. *Radiastraea arachne* Stumm. 1, 2, Longitudinal, 3, transverse sections of hypotype 1 (also topotype), USNM 128014, Nevada Formation.

Figs. 4, 5. *Radiastraea verrilli* (Meek). 4, 5, Longitudinal and transverse sections of hypotype 1 (also topotype), GSC 16982, Hume Formation.



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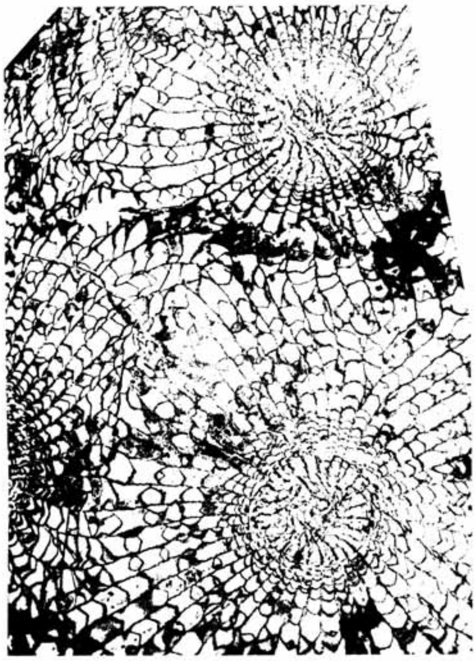

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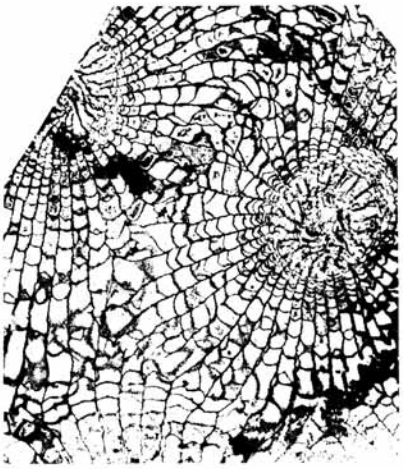

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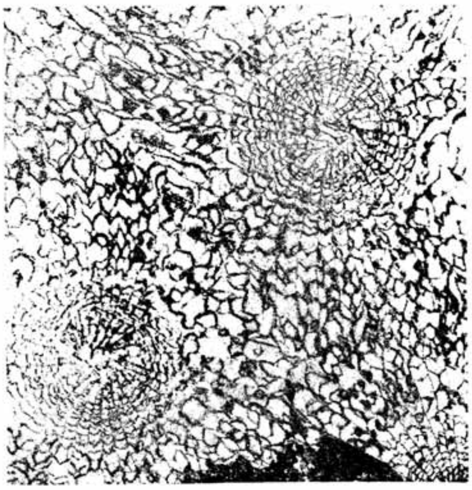

