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RUDIST ASSEMBLAGES OF THE ANTILLEAN UPPER CRETACEOUS

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Jamaica Geological Survey

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CONTENTS

RUDIST ASSEMBLAGES OF THE ANTILLEAN UPPER CRETACEOUS*

L. J. Chubb

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ABSTRACT

In a recent publication it was shown that the oft repeated statement that the rudist genera *Barrettia* and *Titanosarcolites* occur in association in the Caribbean area is erroneous, and that in Jamaica, B.W.I., the *Titanosarcolites* horizon is some 2,500 feet higher than the *Barrettia* horizon. It is now found that a characteristic rudist assemblage, known to include over eight species, occurs in the lower horizon, and a different assemblage, comprising 31 named species, distinguishes the higher. The two faunas have only one species in common.

In Cuba a still lower rudist horizon has been recognised, characterized by *Tepeyacia corrugata* and four other species. Most workers on the Cuban Cretaceous have lumped together the *Barrettia* and *Titanosarcolites* horizons in one comprehensive Habana formation, but a careful scrutiny of the published lists of fossils from recorded localities reveals that in Cuba, as in Jamaica, the rudists found in association with *Barrettia* are, with one possible exception, different from those found in association with *Titanosarcolites*. The former assemblage includes 21 and the latter 18 named species. Our limited knowledge of the rudist faunas of the other Antillean islands suggests that here too different assemblages are associated with the two genera.

It is suggested that the *Tepeyacia* fauna is Cenomanian-Turonian, and that *Barrettia* ranged from Upper Turonian through Lower Senonian. There is general agreement that the age of the *Titanosarcolites* horizon is Maestrichtian.

Two faunal provinces may be recognized, separated by a line which passes between Cuba and Jamaica, and at its eastern end cuts southeast across the latter island. Few species are found on both sides of the line at any stage in the Upper Cretaceous.

INTRODUCTION

Rudists are the dominant, or at least the best known, fossils in the Cretaceous rocks of the Antillean region. The rudist faunas of Cuba and Jamaica have received much intensive study, and approximately 40 species have been described from each area. As these two islands are separated by a distance of less than 100 miles, it might have been expected that their rudist faunas would be substantially the same but, while a few species in the two areas have been recorded under the same names, it would seem

* Read before First British Caribbean Geological Conference, Antigua, Dec. 5-8, 1955.

that on the whole the differences are more marked than the resemblances. The rudist faunas of Haiti, Puerto Rico, and the Virgin Islands, are less well known.

In Jamaica rudists have been found only in the limestones which constitute perhaps five per cent of the total thickness of the Cretaceous. They are usually associated with gastropods, normal lamellibranchs, corals, echinoids, and other fossils, and many mollusks and corals are found at various horizons in the shales and other deposits which lie below, between, and above the limestones. It is not too much to say that in the Jamaican Cretaceous other fossil species outnumber the rudists by at least four to one. In Cuba, however, little attention has been paid to the macrofossils excepting rudists, and a scrutiny of the literature has brought to light only one important reference to Cretaceous shale fossils, other than ammonites, in that island (Lewis and Straczek, 1955, pp. 193-200). This study will, therefore, be concerned mainly with the rudists.

RUDIST ASSEMBLAGES

JAMAICA

The Cretaceous rudists of Jamaica have been described by Woodward (1862), Whitfield (1897a and b), Trechmann (1922 and 1924), and Chubb (1955a and 1956a and b). The rudist fauna of the eastern part of the island is not as yet well known. Brief accounts of the Cretaceous rocks in this area have been given by Barrett (1860), Sawkins (1869, pp. 26, 40-41, 47), and Trechmann (1924, pp. 390-3, 1927, pp. 31-35), from which it would appear that their development here is rather different from that in the rest of the island, due perhaps to deeper water conditions. The original specimens of *Barrettia monilifera* Woodward were found by Barrett in this region, and in other parts of the area Trechmann found *Titanosarcolites giganteus* (Whitfield), the small *Biradiolites mooretownensis,* and other species. The associated shale fauna differs from that in the rest of the island in that it contains several species of ammonites (Spath, 1925). Closer study of the Cretaceous fauna of eastern Jamaica may perhaps show it to have much in common with the Cuban fauna. This area is separated from the rest of Jamaica by the Wagwater Belt, a zone of intense thrusting, crushing, and folding, which crosses the island in a NW-SE direction.

It has recently been shown (Chubb, 1955b) that in central and western Jamaica, that is the area west of the Wagwater Belt, there are two rudist horizons, the upper *Titanosarcolites* limestone series being separated by 2,500 feet of tuffaceous and detrital material from the lower *Barrettia* limestone which is underlain by several thousand feet of sediments, the *Inoceramus* shales. The principal species of *Barrettia* found here is not *B. monilifera,* which is unknown in the area, but *B. gigas* (Chubb, 1955a, pp. 9-12).

The rudist fauna associated with *Barrettia,* so far as it is known at present, includes only the following species:

Plagioptychus toucasi Matheron
Ichthyosarcolites sp.
Praeradiolites verseyi Chubb
Bournonia, n. sp.
Durania nicholasi (Whitfield)
D. cf. *aguilae* Adkins
Barrettia gigas Chubb
B. multilirata Whitfield
rudist spp. indet.

The recently discovered *Plagioptychus* listed above, from the *Barrettia* beds of Haughton Hall, Green Island, Hanover Parish, appears to be the same as the form described by Mullerried (1933, pp. 9-14) from the same horizon in Chiapas, Mexico, and identified by him with *P. toucasi* which characterizes the Turonian of Europe.

The *Titanosarcolites* fauna of central and western Jamaica is far more abundant than the *Barrettia* fauna and is known to include the following rudist species:

Monopleura jamaicensis Chubb
Gyropleura shaviensis Chubb
Plagioptychus jamaicensis (Whitfield)
P. trechmanni Chubb

P. zansi Chubb
P. minor Chubb
Mitrocaprina multicanaliculata Chubb
Antillocaprina occidentalis (Whitfield)
A. quadrangularis (Whitfield)
Titanosarcolites giganteus (Whitfield)
Agria falconi Chubb
Biradiolites forbesi Chubb
B. rudis (Whitfield)
B. rudissimus Trechmann
B. minhoensis Trechmann
B. jamaicensis Trechmann
Thyrastylon adhaerens (Whitfield)
T. coryi (Trechmann)
T. semiannulosus (Trechmann)
Bournonia cancellata (Whitfield)
B. barretti Trechmann
Radiolites annulosus Whitfield
Sauvagesia macroplicata (Whitfield)
S. mcgrathi Chubb
S. fluminisagni Chubb
Durania nicholasi (Whitfield)
Chiapasella radiolitiformis (Trechmann)
Hippurites (*Orbignya*) *mullerriedi* (Vermunt)
H. (*O.*) *ceibarum* Chubb
Parastroma maldonensis Chubb
Praebarrettia sparcilirata (Whitfield)

It may be noted that the only species at present known to be common to the *Barrettia* and *Titanosarcolites* faunas in Jamaica is *Durania nicholasi,* which may be a synonym of *D. curasavica* (Martin) characteristic of the Seroe Teintje limestone of Curaçao, Netherlands West Indies. If so the latter name has priority.

CUBA

Douvillé (1926) described a number of Cuban rudists collected by Sanchez Roig, which were said to come from two horizons, the upper "Couches à *Barrettia*", and the lower "Couches à *Bour-*

nonia." The former yielded not only *Barrettia* but also *Titanosarcolites* and other rudists, while the latter contained *Biradiolites lumbricoides* and small Bournonias.

In the following year he described some new species, and on the basis of lithology divided the rudist succession into five horizons, which he numbered in descending order. The highest horizon, Stage I, was the zone of *Barrettia* and Stage II that of *Titanosarcolites*. Stage IV was the *Bournonia* horizon of 1926, and Stage V was the earliest Cretaceous horizon in Cuba.

Thus Douvillé recognised that the *Barrettia* beds should be separated from the *Titanosarcolites* beds, but following Trechmann (1927), he regarded the former as more recent than the latter. Reliance on lithology alone is notoriously risky, and it is now found that the faunas of Stages I and V commonly occur together while Stages II and IV both contain mixed faunas belonging to two horizons.

Palmer (1933) described a number of new species without attempting to assess their relative ages. Exact localities were not given, but it seems probable that all species reported to occur in one neighborhood do in fact belong to one faunal assemblage.

In the same year (1933) a party of students from Utrecht University under the leadership of the late Prof. L.M.R. Rutten carried out a reconnaissance survey over large areas of Cuba. They included H. R. MacGillavry, M.G. Rutten, A.A. Thiadens, and L.W.J. Vermunt. A second party, including J.J. Hermes, F.G. Keyzer, D.R. deVletter, and A. van Wessem, continued the work in the winter of 1938-39. These workers collected great numbers of rudists, recorded the exact site of every find, and marked it on their maps. So for the first time it became possible to ascertain with some certainty which species are associated together in Cuba.