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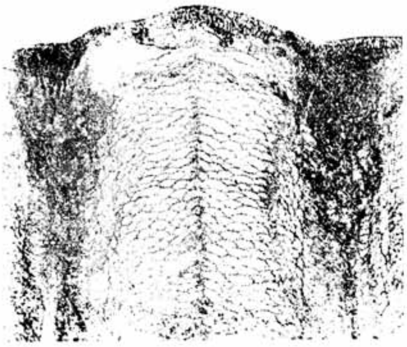
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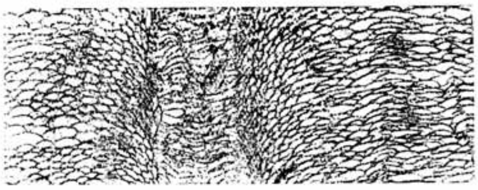
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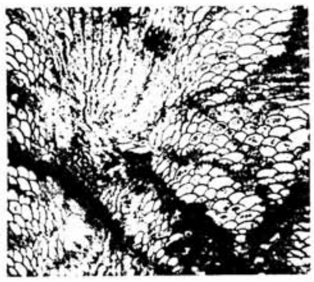
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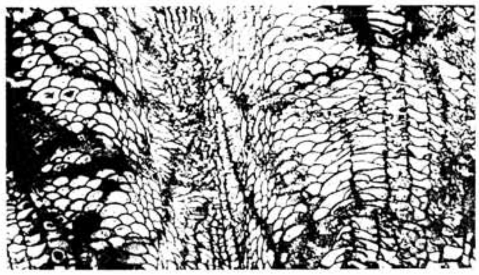
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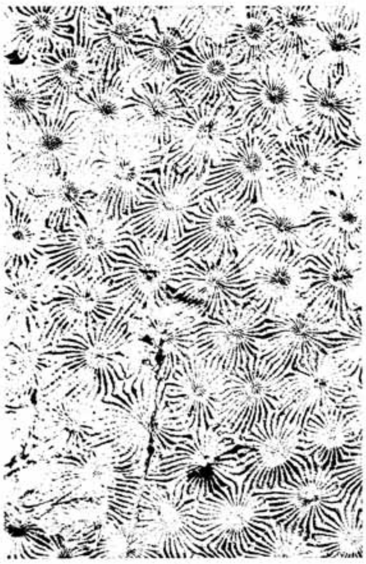
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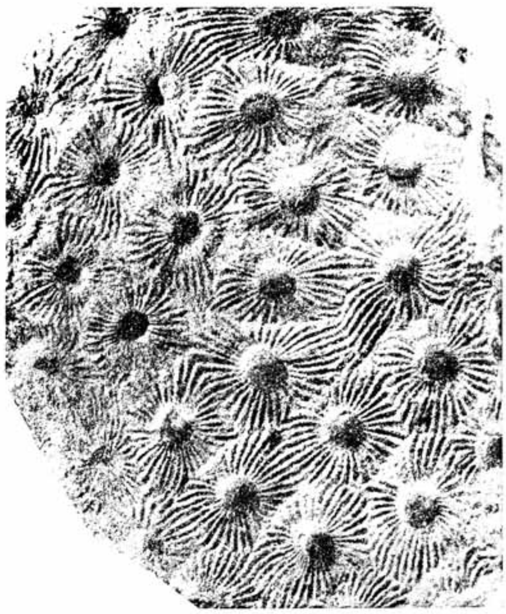
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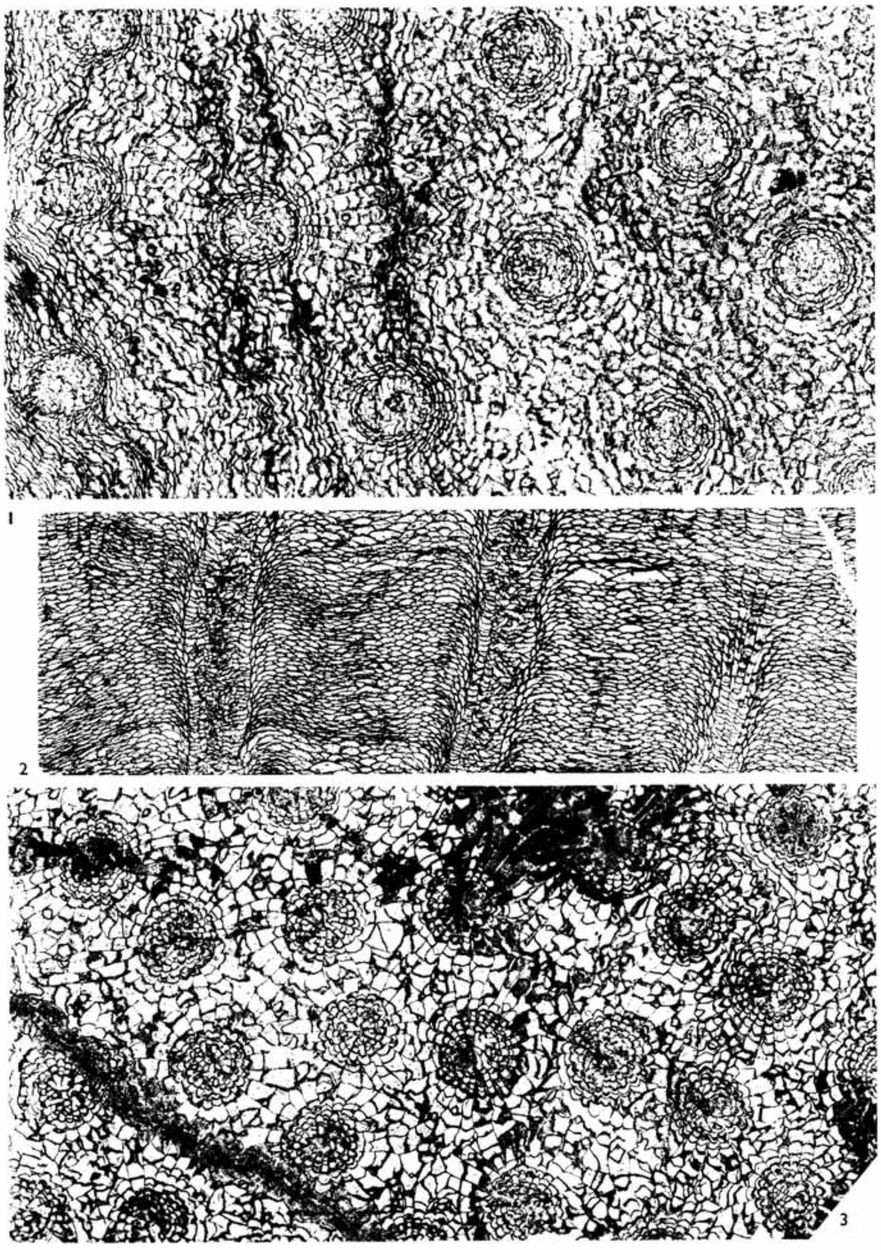

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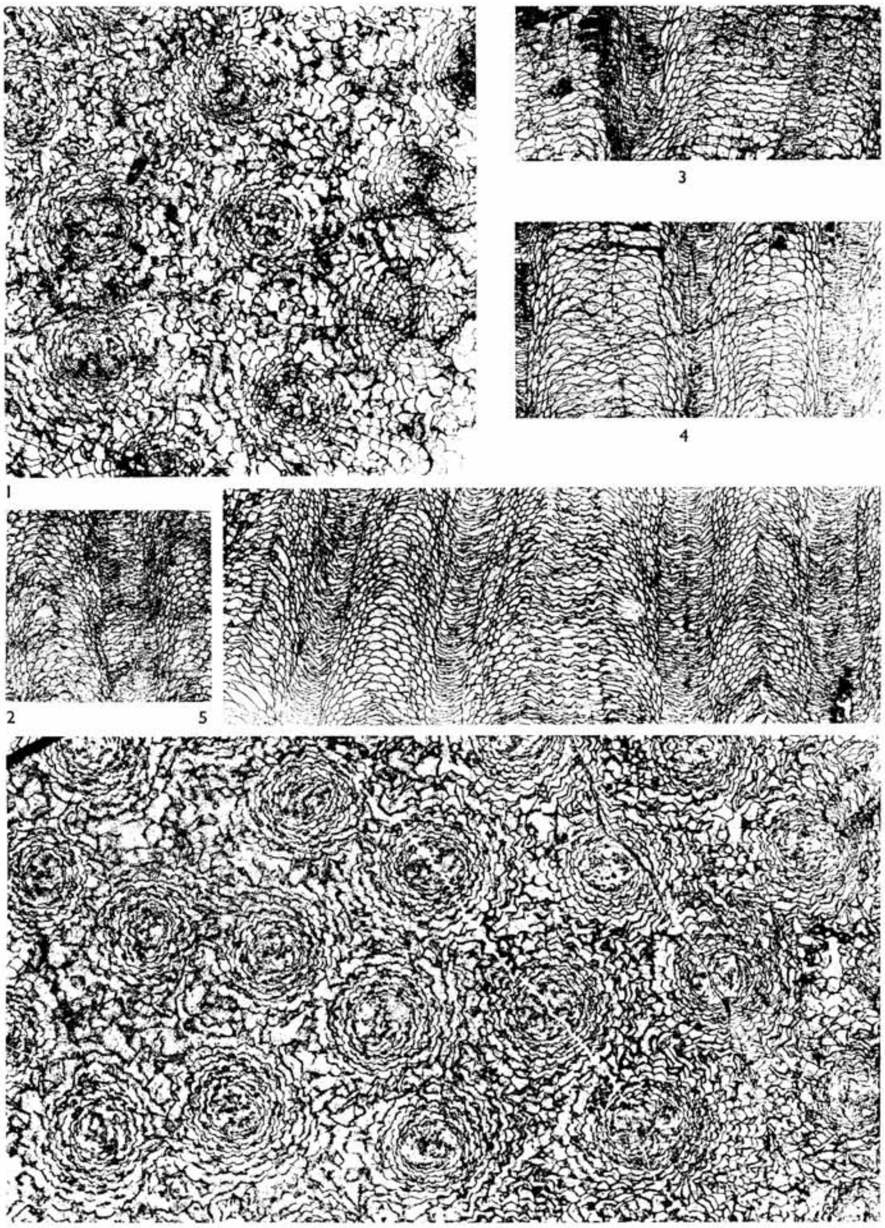

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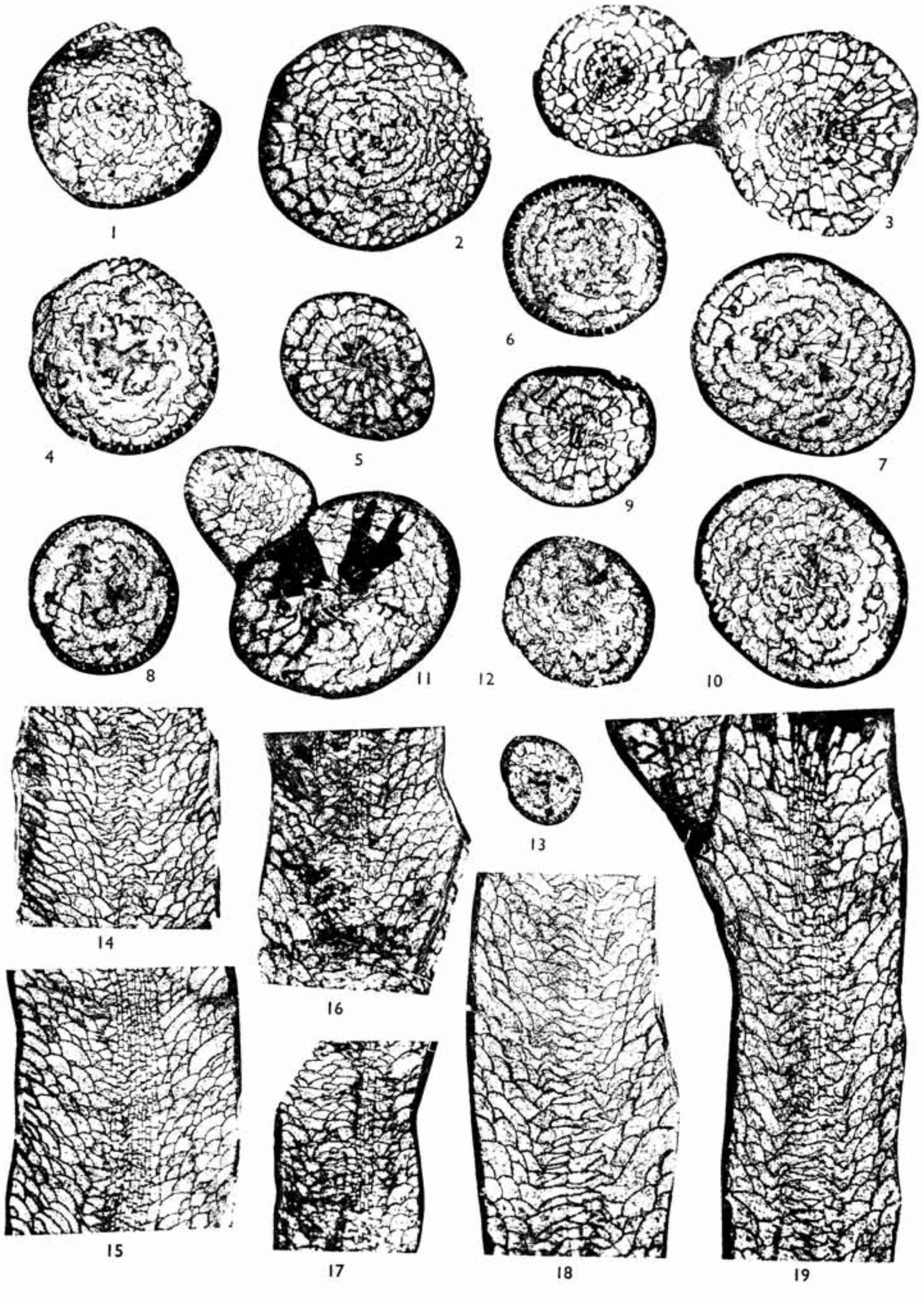