The Utrecht geologists, following Palmer, divided the Cuban Upper Cretaceous into two stages: the lower, or Tuff series, in which were interbedded many lenticles of limestone, certain of which, called the Provincial limestones, yielded a small rudist fauna, characterized by *Tepeyacia* and other forms; and the upper stage, the Habana formation, which contained many rudists, including both *Titanosarcolites* and *Barrettia*.

In a recent publication (Chubb, 1955b, pp. 180-183), it has been shown that the oft-repeated statement that *Titanosarcolites* and *Barrettia, s.s.,* occur together is erroneous. The only actual reports of this association in the Caribbean region are that by Douvillé (1926) quoted above, which he corrected next year (1927, p. 50), and a list by one of the Utrecht geologists, Vermunt, showing the two genera as occurring together in one locality (H.802) near San Diego in Piñar del Río Province. However, this association was reported in only one of this author's publications (1937a, p. 263); in the stratigraphical memoir (1937b, pp. 36-37) *Barrettia monilifera, B. multilirata,* and three other rudist species, all common associates of *Barrettia,* were reported from this spot, but not *Titanosarcolites.* The site is surrounded by outcrops yielding *Barrettia,* while the nearest recorded *Titanosarcolites* locality is over 40 km. away. It appears reasonably certain, therefore, that the reported occurrence of the latter genus at this spot was due to a slip of the pen. If in fact the two genera were found together it was a unique occurrence.

A careful analysis of the other locality lists of rudist species published by the Dutch geologists shows clearly, not only that *Barrettia* and *Titanosarcolites* do not occur together, but also that each of these genera is accompanied by a distinctive rudist assemblage, with hardly any species common to the two faunas. It appears, therefore, that in Cuba three rudist assemblages can be distinguished which may be respectively designated the *Tepeyacia* fauna, the *Barrettia* fauna and the *Titanosarcolites* fauna.

The *Tepeyacia* fauna is that of the Provincial limestone. It is the oldest known rudist fauna in Cuba, and none of its species pass into higher horizons. The part of the Tuff series in which it is interbedded is older than the Habana formation and probably corresponds with the *Inoceramus* series which in Jamaica underlies the *Barrettia* horizon.

The following forms are included in the *Tepeyacia* fauna (Thiadens, 1936b):

Caprinuloidea perfecta Palmer
Coalcomana ramosa (Boehm)
Sabinia sp.

Ichthyosarcolites sp.
Tepeyecia corrugata Palmer

Nothing comparable with this fauna has yet been found in Jamaica.

The *Barrettia* fauna of Cuba, if we may judge by published descriptions and figures, appears to be characterized by the true *B. monilifera,* without *B. gigas,* but sometimes accompanied by *B. multilirata.* Certain limestones outcropping at Loma Yucatan north of Camaguey city, which were regarded by MacGillavry (1937, p. 20) as lower Habana or even pre-Habana, contain species which are typical of the *Barrettia* fauna so, although the zone fossil has not been reported in them, they must be regarded as belonging to this horizon. Douvillé's lowest horizon, Stage V, also has species in common with the *Barrettia* beds. In view of these relationships and by analogy with Jamaica, it seems certain that the *Barrettia* fauna is older than the *Titanosarcolites* fauna, not younger as Douvillé believed. This is confirmed by an observation by Zans, who found *Barrettia* in the basal beds of the Habana formation at Seibabo, south of Santa Clara, immediately above a Tuff series, which he found to contain beds lithologically identical with the Jamaican *Inoceramus* series.

The following species should probably be included in the Cuban *Barrettia* fauna:

Plagioptychus antillarum (Douvillé)
Antillocaprina crassitela MacGillavry
Biradiolites cubensis Douvillé
B. macgillavryi Vermunt
B. tschoppi Vermunt
B. cf. *acuticostatus* d'Orbigny
B. cf. *lameracensis* Toucas
B. cf. *aquitanicus* Toucas
Parabournonia hispida Douvillé
"*Radiolites macroplicatus*" Thiadens *non* Whitfield
Durania curasavica (Martin)
D. lopeztrigoi (Palmer)

Chiapasella cubensis Rutten
Tampsia rutteni Vermunt
Vaccinites macgillavryi Palmer
Torreites sanchezi (Douvillé)
T. tschoppi Macgillavry
Parastroma sanchezi Douvillé
Pironea corralli Palmer
Barrettia monilifera Woodward
B. multilirata Whitfield

Sixteen of these species have been found in association with *Barrettia monilifera,* and the remaining five with other members of the *Barrettia* fauna. These include *Biradiolites* cf. *lameracensis* which in northern Santa Clara is found with *Biradiolites cubensis* and *Plagioptychus antillarum,* two characteristic members of the *Barrettia* fauna. The other four species, *Durania curasavica, D. lopeztrigoi, Torreites tschoppi,* and *Pironea coralli* are associated at Loma Yucatan with *Vaccinites macgillavryi,* which occurs with *Barrettia* in Piñar del Río. The five species must, therefore, be regarded as members of the *Barrettia* fauna. The species called "*Radiolites macroplicatus*" by Thiadens and Vermunt is not the form described under that name by Whitfield, which is a *Sauvagesia* characteristic of the Jamaican *Titanosarcolites* horizon.

A comparison of the *Barrettia* faunas of Cuba and Jamaica west of the Wagwater Belt, reveals only one species common, *Barrettia multilirata,* or two, if *Durania nicholasi* and *D. curasavica* are synonyms.

The *Titanosarcolites* fauna of Cuba includes the following species:

Mitrocaprina tschoppi (Palmer)
Antillocaprina annulata (Palmer)
A. pugniformis (Palmer)
Titanosarcolites giganteus (Whitfield)
Radiolites galofrei (Palmer)
Biradiolites aquitanicus Toucas
B. lumbricoides Douvillé
Bournonia planasi Thiadens

B. thiadensi Vermunt
B. cancellata (Whitfield)
B. cf. *bournoni* Des Moulins
Chiapasella bermudezi Palmer
C. pauciplicata Mullerried
Hippurites (*Orbignya*) *mullerriedi* Vermunt
Parastroma guitarti (Palmer)
Pironea cf. *peruviana* Gerth
Praebarrettia sparcilirata (Whitfield)
P. porosa Palmer

All except five of these species have been found in association with *Titanosarcolites*. Of the five, *Mitrocaprina tschoppi* and *Antillocaprina pugniformis*, according to Palmer (1933) and Macgillavry (1937), are found at Ciego de Avila, Camaguey, in company with *Antillocaprina annulata*, which occurs with *Titanosarcolites* in Piñar del Río; of the other three species Palmer reported that *Chiapasella bermudezi* and *Praebarrettia porosa* occur at Sancti Spiritus, in southern Santa Clara Province, and *Radiolites galofrei* in Sierra Najassa, Camaguey Province, where they are associated with characteristic members of the *Titanosarcolites* fauna such as *Praebarrettia sparcilirata* and *Parastroma guitarti*.

It may be noted that species referred to, or compared with *Biradiolites aquitanicus*, are included in both the *Barrettia* and the *Titanosarcolites* faunas (Vermunt, 1937a, p. 263; Thiadens, 1937, p. 44). Possibly the two forms may be identical, but otherwise no species is known to be common to the two faunas.

If the Cuban *Titanosarcolites* fauna be compared with the corresponding list for Jamaica, it will be found that four species appear to be shared by both, but some reserve is necessary in drawing this conclusion. Certain Cuban specimens determined as *Praebarrettia sparcilirata cubensis*, apparently by Palmer, and lent to the writer by the U.S. National Museum, have only a superficial resemblance to Whitfield's and Trechmann's type specimens of *P. sparcilirata* from Logie Green, Jamaica. It is doubtful if the Cuban species of *Titanosarcolites* is identical with the Jamaican type species, *T. giganteus*, for few if any adult Jamaican specimens have such prominent flanges as those shown in MacGillavry's figures (1937, pl. 2, p. 69). The Cuban form attributed to *Bournonia cancellata* has not been described so it is impossible to be sure if it corresponds with Whitfield's species, but it appears that *Orbignya mullerriedi* really is common to the two islands, though rare in Jamaica.

It is strange that none of the Utrecht geologists realized that they had found two distinct rudist assemblages, with hardly a species in common, in the Habana formation. Their failure to do so led them into frequent misstatements and misinterpretations, for example MacGillavry (1937, p. 111) wrote that *Hippurites mullerriedi* Vermunt occurs at locality H774, Piñar del Río Province, and added "a typical *Barrettia*-strata fauna occurs at this locality so that the species belongs to the Maestrichtian." In fact *Titanosarcolites giganteus* and four other named rudist species were recorded from this locality (Vermunt, 1937b, pp. 36-37), and not one of the four has been reported by any author to occur in association with *Barrettia,* anywhere in Cuba or elsewhere. Actually the fauna is a typical *Titanosarcolites* fauna and is indeed Maestrichtian, though if it had been a *Barrettia* fauna it would probably have been pre-Maestrichtian.