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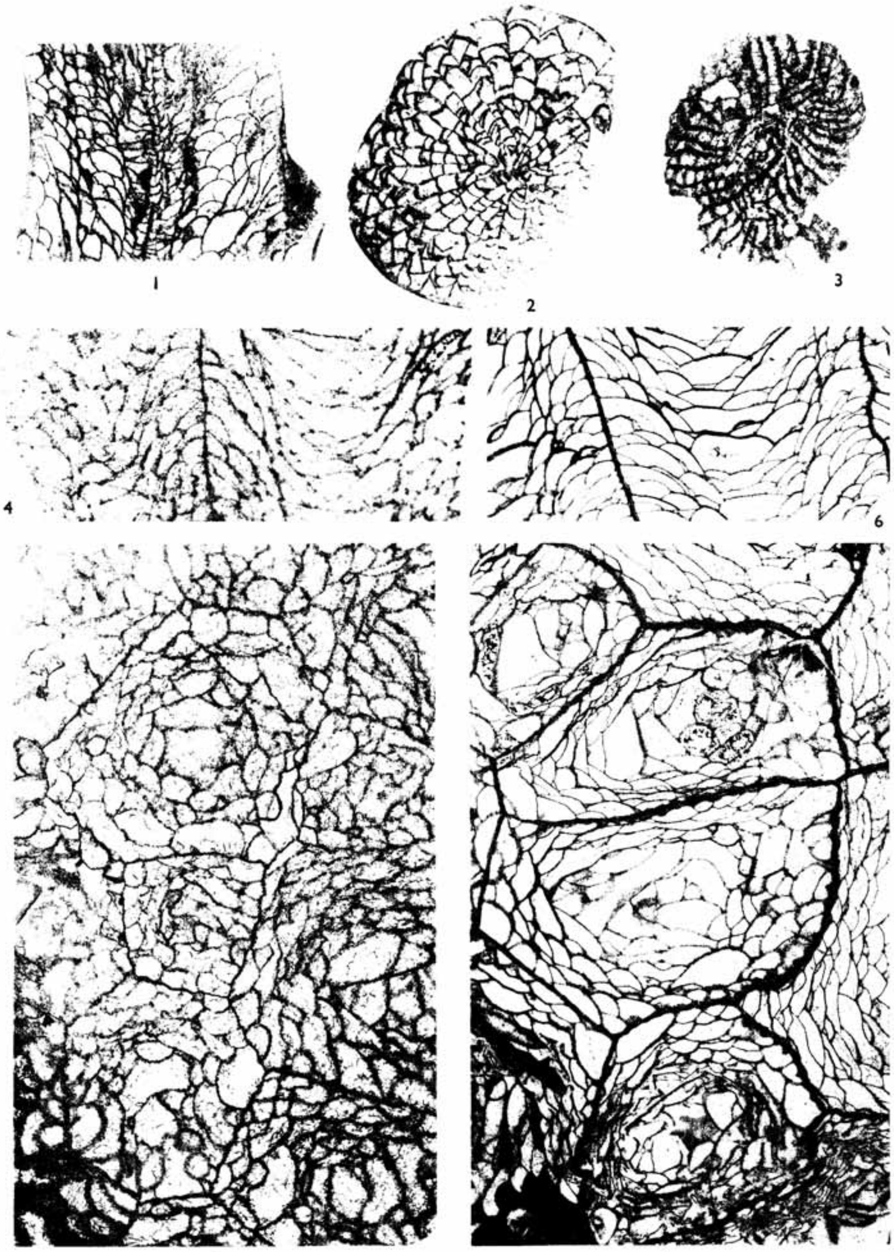

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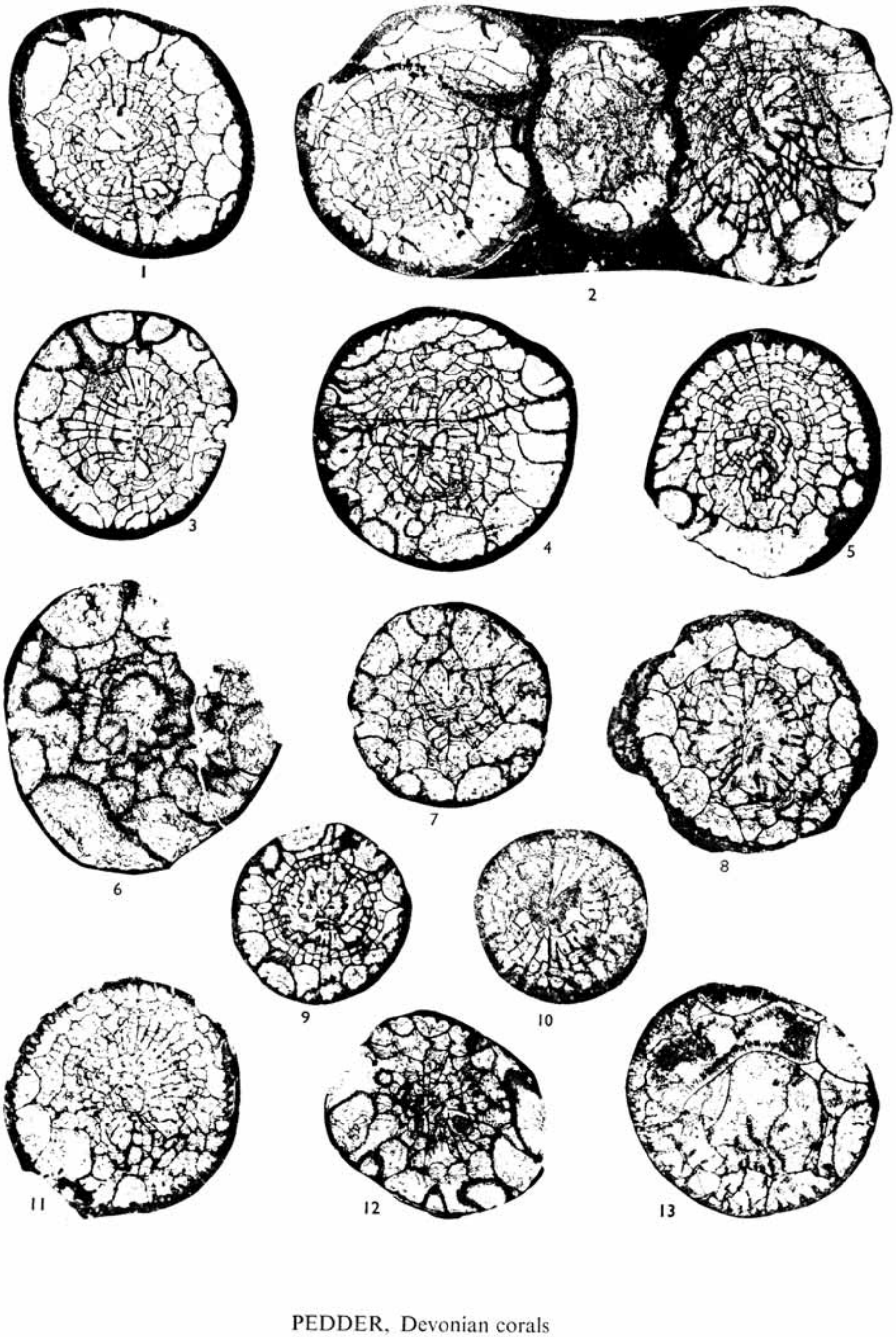

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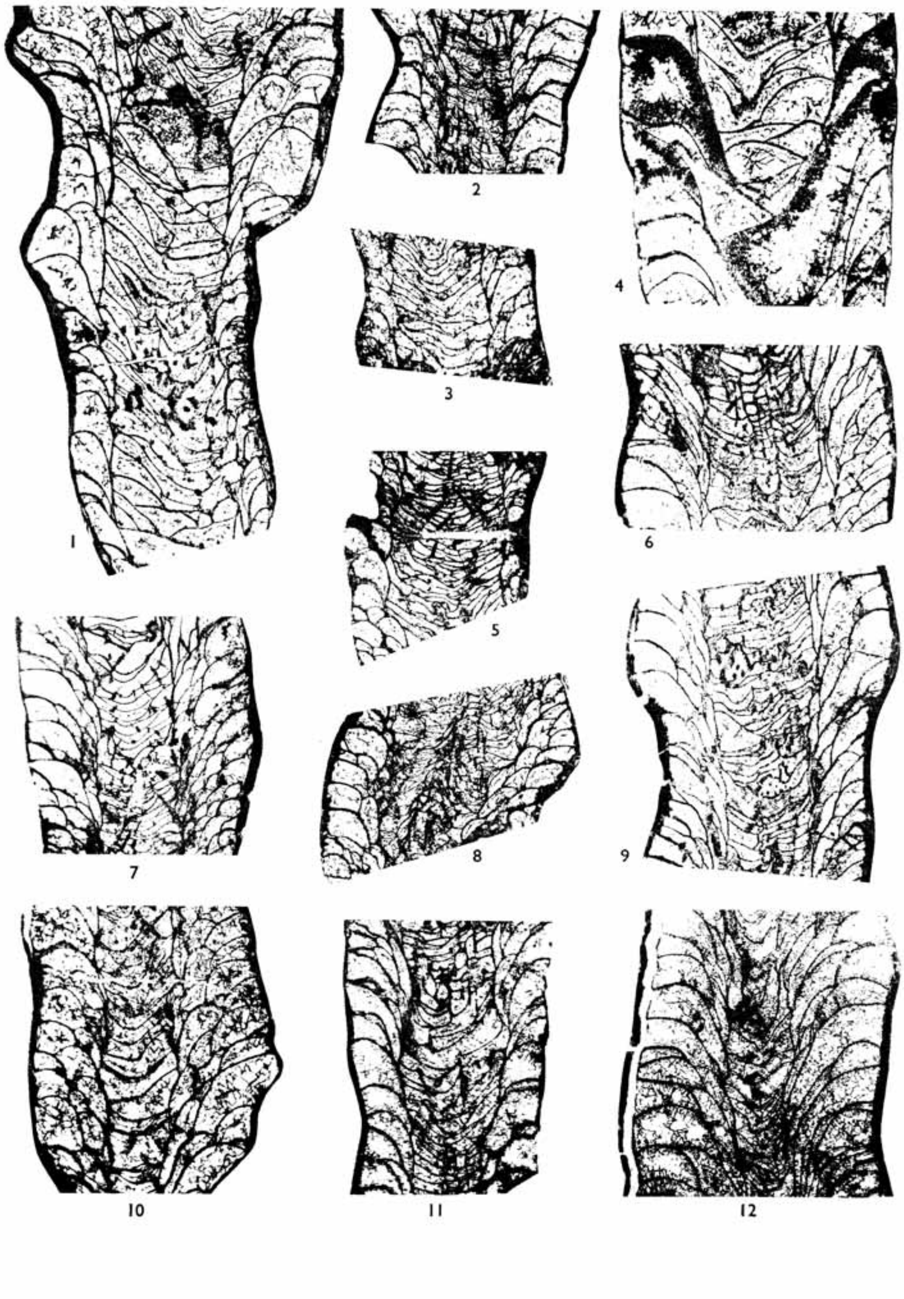

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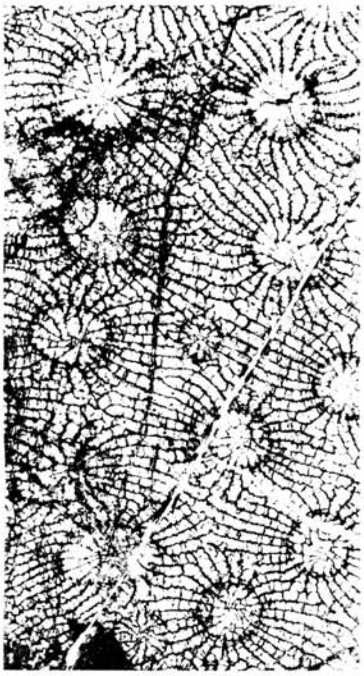

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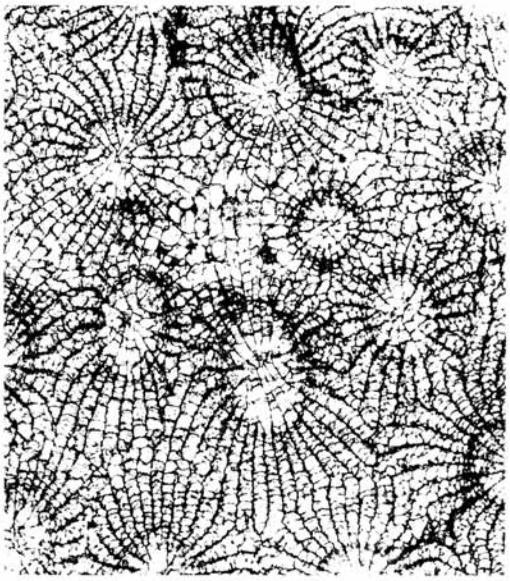