A careful scrutiny of the geological and locality maps published by the Dutch geologists, in conjunction with their fossil lists, reveals the fact that *Barrettia* localities and *Titanosarcolites* localities are not mixed indiscriminately but are to be found in different parts of the area. However, the authors frequently link a group of *Titanosarcolites* outcrops in one part of a map with a group of *Barrettia* outcrops in another part, across distances of up to 45 km., with no intervening rudist localities. If we link all the *Barrettia* localities on, for example, MacGillavry's geological map of the region around Camaguey (1937), and similarly link all the *Titanosarcolites* localities, we will find that we have two roughly parallel belts alternating with belts of "Tuff Series" which lie between and on both sides of the rudist belts. There is probably a fault trending NNE-SSW, and running from immediately east of Arroyo Hondo to the western end of the Sierra Najassa. This may bring the *Titanosarcolites* limestone on the west into line with the *Barrettia* limestone on the east. Both the limestones and the belts of "Tuff Series" are continued on neighbouring sheets. It, therefore, appears that in Cuba, as in Jamaica, the two principal rudist horizons have tuffaceous and detrital beds below, between and above them.

OTHER ANTILLEAN ISLANDS

Some account of current knowledge about the rudist faunas of the islands east of Jamaica has already been given (Chubb, 1955b, pp. 181-182). *Barrettia monilifera* and *B. multilirata* have been found in Haiti, *B. monilifera* and *Caprinula* sp. in Maguey Is., and *B.monilifera* and "*Radiolites*" in Puerto Rico. *Titanosarcolites* has not been recorded from these islands.

A slightly larger rudist fauna is known from St. Croix in the Virgin Islands (Vaughan, 1923, p. 305), and following an examination of the type specimens in the U.S. National Museum it has been possible to divide this into two faunal assemblages, based on differences in matrix, and on the fact that some specimens are silicified and others not.

The St. Croix *Barrettia* fauna, comprising all the nonsilicified specimens, includes the following:

Antillocaprina sp.
Caprinula sp.
Durania nicholasi (Whitfield)
Barrettia monilifera (Woodward)

The *Caprinula* resembles that from Maguey Is.

The *Titanosarcolites* fauna, all members of which are more or less silicified, includes:

Titanosarcolites giganteus (Whitfield)
Durania nicholasi (Whitfield)
Praebarrettia sparcilirata (Whitfield)

There are also silicified gastropods and normal pelecypods. It is interesting to note that, as in Jamaica, *Durania nicholasi* appears to be common to both faunas, for one specimen was silicified and two were not.

Thus the evidence from these islands, so far as it is known, tends to confirm the previous conclusion that the *Barrettia* and *Titanosarcolites* faunas are distinct, with few species in common.

CORRELATION

Recently an attempt was made to correlate the Cretaceous succession in Jamaica with the standard succession (Chubb, 1955b, pp. 183-193). It was suggested that the *Inoceramus* series was Cenomanian and the *Barrettia* limestone Upper Turonian; the *Veniella* shale, which underlies the *Titanosarcolites* limestone series was regarded as Campanian, and the latter series as Maestrichtian.

As noted above, it is probable that the Provincial limestone of Cuba is equivalent to some part of the *Inoceramus* series in Jamaica. This limestone was regarded by MacGillavry (1937, pp. 11-12) as Upper Middle Albian, and by Thiadens (1937, p. 12) as Cenomanian-Turonian. The latter determination nearly agrees with the writer's suggestion as to the age of the *Inoceramus* series.

The determination of the Jamaican *Barrettia* limestone as Upper Turonian requires some modification as it is now known that an ammonite found by Trechmann (1936, p. 253) in the St. Ann's Great River section, and determined by Spath as *Nowakites* aff. *paillettei* (Grossouvre), a Lower Senonian form, came from an horizon high in the *Inoceramus* series, and about 800 feet below the *Barrettia* limestone. At my request Dr. Spath has recently reexamined this ammonite, and he confirmed that it is Coniacian in age. An *Inoceramus* found near this spot, which has been mentioned as resembling *I. inconstans* Woods (Chubb, 1955b, p. 191), should probably be ascribed to the American species, *I. deformis* Meek. Recently Cobban and Reeside (1952, pp. 1018-1019) selected this species as a zonal index for the lower member of the Niobrara formation, the Fort Hayes limestone, which is regarded as basal Coniacian. Dr. P. Bronnimann confirmed the age of this horizon as he found Foraminifera including *Globotruncata coronata, G. helvetica, Thalmanninella* sp., *Gumbelina globulosa*, and other species indicating a Turonian or possibly a Turonian-Coniacian age. In Cuba an horizon yielding Turonian-Coniacian ammonites was found by M. G. Rutten (1936a, p. 7), but it appears to be uncertain whether or not it was interbedded in the Tuff series below the *Barrettia* horizon. On the other hand in Mexico Mullerried (1936, pp. 38-39) found Turonian-Coniacian ammonites not below, but above *Barrettia*.

This apparent inconsistency is resolved if it is assumed that *Barrettia, s.s.,* ranges through from the Upper Turonian into the Lower Senonian, a reasonable assumption. Possibly future investigation may show that the range of *Barrettia monilifera* is not the same as that of *B. gigas,* though as both occur in association with *B. multilirata* there is probably no great difference. Recent evidence suggests that *B. monilifera* ranges at least into the Campanian in Puerto Rico as well as in Cuba. There is general agreement as to the age of the higher beds, the *Titanosarcolites* limestone series in both Cuba and Jamaica being almost universally regarded as Maestrichtian or Campanian-Maestrichtian. The few dissentient opinions have been discussed in the previous paper (Chubb, 1955b, p. 185).

An attempt to correlate the Jamaican Cretaceous with the standard succession shows that, on the whole, the macrofossils give consistent results, but the microfossils have not always done so. As mentioned above, a sub-*Barrettia* horizon yielding an ammonite and an *Inoceramus* of Coniacian age yielded also Turonian-Coniacian Foraminifera. But another sample of identically the same material which was submitted to Dr. Bronnimann earlier yielded *Globotruncana fornicata.* He informed me that this does not contradict his age determination, as this species ranges at least from Coniacian to Campanian, and probably from high Turonian to basal Maestrichtian. Bronnimann is evidently right, yet according to Bolli (1951, p. 195) and Sigal (in Piveteau, 1952, Vol. 1, p. 238) it originated in the Middle Campanian. Further, in St. James Parish, 40 miles west of St. Ann's Great River, the sub-*Barrettia* shales yielded Foraminifera which he ascribed not to the Turonian-Coniacian, but to the Campanian, as far down as 3,000-5,000 feet below the beds that contain a Campanian macrofauna, a discrepancy which suggests that the St. Ann sequence is older than the St. James sequence.

The accuracy of the age determination made by means of any fossil species depends in part on the accuracy of the determination of the age of the formation in which the species was originally found. If the latter determination was erroneous it follows that any age determinations based on the occurrence of the species will also be erroneous.

Two such cases from Jamaica may be cited. In the Cambridge-Catadupa area the middle Eocene Yellow limestone rests directly upon an Upper Cretaceous *Titanosarcolites* limestone without any obvious angular discordance. Trechmann found a shale between the two limestones, from which he collected a foraminifer that was named *Eponides jamaicensis* by Cushman and Jarvis and attributed to the middle Eocene, and for years thereafter this species was regarded as an index fossil of that horizon. However, the writer found it a little startling to be informed that the *Veniella* shale, which is crowded with Campanian macrofossils, and underlies the main rudist horizon of Jamaica, was middle Eocene. The determination was of course based on the presence of *E. jamaicensis,* which Dr. Bronnimann subsequently found to be a synonym of *Lockhartia bermudezi* Cole, an Upper Cretaceous species. Evidently the shale in the Cambridge-Catadupa section is part of the *Titanosarcolites* series, and the unconformity is above it.

Another case has been mentioned by Mullerried (1936, p. 158). He pointed out that *Barrettia* was originally attributed to the Maestrichtian because it was accompanied by a foraminifer believed to be *Orbitoides,* a Maestrichtian genus. But this foraminifer was subsequently found by Douvillé to be a new genus, which he named *Pseudorbitoides.* This latter genus is today generally regarded as Maestrichtian, because of its association with *Barrettia,* a complete argument in a circle. As *Pseudorbitoides trechmanni* is confined to the *Barrettia gigas* limestone, which lies 2,500 feet below the Campanian *Veniella* shale, it cannot be Maestrichtian, though the possibility that it may range into the Campanian is not excluded.

FAUNAL PROVINCES

In an earlier paper (Chubb, 1955a, pp. 11-12) it was shown not only that the known occurrences of *Barrettia gigas* in central and western Jamaica lay west of the Wagwater Belt but also that all known occurrences of *B. monilifera* throughout the Antillean region, including eastern Jamaica, Haiti, Maguey Is., Puerto Rico, and the Virgin Islands lay east of this belt. It was further pointed out that, if the line of the Wagwater Belt were produced towards the northwest, it would divide Cuba from Jamaica. Hence it might be expected that the Cuban *Barrettia* would be a true *B. monilifera* as has now been found to be the case. On the other hand, it seems probable that the Guatemalan and south Mexican *Barrettia* is *B. gigas.*

In this paper it has been shown that the rudist faunas associated with *Barrettia* on the two sides of the Wagwater Line are, in the main, quite different; also that the higher *Titanosarcolites* horizon contains different rudist assemblages on the two sides of the line. An interesting observation by Hill (1899, p. 173) may be quoted: "In San Domingo, St. Thomas and Porto Rico these formations (pyroclastics) are associated with limestone beds and Cretaceous fossils, in part resembling in species and faunal associations those of Jamaica, and in part containing species not found in the latter island. In Cuba both the Jamaican and continental types of Cretaceous faunae are found."

It thus appears that in Upper Cretaceous times there was a kind of "Wallace's Line" which ran between Cuba and Jamaica, and at its eastern end cut southeast across the latter island. It cannot be correlated with the Bartlett Trough, a long relatively narrow trench approaching a depth of 4,000 fathoms in places, which today separates the islands, as this feature cuts across the line at a considerable angle. The Trough is much more recent in origin.

The line divided the Antillean region into two faunal provinces, probably throughout Upper Cretaceous. In the earlier publication it was suggested that the Wagwater Belt and its northwestern extension already existed, and separated a northeastern deeper water from a southwestern shallow water area. The lithology of the rocks in the two areas suggests this, and *Barrettia gigas* would appear to be better adapted to shallow water conditions than *B. monilifera.* But it would be difficult to demonstrate that the other rudists associated with *Barrettia* and *Titanosarcolites* on the two sides of the line are adapted to different ecological conditions, indeed all rudists must have been relatively shallow water organisms.

But the theory of slightly deeper water on the northeastern side of the Line becomes more plausible if the Cretaceous shale faunas are taken into consideration. Ammonites are generally regarded as indicative of conditions of open sea of at least moderate depth, and, as mentioned above, ammonites have been found in the Providence shales of eastern Jamaica (Spath, 1925), including species of *Epigoniceras, Pachydiscus* (*Parapachydiscus*), *Glyptoceras,* and *Baculites.* Trechmann recently found another ammonite in these shales which Spath recognised as a species of *Desmophyllites.* A similar fauna has been reported from Haiti (Reeside, 1947), including *Parapuzosia ? Pachydiscus* (*Parapachydiscus*), *Paralenticeras, Texanites,* and *Baculites.* From Puerto Rico species of *Barroisiceras* and *Parapuzosia* have been recorded (Myerhoff, 1932), and from Cuba species of *Austiniceras, Pachydiscus, Peroniceras, Crioceras,* and *Barroisiceras* (Rutten, 1936a).

Yet in Jamaica west of the Wagwater Belt, the area in which the Cretaceous shales have probably been more intensively studied than in any other area in the Greater Antilles, one solitary specimen of ammonite has been found, the *Nowakites* aff. *paillettei* referred to above. This relative abundance of ammonites in the areas northeast of the Wagwater Line certainly suggests that on that side the sea was more open, rather deeper, and less obstructed with rudist or coral reefs.

The alternative explanation of the difference between the two faunas is that some kind of barrier existed, either a land barrier or a belt of deep water. In Schuchert's paleogeographic map of the middle Upper Cretaceous (1935, plate 6), Jamaica is shown as covered by an extension of the Caribbean Sea, and parts of Cuba, Hispaniola, Puerto Rico, and the Virgin Islands by an extension of the Gulf of Mexico. A land barrier between Jamaica and Cuba extended eastwards to include the southern parts of Haiti and the Dominican Republic. But as rudists were purely benthonic forms, really deep water could form nearly as effective a barrier to migration as a ridge of land. Until further evidence is available it would be fruitless to speculate as to which of these hypotheses is the true one.

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My thanks are due to my colleagues on the staff of the Jamaican Geological Survey, V. A. Zans, H. R. Versey, J. B. Williams, B. R. G. McGrath, and B. V. Bailey, who collected most of the Jamaican rudists listed in this paper. I also owe a debt of gratitude to Dr. P. Bronnimann of the Cuban Gulf Oil Company of Havana, Cuba, who has kindly determined the Foraminifera in many samples of Jamaican Cretaceous material. His findings have been helpful in correlating certain parts of the succession. I should also like to acknowledge my indebtedness to the work of the eight former students of the late Prof. L. M. R. Rutten who, by their careful collecting and generally accurate locating of Cuban fossils, have rendered possible an analysis of the rudist faunas of that island.

REFERENCES

Barrett, Lucas

1860. *On some Cretaceous rocks in the southeastern portion of Jamaica* Quart. Jour. Geol. Soc., vol. 16, pp. 324-326.

Bolli, Hans

1951. *The genus Globotruncana in Trinidad, B.W.I.* Jour. Paleont., vol. 25, pp. 187-199.

Chubb, L. J.

1955a. *A revision of Whitfield's type specimens of rudistid mollusks from the Cretaceous of Jamaica, B.W.I.* Amer. Mus. Novitates, No. 1713, pp. 1-15.

1955b. *The Cretaceous succession in Jamaica.* Geol. Mag., vol. 92, pp. 177-195.

1956a. *Some rarer rudists from Jamaica, B.W.I.* Palaeontographica Americana, vol. 4, No. 26, pp. 1-30, 5 pls.

1956b. *Thyrastylon, a new rudist genus from the Upper Cretaceous of Guatemala, the Antilles, and Persia. Ibid.*, vol. 4, No. 27, pp. 31-48, 2 pls.

Cobban, W. A., and Reeside, J. B.

1952. *Correlation of the Cretaceous formations of the Western Interior of the United States.* Geol. Soc. Amer. Bull., vol. 63, pp.1011-1044.

Douvillé, H.

1926. *Quelques fossiles du Crétacé supérieur de Cuba.* Soc. Géol. France Bull., ser. 4, vol. 26, pp. 127-138.

1927. *Nouveaux Rudistes du Crétacé de Cuba. Ibid.*, vol. 27, pp. 49-56.

Hermes, J. J.

1945. *Geology and palaeontology of east Camaguey and west Oriente, Cuba.* Geog. en. Geol. Med. Utrecht, ser. 2, No. 7.

Hill, R. T.

1899. *The geology and physical geography of Jamaica: study of a type of Antillean development.* Mus. Comp. Zool., Bull., vol. 34, pp. 1-256.

Lewis, G. E., and Straczek, J. A.

1955. *Geology of south-central Oriente, Cuba.* U.S. Geol. Sur., Bull. 975-D, pp. 1-336.

MacGillavry, H. J.

1937. *Geology of the province of Camaguey, Cuba, with revisional studies of rudist palaeontology.* Geog. en Geol. Med. Utrecht, ser. 2, No. 14.

Meyerhoff, H. A.

1932. *The pre-Oligocene stratigraphy of Puerto Rico.* Science, n.ser., vol. 75, pp. 342-343.

Mullerried, F. K. G.

1933. *El genero Plagioptychus en Mexico.* An. Inst. Biol. Mexico, vol. 4, pp. 3-14.

1936. *La edad estratigrafica de la Barrettia y formas cercanos. Ibid.,* vol. 7, pp. 155-164.

Palmer, R. H.

1933. *Nuevos rudistas de Cuba.* Revista de Agricultura, vol. 14. pp. 95-125.

Piveteau, J.

1952. *Traité de Paléontologie.* Masson, Paris.

Reeside, J. B.

1947. *Upper Cretaceous ammonites from Haiti.* U.S. Geol. Sur., Prof. Paper 214-A, pp. 1-11.

Rutten, M. G.

1936a. *Geology of the northern part of the province of Santa Clara, Cuba.* Geog. en Geol. Med. Utrecht, No. 11.

1936b. *Rudistids from the Cretaceous of northern Santa Clara Province, Cuba.* Jour. Paleont., vol. 10, pp. 134-142.

Sawkins, J. G.

1869. *Reports on the geology of Jamaica.* Mem. Geol. Survey: H. M. Stationery Office.

Schuchert, C.

1935. *Historical geology of the Antillean-Caribbean Region.* New York.

Spath, L. F.

1925. *On Senonian Ammonoidea from Jamaica.* Geol. Mag., vol. 62, pp. 28-32.

Thiadens, A. A.

1936a. *Rudistids from southern Santa Clara, Cuba.* Proc. Kon. Ak. v. Wet. Amsterdam, vol. 39, pp. 1010-1019.

1936b. *On some caprinids and a monopleurid from southern Santa Clara, Cuba. Ibid.,* pp. 1132-1141.

1937. *Geology of the southern part of the province of Santa Clara, Cuba.* Geog. en Geol. Med. Utrecht, No. 12.

Trechmann, C. T.

1922. *The Barrettia beds of Jamaica.* Geol. Mag. vol. 59, pp. 501-514.

1924. *The Cretaceous limestones of Jamaica and their Mollusca. Ibid.,* vol. 61, pp. 385-410.

1927. *The Cretaceous shales of Jamaica. Ibid.,* vol. 64, pp. 27-42 and 49-65.