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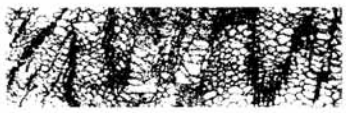

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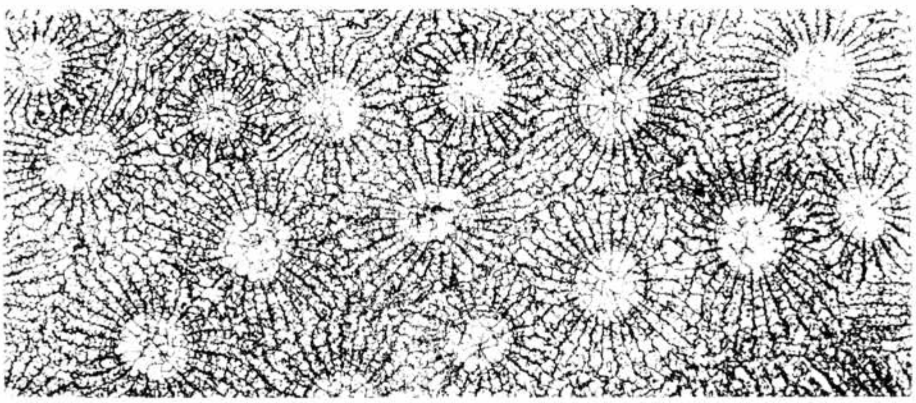

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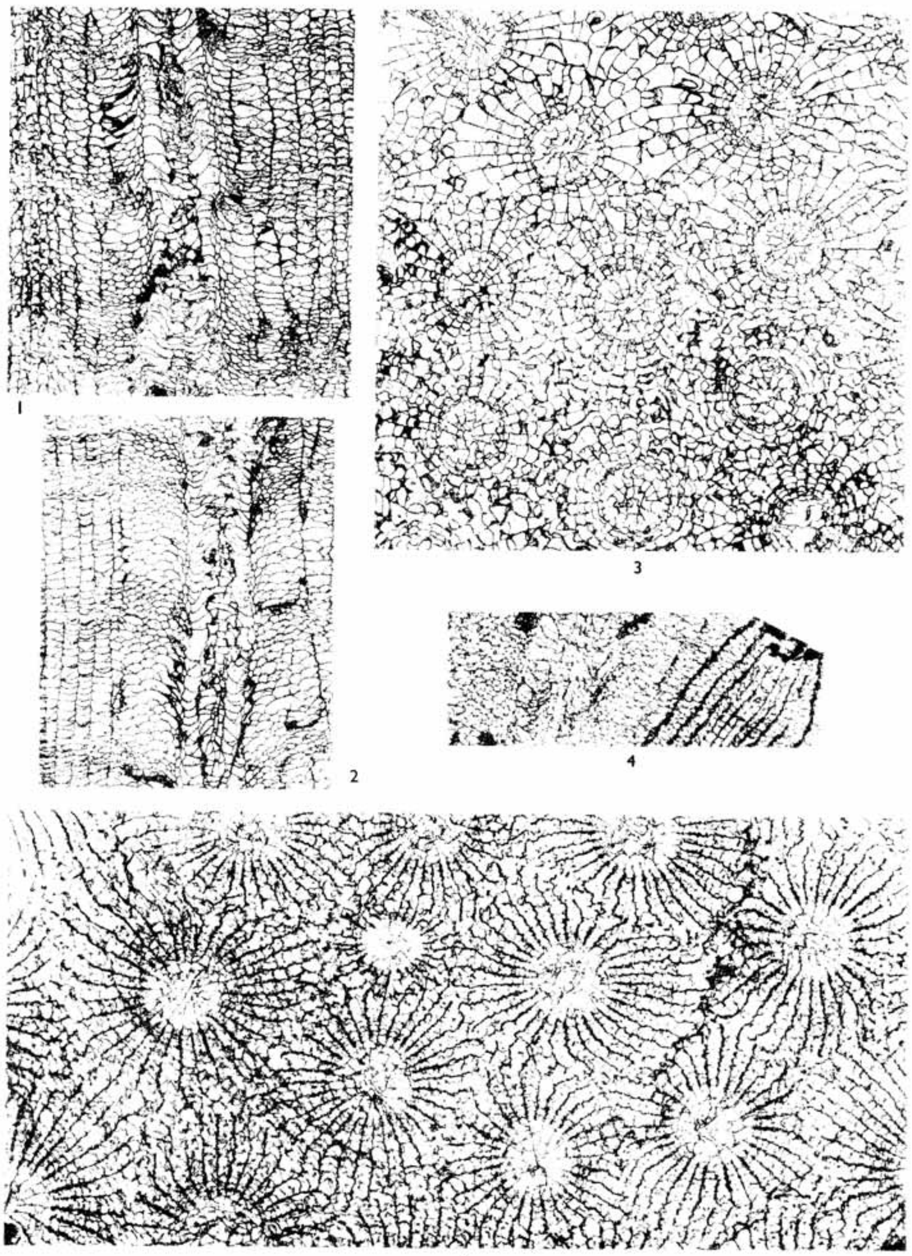