1936. *The basal complex question in Jamaica. Ibid.,* vol. 73, pp. 251-267.

Vaughan, T. W.

1923. *Stratigraphy of the Virgin Islands of the United States and of Culebra and Viegues Islands, and notes on eastern Porto Rico.* Washington Acad. Sci., vol. 13, No. 14, pp. 303-317.

Vermunt, L. W. J.

1937a. *Cretaceous rudistids of Piñar del Río, Cuba.* Jour. Paleont., vol. 11. pp. 261-275.

1937b. *Geology of the province of Piñar del Río, Cuba.* Geog. en Geol. Med. Utrecht. No. 13.

Wessem, A. van

1943. *Geology and paleontology of central Camaguey, Cuba. Ibid.,* ser. 2, No. 5.

Whitfield, R. P.

1897a. *Descriptions of species of Rudistae from the Cretaceous rocks of Jamaica, W.I.* Amer. Mus. Nat. Hist. Bull., vol. 9, pp. 185-196.

1897b. *Observations on the genus Barrettia Woodward, with descriptions of two new species. Ibid.,* pp. 233-246.

Woodward, J. P.

1862. *Some account of Barrettia, a new and remarkable shell from the Hippurite limestone of Jamaica.* The Geologist, vol. 2, pp. 372-377.

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MIDDLE DEVONIAN STROMATOPOROIDEA OF INDIANA, KENTUCKY, AND OHIO

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June 28, 1957

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MIDDLE DEVONIAN STROMATOPOROIDEA OF INDIANA, KENTUCKY, AND OHIO

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ABSTRACT

Seventy-six stromatoporoid species are described and figured from the Middle Devonian of Indiana, Kentucky, and Ohio, and nine are type species not found in the area discussed. Fifty-three are new species. A description and figures of the type species of 12 of the 15 genera in the fauna are included. We have published (Journ. Paleont., vol. 30, 1956, p. 170) a complete bibliography of stromatoporoid literature, embracing 502 titles; only the most important references are given in the present paper. A check list of all known Devonian genera and species of the world is given, including 23 valid and 13 invalid genera, and 408 valid and 141 invalid species.

Splendidly preserved stromatoporoids occur in the Logansport limestone of Hamilton age and Little Rock Creek limestone of Tully age, in north-central Indiana, in the lower Jeffersonville limestone of Onondaga age throughout southern Indiana and northern Kentucky, in the Columbus limestone also of Onondaga age in Ohio. They make exceptionally good index fossils. The families Clathrodictyidae, Actinostromatidae, Stromatoporoidae and Idiostromatidae, four of the five stromatoporoid families, are well represented, making the faunas ideal for systematic and stratigraphic studies. The area from which the material was collected is nonorogenic, so that the true stratigraphic relations of the faunas are well established.

Twenty-seven species are described from the Jeffersonville limestone of Indiana and Kentucky, of which 20 are new, correlating with faunas from the Columbus limestone of Ohio and the Onondaga limestone of Ontario. We have 16 species from the Columbus limestone of Ohio, six of which are new. The Logansport fauna contains 28 species, of which 21 are new, correlating best with Frasnian and Faminian faunas from the Dinant Basin, Belgium. The Little Rock Creek fauna contains seven species, of which six are new, some of which resemble species from the Potter Farm formation of Upper Hamilton age in Michigan. *Anostylostroma microtuberculatum* (Riabinin) from the Little Rock Creek limestone, is close to the type from the main Devonian Field, south of Leningrad, Russia. *Amphipora ramosa* (Phillips), from the Jeffersonville limestone, is the most widespread species, occurring in the Middle Devonian of Montana, midwestern North America, England, Europe, the Urals, Yunnan, China, and Western Australia.

The midwestern fauna (Middle Devonian stromatoporoid faunas are significant because they are diversified) can be correlated over large areas, occurs under several ecological conditions, as in bioherms, biostromes, and inter-reef facies, and is associated on the surface with the stratigraphic and lithologic units which are Devonian oil reservoirs in the subsurface.

The specimens are in the paleontological collections of Indiana University, and portions of the figured specimens are deposited in the U. S. National Museum.

INTRODUCTION

PURPOSE OF THE STUDY

The stromatoporoids are nearly world-wide in occurrence and are abundant in large areas of the North American continent. They reached their maximum areal distribution, abundance, and diversification in the Devonian. Despite their common occurrence, few paleontologists are familiar with the structure and relationships of the stromatoporoids with each other and to other organisms. Information is scarce concerning the geologic ranges and the geographic distribution of the genera and species. It has been our purpose to try to make the stromatoporoids understandable and useful to paleontologists and stratigraphers.

The study of the stromatoporoids herein discussed was first seriously begun by the senior author in 1939. He began the study because the stromatoporoids occur in profusion in Indiana, no study had ever been made of Indiana forms, and because it was important that reef-building organisms of Indiana and neighboring states be made known to paleontologists, stratigraphers, and petroleum geologists. Furthermore, Foraminifera had been the senior author's main field of research for many years, and since Parks (1935) tried to show that Stromatoporoidea were Foraminifera, a first-hand knowledge of Stromatoporoidea seemed urgent.

Extensive collections were made from the Devonian formations of Indiana, Michigan, Ontario, Ohio, Kentucky, Illinois, Missouri, and Iowa. Many specimens, including types and topotypes, were borrowed from a score of institutions for study. The work has resulted in a complete reclassification of the genera and families of the order Stromatoporoidea, now in final preparation for publication. In addition, because of the need to study the phylogeny to determine the proper classification, a study of the more primitive species of the Ordovician was undertaken. This study resulted in a paper on Ordovician forms, which is nearing completion. The present paper deals with the Middle Devonian faunas from Indiana, Ohio, and Kentucky, embracing 76 species. Our collections are extensive but not exhaustive; many other species may be found in the quarries from which most of our material came.

The usefulness of the stromatoporoids for stratigraphic correlation is emphasized by their rapid change in geologic time. The most useful stratigraphic characteristics of a species are minute structures, because such characters and combination of characters change rapidly in time. Structures in stromatoporoids of the same age, over long distances, have a remarkable similarity, so that homologous species are valuable for stratigraphic correlation on a world-wide basis.

The stromatoporoids occur abundantly in the Devonian throughout northern and central North America, Europe, Asia, North Africa, and Australia. It is difficult to account for the absence of stromatoporoids in most of Africa and South America; it may be due to lack of paleontological investigation rather than actual distribution.

The Devonian stromatoporoids are of further interest because of geological and biological problems concerning them. They reached their peak in the Middle Devonian, diminished rapidly, and became extinct in the Upper Devonian. The nearest related organism, the sphaeractinoids, appear in the Pennsylvanian. There is, to our knowledge, no organism similar to either the stromatoporoids or sphaeractinoids which has been reported from the Mississippian. The marine Etroeungt beds in Europe, which are generally considered to be transitional from uppermost Devonian to lowermost Carboniferous or Mississippian, contain stromatoporoids of Devonian aspect. The sphaeractinoids, composed of a mass of anastomosing rods, have been called stromatoporoids by several investigators, but they are easily differentiated. There are no sphaeractinoids below the Carboniferous and no definite stromatoporoids, composed of laminae and pillars, above the Devonian. The closest living relative of the stromatoporoids seems to be the colonial *Hydractinia,* though the differences between the two are great.

Recent paleontological studies have turned more and more to the study of paleoecology. By determining the physical and biological conditions under which an organism lived, it is possible to predict the occurrence of economic materials sought. In the Devonian, the stromatoporoids occur in biostromes and bioherms, and the association of petroleum with both is well known. Slight use has been made of stromatoporoids in subsurface geology, although cores from wells contain stromatoporoids. Stromatoporoid fragments may be recognized from well cuttings and used for age determination. Another important industry involving rocks which contain stromatoporoids is the limestone industry, especially the production of road metal, lime, and the use of limestone as a flux in iron smelting.

Due to a general lack of knowledge and scarcity of systematic literature, slight use has been made of the stromatoporoids. Studies similar to the present one should be made for all of North America.

PREVIOUS WORK

Works dealing with the Devonian Stromatoporoidea of the continent of North America are surprisingly rare, considering the abundance and distribution of the stromatoporoids during the Devonian period. The majority of references deal only incidentally with stromatoporoids. The papers are mostly of a stratigraphic nature, describing or listing the faunas, such as Stauffer's extensive paper on the Devonian of Ontario (1915), and Northrop's work on the stratigraphy and paleontology of Gaspé (1939). There is a moderate amount of literature on the Devonian stromatoporoids of Europe, Asia, and Australia.

In North America an attempt was made to monograph the Devonian Stromatoporoidea by the late Prof. W. A. Parks, of the University of Toronto. The study was planned for three separate units: (1) an introduction, and description of genera and species with compact wall tissue, (2) descriptions of genera and species with maculate wall tissue, and (3) a general work on the nature and classification of the stromatoporoids, including a bibliography and index. Unfortunately, due to the untimely death of Dr. Parks in 1936, only the first part was completed.