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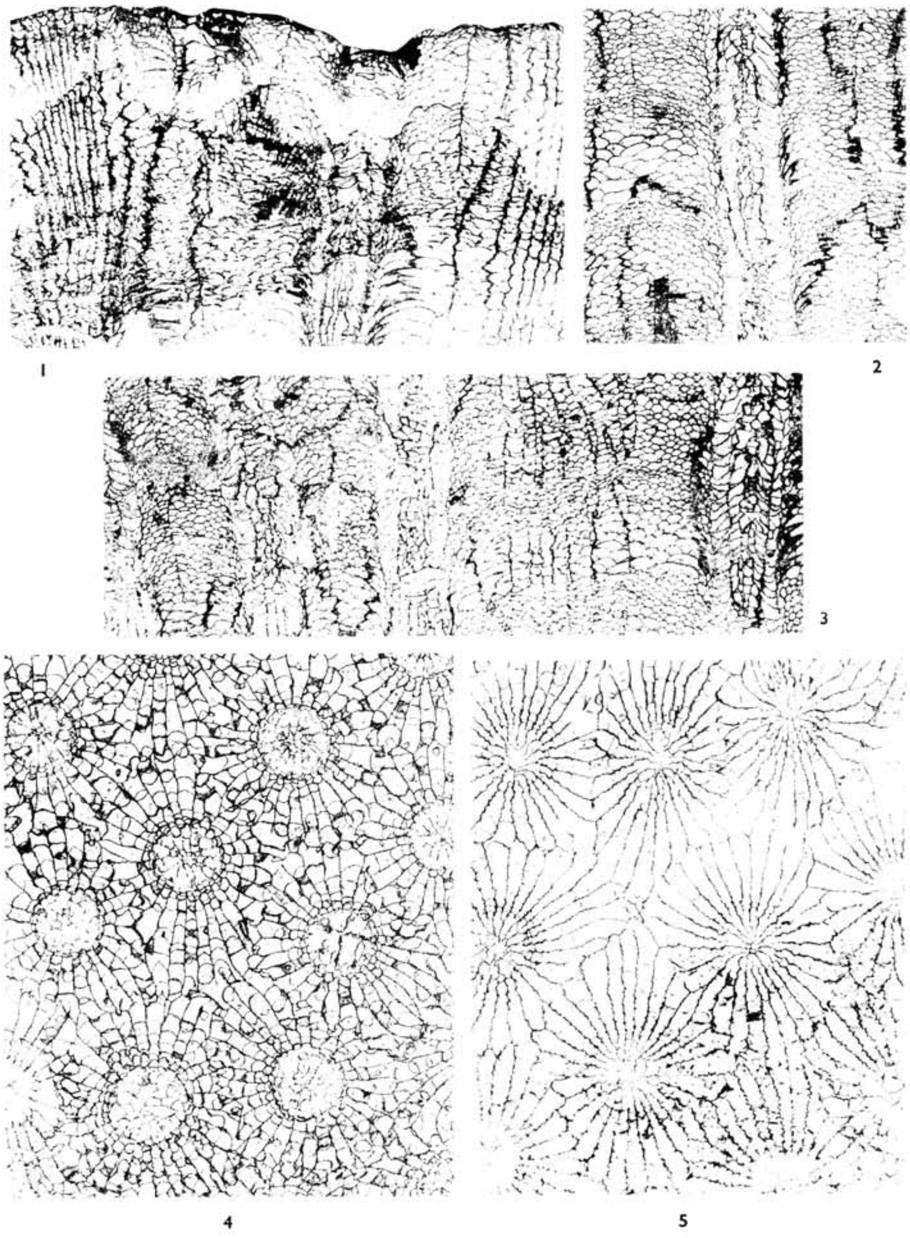

PEDDER, Devonian corals

species to possess a tubular axial wall. Later (1949, p. 35), however, he corrected this misinterpretation of the septal ends and suppressed *Radiastraea* as a synonym of *Billingsastraea*. Unfortunately *Billingsastraea* (Grabau 1917, p. 957) is based on *Phillipsastrea verneuili* Edwards and Haime (1851, pp. 447, 448, pl. 10, fig. 5), which in turn is founded on a single drift specimen that has never been sectioned. The position is aggravated by the lack of agreement on the interpretation of the genus. Thus Stumm (1949) regarded it as a senior synonym of *Radiastraea*, but Ehlers and Stumm (1951, 1953) assigned to it species which I regard as constituting a compound *Heliophyllum*-like genus. Schouppé (1958), on the other hand, used *Billingsastraea* for species of '*Pseudoacervularia*' sensu Różkowska (1953). The resolution of this problem must await knowledge of the interior of the holotype of *B. verneuili*, but letters to the institution reputed to possess this specimen remain unanswered. In the meantime the obvious course is provisionally to interpret *B. verneuili* on specimens assigned to it by Ehlers and Stumm (1953, pp. 2, 3, pl. 1, figs. 1–3). These match the original description as far as it goes and in the sense that they come from the Bois Blanc Formation (Onondagan) of Michigan and Ontario (the likely source of the holotype), are the nearest specimens to topotypes available. With this interpretation the distinction between *Radiastraea* and *Billingsastraea* lies in the dissepimentarium. The dissepiments in *Billingsastraea* are very uneven in size and appear to bear septal crests, whereas in the other they are of the normal disphyllid type.

Taimyrophyllum resembles *Radiastraea*, but the resemblance is believed to be due to homoeomorphy rather than to indicate close phylogenetic relationship. In *Taimyrophyllum* the septa differ in having twisted and carinate axial ends and the tabulae are more complete and tend to sag axially.

Types. Three topotype specimens of *Radiastraea arachne* are figured on Plates 72 and 73. They are: *Hypotype* 1, USNM 128014 (Plate 72, figs. 1–3; Plate 73, fig. 2), basal 300 to 400 feet of the Nevada Formation, Lone Mountain, 18 miles north-west of Eureka, Nevada; collected by E. Kirk. *Hypotype* 2, USNM 135680 (Plate 73, figs. 3, 4), basal 500 feet of the Nevada Formation, locality and collector as above. *Hypotype* 3, GSC 17541 (Plate 73, figs. 1, 5), *pinyonensis* Zone of the Nevada Formation, same locality as above, obtained for the writer by Dr. J. G. Johnson, who kindly allowed it to be presented to the Geological Survey of Canada. A transverse peel of another topotype specimen has been figured by Merriam 1940, pl. 13, fig. 5.