The first paper to describe stromatoporoids from the Devonian formations of North America was published by Alexander Winchell seventy years prior to Parks' work, in an Appendix to a Report on the Grand Traverse Region (1866). Winchell described four species, all of which he referred to the genus *Stromatopora*. Winchell's report is an areal faunal and stratigraphic study. He referred to the limestones with stromatoporoids as "Stromatopora Beds". Winchell erected the family Stromatoporidae in 1867 and proposed two new genera, *Idiostroma*, which has become the type of a family, and *Coenostroma*, which is a *Stromatopora* with mamelons and astrorhizae.

Six years later, in 1873, Hall and Whitfield published and figured five species from Rockford, Hackberry, and Waterloo, Iowa. Like Winchell, they noted the profusion of stromatoporoids in certain formations, and further, their descriptions were based partly on the internal as well as external characters of the coenostea, although they figured only the surfaces. In the same year, 1873, Dr. H. Alleyne Nicholson published his first paper on the stromatoporoids; he described and figured three species from the Devonian of Port Colborne, Ontario, and attempted to illustrate the internal structures as well as the general surface characters. In succeeding years he published many articles on the stromatoporoids, culminating in the critical study of the group by means of thin sections, published between 1886 and 1892 in the Annals and Magazine of Natural History and in his great monograph of the British stromatoporoids. He paid great attention to the microscopic structure of the laminae and pillars as well as to their sizes and arrangements, resulting in fundamentals of classification which are still the best criteria which have been established. He had greater insight on the value of structures in identification and classification than any succeeding student of the group, and his industry was prodigious. It is most unfortunate that scarcely a succeeding student of the group has paid any attention to the microscopic tissue structure; no succeeding student has equaled Nicholson's illustrations. Most later illustrations have been too vague, with too little magnification, and little or no attempt to show the significance of dense, fibrous, porous or maculate tissue structure.

Since Nicholson's last published description of stromatoporoids from the Devonian of North America in 1891 and 1892, to the publication of Parks' work on the Devonian in 1936, relatively little work has been done with the group. Keyes published one of Hall and Whitfield's species from Missouri in 1894; Girty published seven species from New York in 1895; Swartz published in 1913, four species from Maryland from formations he considered to be Lower Devonian but which are now considered to be Upper Silurian; Branson published on one of Hall and Whitfield's species from Missouri in 1922; and Thomas published one species from Iowa in 1923. Since Parks' work there have been only two papers describing Devonian stromatoporoids from North America, both from the West. Three species were described from California by Stauffer in 1930, and one species was described from Wyoming by Johnson and Pfender in 1939.

The paucity of literature concerning specimens from western North America seems remarkable, considering the abundance and wide distribution of the stromatoporoids, especially throughout the North American Cordillera. Mr. L. F. Brady, Curator of Geology at the Museum of Northern Arizona, sent us a stromatoporoid from Arizona and one from Nevada. Mr. Stephen Theodosis, with the Billings Division of the Shell Oil Company (personal communication) reported numerous outcrops containing stromatoporoids ranging throughout much of the Devonian of Montana, and Dr. V. J. Okulitch, of the University of British Columbia (personal communication) reported stromatoporoids from the Devonian of Alberta and British Columbia, especially in the Banff-Lake Louise area. Mr. Dan Kralis collected a specimen from the Mackenzie Valley region of the Northwest Territories. Mr. Brady and Mr. Theodosis sent specimens, but the area is beyond the scope of the present work. Mr. H. L. Thomsen, Division Exploration Manager of the Billings Division of the Shell Oil Company, loaned us cores, some saturated with oil, containing stromatoporoids from the Silurian and Devonian from eastern Montana. Many species, well preserved, occur in the Upper Devonian of the House and Thomas Ranges of Utah.

The foregoing discussion demonstrates that though the stromatoporoids have been known from the Devonian of North America for 90 years, except for the works of Nicholson and Parks, little has been done, and there is much opportunity for systematic and stratigraphic work with this widespread group of Middle Paleozoic fossils.

PROCEDURE OF INVESTIGATION

Most of our collections came from quarries, road cuts, and stream courses, where the specimens are still well preserved by infiltration of calcium carbonate and not much weathered or replaced by silica; consequently, the structure is as satisfactorily made out, even to the finest tissue structure, as is true for other fossils, such as corals and bryozoans.

In preparing the material for study, at least two oriented thin sections were made of each specimen, one cut vertically, parallel to the pillars, the other cut tangentially, parallel to the laminae. In massive specimens, which include most stromatoporoids, the structure is the same throughout the coenosteum; there is no immature region, so that satisfactory sections may be made from any part of the coenosteum. In well-preserved specimens, it is easiest to cut a tangential section from near the surface and the vertical section at right angles to the surface. In cylindrical or dendritic specimens, as *Aulacera* and the Idiostromatidae, it is necessary to cut an axial section and a tangential section, and even a cross-section is useful. We mounted the sections with Lakeside Thermoplastic Cement on thick, 1 x 3 inch glass slides, which had been frosted; ground the section thin so as to show the microscopic characters of the laminae, pillars, and cyst plates. We labeled each slide on the ground glass, with the generic and specific names and author, the geologic horizon, the locality, the collector, identifier, number of the slide box, and catalogue number.

The descriptions were divided into three parts, one based on the characters of the coenosteum, a second based on the vertical thin section, and a third based on a tangential thin section. All measurements of the thin sections were done by means of a camera lucida, which is reasonably accurate, but only to hundredths of a millimeter.

The slides were scrutinized for the most characteristic area which was marked off with India ink and photographed. Consideration was given to the photogenic qualities of each portion of the slide. When the specimens were poorly preserved, several sets of slides were made in order to find the typical characters of the species. Details of the skeleton were not always sharply defined, making retouching desirable. The photographs were retouched with a photographic retouching medium to bring out structures that did not photograph well, but in so doing comparison was continually made with the exact place on the slide under the microscope in order to faithfully reproduce the structures. Areas such as gallery spaces which are infiltrated with foreign substances, were lightened, but not completely obliterated, either by scraping off some of the photographic emulsion with steel wool or a pen knife, or by applying Chinese white.

Throughout the preparation and presentation of the faunas, we strove to achieve accuracy of detail, and to present the information in a brief, concise form. We found that a thin section, carefully selected, and two cm. on a side, which can be magnified 10 to 30 diameters to show the character of the tissue as well as the pattern made by laminae and pillars, far excels a section several inches in diameter, which does not show microscopic characters but shows only the arrangement of laminae and pillars.

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GLOSSARY OF STRUCTURAL TERMS APPLYING TO STROMATOPOROIDEA

Amalgamated. United without visible sutures; coalesced or fused. Used particularly for the condition of the union of the horizontal and vertical structures in the family Stromatoporidae. "Continuously reticulated skeleton" of Nicholson (1886b, p. 34, 74).

Astogeny. Development of a colony from its beginning to the adult condition.

Astrorhizae. A group of radiating, branching grooves, generally centering at a mamelon and superposed in the axis of a mamelon, but not usually superposed when there are no mamelons. In vertical sections appearing as large, round, horizontal pores, or as vertical or oblique, tabulate tubes. (Named by Carter, H. J., 1880b, Ann. Mag. Nat. Hist., ser. 5, vol. 6, p. 341.) Commonly present in examples of the family Stromatoporidae, may occur in Actinostromatidae, Clathrodictyidae, and Labechiidae, not typically developed in the Idiostromatidae. Astrorhizae occur in many genera of the Hydrozoa other than the Stromatoporoidea.

Astrorhizal cylinders. Superposed mamelons and astrorhizae, in which the laminae turn upward into the mamelons, giving the superficial appearance of a cylinder. Also called columns and astrorhizal systems. *Stromatopora divergens, Anostylostroma columnare.*

Axial column. The tubular axis with arched tabulae, as in *Aulacera.*

Caespitose or *cespitose.* Bushy, fasciculate. *Idiostroma.*

Caunopore tubes. Conspicuous, vertical tubes, 0.5 to 1.5 mm. in diameter, having their own walls, generally with cystose or infundibular tabulae, and connected at their lower ends by stolons. They are most probably parasitic or commensal organisms, now generally agreed to be the coral *Syringopora*. *Caunopora* Phillips and *Diapora* Bargatzky are composite masses of stromatoporoids and tubular organisms and are not considered to be valid genera by systematists. Specimens with such tubes are often referred to as being in the "caunopore state." Caunopore tubes are common in *Stromatopora, Stromatoporella, Anostylostroma, Stictostroma, Gerronostroma and Actinostroma,* but are rare or absent in other genera of stromatoporoids.

Chamber. An enclosed space, as the space in a cyst, as of the Labechiidae. Chamber is not a suitable term for the continuous interlaminar spaces traversed by pillars (used by Lecompte, 1951); galleries seems to be a more appropriate term for interlaminar spaces.

Coenosteum. The entire head or colony or skeleton of a milleporoid or a stromatoporoid. (Proposed by Moseley, 1881, p. 12, for the skeleton of the Hydrocorallina, and adopted by Nicholson, 1886c, p. 73, for the skeleton of the Stromatoporoidea.) (*Coeno,* common, *osteo,* bone or skeleton.)

Columns. Vertical structures much larger than ordinary pillars, 1 to 10 mm. in diameter, making mamelons at the surface, composed primarily of upturned laminae, frequently with astrorhizae. *Anostylostroma columnare, Parallelopora nodulata.* Also the cystose axial column of *Aulacera* and *Cryptophragmus.*

Compact. Homogeneous, not alveolar or porous or maculate, nor dense like a mineral crystal or glass, but made of crystals of calcite closely appressed, as in the Clathrodictyidae, Actinostromatidae, and Labechiidae. A better term than "dense."

Cystose vesicles. Cysts formed by outwardly convex plates. Labechiidae.

Cyst plates. Curved or lenticular plates composing the skeleton of the Labechiidae. Also the less regular, occasional curved plates crossing galleries, generally more or less horizontally or diagonally. Also commonly called interlaminar septa and dissepiments. Common in *Actinodictyon, Anostylostroma, Stromatoporella,* and in many other genera where there has been resumption in growth, as at the base of latilaminae and repair of injury. The generic and specific value of cyst plates must be appraised. There is no indication that cyst plates are threads, fibers or trabeculae.

Cysts. Vesicles formed by outwardly convex plates. Labechiidae, *Actinodictyon, Clathrodictyon.*

Dendritic. Repeatedly branching, as a tree. Idiostromatidae. Also the branching canals of astrorhizae.

Dense tissue. Apparently solid, compact and homogeneous, excepting for small, granulose calcite crystals. Not dense like glass, but finely crystalline. Not porous and maculate, as in the Stromatoporidae, nor with transverse pores, as in *Stromatoporella. Actinostroma* has typically "dense" tissue. *Trupetostroma* has dense tissue with small, ovoid vacuoles. Compact is the better term.

Denticles. Short spines on the upper cyst plates. *Rosenella.*

Dissepiments. Thin, upward or obliquely curved plates, composing the coenostea of the Labechiidae and occurring in galleries of many genera. Also called interlaminar septa, curved plates or tabulae, cyst plates, partitions. *Labechia, Actinodictyon, Anostylostroma.*

Epitheca. A thin, wrinkled, basal layer, of finer and different structure than the superjacent, normal structures. Occurs at the base of many coenostea. More properly called peritheca; also called holotheca. Of no taxonomic importance.

"Fiber" or "fibre". Microscopic structure or histology of the skeletal tissue. A misnomer, for the term does not refer to thin strands or threads. Also "skeletal fiber"; or, "ultimate fibre" (Parks, 1936, p. 8). Tissue is a better term.

Fibers. Fine, short strands transverse to the laminae. *Anostylostroma Clathrocoilona.*

Fibrous. Composed of short strands transverse to the laminae. *Anostylostroma, Amphipora.*

Flocculent. In loose groups, or not compact, as in the secondary layers of the cyst plates of the Labechiidae.

Foramen, Foramina. A large or principal opening between two chambers, cells or superposed galleries.

Fused. Same as amalgamated.

Galleries. Interlaminar spaces, traversed by pillars, not by vertical walls, in life occupied by part of the soft body of the animal or abandoned after a new lamina was laid down. Sometimes less aptly called chambers and cells. Superposed galleries, especially where the laminae between are missing, possibly resorbed, were referred to by Nicholson and others as "zooidal tubes."

Granules. Small elevations at the surface; a fraction of a mm. in diameter; usually the ends of pillars, or pillars not covered by a lamina, which then become papillae. Granules in the laminae and pillars are extremely minute grains of calcite. Surface of *Stromatoporella granulata,* and many genera which have pillars, especially long pillars, as the Actinostromatidae.

Horizontal section. A section parallel to the laminae or latilaminae, when the laminae curve little, as in lenticular specimens. When the laminae curve much, the section is tangential. Usually referred to as the "tangential section."

Hydractinoid. Having pillars distinct from the laminae or horizontal processes, much as in the hydroid genus *Hydractinia,* and the tissue of neither the pillars nor laminae is maculate and porous, nor vesicular. Used by Nicholson, and sometimes by others, to refer to all genera excepting those in the families Stromatoporidae and Idiostromatidae. (Nicholson, Mono., 1886, p. 40, 41, 74.)

Infiltrated. Filled in solid by calcite from solution, after burial, preserving the hard parts nearly perfectly. The usual method of fossilization of colonial organisms, such as stromatoporoids, corals, and bryozoans. A better term than permineralized.

Interlaminar septa. Thin, outwardly or upwardly curved or oblique plates or tabulae in the galleries. Also called dissepiments, cyst plates, and partitions. *Anostylostroma, Stromatoporella, Actinodictyon.*

Interlaminar spaces. The galleries, cavities, spaces or chambers between the laminae. The spaces are more aptly designated as galleries. The spaces are high in genera with thin walls, as *Actinostroma* and *Anostylostroma;* the spaces are narrow or more or less completely filled with porous and maculate tissue in the Stromatoporidae. Interlaminar spaces are partly filled by pillars, partly by secondary tissue, partly by dissepiments.

Knobs. Large subconical or subhemispherical surface prominences, irregular in size 10 to 50 mm. in diameter and height.

Lamina, -ae. The thin, parallel or concentric layers making up most of the coenostea. They are the fundamental structures of most stromatoporoids, modified from cyst plates of the Labechiidae. The primary or original laminae are thin. In most genera, the laminae have been thickened by secondary layers deposited above and below the primary laminae. The primary laminae are inconspicuous in the Stromatoporidae and Idiostromatidae, but are usually detectable.

Laminar. In layers, whether thin or thick, as seen with the unaided eye or with a low-power hand lens, and in most slightly weathered stromatoporoids. Some coenostea are thin and broad, *i. e.,* laminar, as *Stromatoporella granulata.*

Latilamina, -ae. Thick layers, 1 to 20 mm. in thickness, in turn composed of many laminae or cysts; seen in most weathered specimens of stromatoporoids. They may or may not be in specimens of the same species; they seem to be due to pauses in growth, reproductive or perhaps seasonal pauses, and are without taxonomic significance. The curved latilaminae make the stromatoporoid distinguishable in the field from mere pieces of rock, but do not distinguish stromatoporoids from stromatolites. (Proposed by Nicholson, 1886, p. 40.)

Lumen, lumina. Vertical, round, lighter or darker colored centers of pillars. They were probably originally not open tubes, but the primary pillars around which the secondary material, of different color, was laid down. The luminalike portions of the pillars were considered by authors to be characteristic of *Hermatostroma* and *Labechia,* and occur in some species of *Trupetostroma, Actinostroma,* and *Atelodictyon.* The lumina of the hollow pillars of *Stromatoporella* are due to upturns of the laminae and were, therefore, originally hollow.

Maculate. Having dark or light spots or dots in a gray groundmass. The dots are 0.01 to 0.06 mm. in diameter, typically with clear centers and occur in the laminae, pillars and secondary tissue, typically seen in *Stromatopora, Syringostroma,* and *Parallelo-*

pora. The maculate structure is characteristic of the family Stromatoporidae, contrasting with the compact, fibrous, and homogeneous tissue structure of the other four families. "Minutely porous or tubulated," (Nicholson, 1886, p. 74); "minutely porous" (Parks, 1907, p. 29); "finely reticulate or spongy" (Parks, 1936, p. 99); "feinporöus oder von feinen Kanälen" (Kühn, 1939, p. A44); "microstructure poreuse ou vesiculaire" (Le Maître, 1949, p. 517); "microstructure est du type réticulé" (Le Maître, 1949, p. 523); "Fibre squelettique alvéolaire," (Lecompte, 1951, p. 195); "Fibre poreuse ou réticulée," "Fibre squelettique cellulaire "(Lecompte, 1952, p. 263). The appearance of the microstructure depends somewhat upon the character of fossilization. Care and experience help in distinguishing maculate from porous and compact tissue.

Mamelons. Round, regular or irregular elevations on the surface, as in *Labechia huronensis* (Billings) and *Parallelopora nodulata* (Nicholson). They vary from 2 to 15 mm. in diameter and 1 to 8 mm. high. They may be solid or occupied by a tube, frequently have astrorhizae at the summits and throughout the columns which make the mamelons. Surface elevations in order of size: granules, papillae, ring-pillars, tubercles, monticules, mamillae, mamelons, knobs or nodes, and undulations.

Mamillae. Small mamelons, 1 to 2 mm. in diameter, some with a nipplelike point. *Lophiostroma magnum* (Parks).

Mamillate. Having small mamelons or mamillae, generally less than 2 mm. in diameter.

Marginal vacuoles. Light-colored areas around pillars and on both sides of the laminae, as in typical species of *Hermatostroma.*

Microlamina, -ae. Thin laminae, which may be thickened on one or both sides, as in *Stromatopora, Trupetostroma,* and *Stictostroma.* Also used to distinguish laminae from latilaminae.