Radiastraea verrilli (Meek 1867)

Plate 71, figs. 1–5; Plate 72, figs. 4, 5

1867 *Smithia verrilli* Meek, pp. 83, 84, pl. 11, figs. 7–7*b*.
1901 *Phillipsastraea verrilli* (Meek); Lambe (*partim*), pp. 167, 168, *non* figs. (includes *Phillipsastrea nevadensis*, '*P*' *whittakeri* and '*Billingsastraea*' *spp*.)
1945 *Phillipsastraea verrilli* (Meek); Smith, pp. 38, 39, pl. 19, figs. 2*a*-*c*; pl. 23, fig. 1.
1950 *Phillipsastraea verrilli* (Meek); Bassler (*partim*), p. 168 only.
?1949 *Phillipsastraea verrilli* (Meek); Warren and Stelck, p. 141.
?1950 *Phillipsastraea verrilli* (Meek); Warren and Stelck, p. 75.
1955 *Phillipsastraea verrilli* (Meek); Stumm, cards 226, 227.
?1956 *Radiastraea arachne* Stumm; Warren and Stelck, pl. 1, fig. 8.
?1956 *Phillipsastraea verrilli* (Meek); Warren and Stelck, pl. 3, fig. 3.
1960 *Billingsastraea verrilli* (Meek); Crickmay, pp. 6, 7, pl. 3, fig. 5; pl. 4, fig. 1.
1961 *Billingsastraea verrilli* (Meek); Lenz, pp. 504, 505, pl. 3, figs. 4, 5.
non 1940 *Phillipsastraea verrilli* (Meek); Stumm, p. 66, pl. 7, fig. 12; pl. 8, figs. 14*a*, *b* (= ? *Phillipsastrea sp*.).
non ?1958 *Phillipsastraea verrilli* (Meek); Sun, p. 20, pl. 11, fig. 4 (indeterminate).

Types. The *lectotype* (Smith 1945, p. 39) is USNM 140316 and was figured by Meek 1867, pl. 11, figs. 7–7*b*; Smith 1945, pl. 23, fig. 1; Stumm 1955, cards 226, 227. Presumably it was collected from the Hume Formation. In one place Smith (1945, p. 39) states that it came from Anderson River and in another (1945, legend pl. 23) from the Porcupine River. The museum label indicates that it is from Anderson River, NWT.

Paralectotype, USNM type lot 1169, also BM R28675, figured by Smith 1945, pl. 19, figs. 2*a–c*; Stumm 1955, card 227. Also presumably Hume Formation, Anderson River, NWT. *Hypotypes* 1, 2, GSC 16982 (Plate 72, figs. 4, 5), GSC 16983 (Plate 71, figs. 4, 5), previously TOCL D15*f*, *e*, respectively, Hume Formation, Anderson River, NWT, about 68° 30′ N., 127° 25′ W.; collected by A. E. H. Pedder, 1959. *Hypotype* 3, GSC 16981 (Plate 71, figs. 1, 2), previously TOCL G9095*a*, 30 to 40 feet below the top of the Nahanni Formation, Deceiver Creek, NWT, about 62° 19′ N., 123° 37′ W.; collected by E. O'bertos, 1960.

Additional material. A total of forty-seven specimens from fifteen localities in the Hume, Nahanni, and Headless Formations has been studied.

Description of hypotypes. An astreoid tetracoral. Hypotype 1 is complete and between 80 and 90 mm. in diameter and 40 mm. high; the other hypotypes are larger but were incompletely collected. The calices have the form of a shallow crater; the largest are between 3·5 and 4·5 mm. in diameter at the rim and between 0·5 and 1·5 mm. deep; the axes of adjacent adult corallites are between 7·0 and 12·0 mm. apart. The calicular rims are slightly elevated above the calicular platforms, which gently slope away from the calices. The upper edges of the septa are denticulate and prominently elevated over the calicular platforms, but are smooth and less elevated within the calices.

Transverse sections. The septa, which are differentiated only in the tabularium, number from 28 to 32; in places they are thin and smooth, but throughout most of the dissepimentarium they are moderately thick and carinate. The carinae are most commonly of the zigzag type, but a few are opposed. The peripheral ends of the septa are either free, or more commonly contratingent, or confluent with those of adjacent septa; in the latter case the contact is generally angular. On entering the tabularium the septa become thinner and smooth. Some of the major septa extend beyond the axis of the corallite, others terminate at, or short of it; their axial ends may be free, or contratingent, and may be curled, but there is no axial vortex. The minor septa have a very short thin axial part and only just protrude into the tabularium. Dissepiments are abundant, especially near the margin of the tabularium, where they appear more numerous because of their greater inclination.

Longitudinal sections. The dissepiments are globose to broadly arched; throughout most of the dissepimentarium they are more or less horizontally disposed and are mostly less than 1·0 mm. long, but close to the tabularium they are smaller and more steeply inclined. Tabellae are present in some parts of the tabularium. The tabulae are closely spaced and markedly incomplete. The trabeculae are upwardly and inwardly directed and are slightly divergent.

Remarks. In general dimensions and septal count *R. verrilli* is similar to *R. arachne*. The

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EXPLANATION OF PLATE 73

All figures × 3.

Figs. 1–5. *Radiastraea arachne* Stumm, Nevada Formation. 1, 5, Longitudinal and transverse sections of hypotype 3 (also topotype), GSC 17541. 2, Longitudinal section of hypotype 1 (also topotype), USNM 128014. 3, 4, Longitudinal and transverse sections of hypotype 2 (also topotype), USNM 135680.

main distinction between the species is in the septa, which in *R. verrilli* are consistently more dilated and carinate in the dissepimentarium. In addition there are differences in the dissepimentaria of the two species, which were kindly brought to the writer's attention by Dr. W. A. Oliver. In *R. arachne* the calicular platforms tend to slope downwards peripherally, whereas in *R. verrilli* they are flatter. This is reflected in the arrangement of the dissepiments, which in *R. verrilli* are more horizontally disposed in the marginal and periaxial parts of the dissepimentarium.

Warren and Stelck (1949, 1950) reported its presence in the upper Hare Indian Formation of the central Mackenzie region. Their accompanying faunal list suggests that the assemblage containing *R. verrilli* was obtained, at least partly, from the Hume Formation of current nomenclature. The species has not been seen by the writer in beds younger than this formation.

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A. E. H. PEDDER
Department of Geology,
University of New England,
Armidale, N.S.W.,
Australia

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