Milleporoid. Having the laminae and pillars completely amalgamated and hardly recognizable as distinct structures, much as in the hydroid genus *Millepora;* the tissue is mostly secondary and maculate. Used by Nicholson and others for the families Stromatoporidae and Idiostromatidae. (Nicholson, Mono. 1886, p. 40, 74.)

Monticules. Small mamelons, 1 to 2 mm. in diameter.

Nodes. Large knobs on the surface, generally irregular in size and height.

Nodules. Irregular mamelons.

Ontogeny. The development of a single individual, not that of a colony.

Papillae. Small knobs at the surface, generally less than 1 mm. in diameter, the upper ends of pillars. *Actinostroma, Labechia.*

Peritheca. The basal layer of many coenostea; less aptly called epitheca and holotheca.

Pillars. Small, vertical structures between laminae (short), or passing through many laminae, (long, continuous). Pillars are substantially solid or compact, as in *Anostylostroma* and *Actinostroma,* maculate and porous, as in *Stromatopora,* maculate porous and with parallel tubules, as in *Parallelopora,* or short and hollow, made of upturned laminae, as in *Stromatoporella.* Pillars are smaller than columns. They may be round, irregular, branched, and they frequently divide and expand in the laminae, making vermicular, areolate and odd patterns, as seen in tangential sections. Pillars are mostly built on the primary lamellae and are frequently superposed, as in *Trupetostroma* and *Gerronostroma,* apparently go through the laminae, as in *Hermatostroma* and *Actinostroma,* and some clearly pierce the cyst plates, as in the Labechiidae. Pillars are mostly primary structures, as in the Labechiidae and Actinostromatidae; some are secondary, as the short pillars of *Stromatopora* and *Syringostroma.* Also called radial pillars (Nicholson and Murie, 1878, p. 196), applicable to globular specimens.

Pits. Small round depressions at the surface.

Pores. Small, transverse tubes through the laminae, as in *Stromatoporella* and *Stictostroma.* Not well used for zooidal tubes or horizontal cavities or pits. Pores occur in ring-pillars at the surface, and at the summits of monticules, as in *Stromatoporella granulata.*

Porous. Having minute pores through the tissue. *Stictostroma, Stromatoporella.*

Primary plate. The thin, compact, homogeneous, median layer of the cyst plates, especially of the Labechiidae.

Primary tissue. The material of the laminae, dissepiments, and laminae as first constructed, and on which thickening or secondary tissue may be added. *Clathrodictyon vesiculosum, Trupetostroma warreni.*

Protocoenosteum. The earliest astogenetic stage of stromatoporoids.

Pseudopillars. Vertical, thin bands of darker flocculent material in the flocculent, lower layer of the cyst plates in the Labechiidae.

Pseudozooidal tubes. Vertical tubes or superposed and restricted galleries, irregular in cross section, incidentally round, generally crossed by thin tabulae, the remnants of laminae; characteristic of the Stromatoporidae and Idiostromatidae. They have been called "zooidal tubes", but there is little or no evidence that they were occupied by zooids.

Radial processes. Arms in whorls extending from pillars, *Actinostroma.*

Ramose. Referring to round, erect and branching coenostea. *Idiostroma, Amphipora.*

Reticulate. Like a net, referring to the network of laminae and pillars. "Continuously reticulated" of Nicholson (1886, p. 34, 74) refers to the network of laminae and pillars which are united so that the laminae and pillars are not discernible, but amalgamated, in the Stromatoporidae. Reticulate is not synonymous with maculate and porous structure of the finer tissue, although some authors so used the word.

Ribs. Longitudinal ridges, as in *Aulacera undulata.*

Ring-pillars. Short, hollow, thick-walled pillars, made by sharp upturns of the laminae; "hollow inflected points" of Parks, (1936, p. 94); characteristic of *Stromatoporella.* Rings made by mere upward inflections of laminae, or by splitting of pillars or by tubes in mamelons or by spherical cysts, are not ring-pillars.

Rods. Thin, dark, vertical, parallel rods in the pillars of *Parallelopora.*

Sarcodeme. Obsolete term for coenosteum. (Nicholson, Ann. Mag. Nat. Hist., 1874, p. 5.)

Secondary tissue. Tissue laid on the primary plates or laminae and pillars, in many genera and constituting the bulk of the tissue in some genera, as *Stromatopora* and *Syringostroma.*

Skeleton. All the hard parts of a stromatoporoid, usually implying the totality of internal structures, rather than the external appearance of the coenosteum.

Spines. Short, conical pillars, as in *Rosenella.* Denticles.

Spongy. Filled with irregular, minute vesicles or pores, as the finer skeletal tissue of the family Stromatoporidae. Sometimes used for larger structures, as the columns of some species of *Anostylostroma,* which are filled with irregular pillars and vacuities. The term has no implication of relationship with sponges nor of having spicules. A term to be avoided.

Tabulae. Thin, flat, or curved structures in vertical tubes or between superposed galleries, either distinct structures or the remnants of laminae. *Stromatopora, Parallelopora, Stromatoporella.*

Tangential. Refers to a section as nearly parallel with the laminae as possible, especially as applying to small, globular or ramose forms, and in descriptions called the "tangential section."

Tissue. The microscopic structure or histology of the laminae, the pillars, the cysts, or other finer structures. Sometimes called "ultimate fibre" (Parks, 1936, p. 8) but not actually the finest calcite granules which compose the skeleton. The word "fibre" is not appropriate, since the substance is not composed of threadlike bodies.

Trabeculae. Rods, frequently anastomosing, as in *Millepora, Hydractinia,* the family Disjectoporidae, and the order Sphaeractinoidea. Trabeculae do not make up the skeleton of the Stromatoporoidea.

Tubercles. Small, unequal prominences at the surface. *Stromatoporella granulata* and *S. elevata.*

Tubes. Round, elongate openings, as in the axis of the Idiostromatidae, and in the axes of some mamelon columns. The "axial tube" of *Aulacera* and *Cryptophragmus* is better called an axial column.

Tubulate. Having small tubes or pores (not referring to pseudozooidal or caunopore tubes) in the laminae, as of *Stromatoporella* and *Stachyodes.* There are small tubules in the pillars of *Parallelopora.*

Tubules. Minute parallel tubes, as in the pillars of *Parallelopora,* and through the laminae of *Stictostroma* and *Stromatoporella.*

Vacuole. A small cavity or space in the tissue of an organism, as in *Trupetostroma.* A vacuity.

Vertical tubes. Remnants of superposed galleries, pseudozooidal tubes, formerly called "zooidal tubes."

Vesicle. Small vacuities, as in the tissue of *Trupetostroma;* also the cavities made by cysts.

Vesicular. Full of irregular vacuities, or spongy in appearance, as the skeleton of *Dermatostroma* and *Hydractinia.*

Villi. Small, finger-like projections from the upper layer of the wall, as in *Cryptophragmus,* and in the most primitive genus known.

Walls. The substance surrounding the zooidal or other tubes or vesicles. Rarely used because the structures are not in general tubular, nor are they chambers, excepting in the Labechiidae. Caunopore tubes have walls.

"Zooidal tubes". Vertical tubes, small and generally irregular and not round in cross section, usually tabulate, characteristic of forms with maculate tissue, as *Stromatopora, Syringostroma,* and *Parallelopora.* They are restricted galleries which are superposed. Better called vertical tubes or pseudozooidal tubes. Superposed galleries, without the thin laminae between, and not making tubes, are common in forms with thick laminae, as *Actinostroma* and *Trupetostroma;* they are rare in forms with thin laminae, as *Clathrodictyon* and *Anostylostroma,* and are absent in the Labechiidae. Parks did not recognize the existence of zooidal tubes but considered them to be superposed interlaminar spaces or chamber cavities (galleries), and the tabulae as remnants of laminae (Parks, 1936, p. 10).

Yavorsky (1931, p. 1405-1412) mistakenly used "zooidal tubes" for simple galleries.

FOSSILIZATION OF DEVONIAN STROMATOPOROIDEA

The skeletons of stromatoporoids were constructed originally of calcium carbonate, apparently in the form of calcite, rather than that of aragonite. There is little indication of change in the form of crystallization since the skeletons were made. We agree with Nicholson (1886, p. 30) that there is no possibility of the skeleton having been originally siliceous and replaced by calcite.

Stromatoporoids from solid or shaly limestone, obtained from quarries, road cuts, and stream gorges, or other fresh exposures, are well preserved. They have been preserved by infiltration of calcium carbonate from solution in water, and the original structures of the laminae, pillars, and dissepiments usually are preserved in their original condition. Even finer structures are well preserved, such as the dark spots in the laminae and pillars of forms in which the tissue is maculate or has pores through the laminae, the lighter centers of pillars, and even the exceedingly fine fibrous strands of which pillars may be constructed. The tissue of both laminae and pillars in specimens from porous limestone shows more or less recrystallization. The preservation of stromatoporoids is the equal of that of other colonial organisms studied by means of thin sections: Bryozoa, tabulate corals, the fusulinids, and calcareous algae. Stromatoporoids, which are suitable for study by means of thin sections, should be collected from rocks which have been little disturbed and little weathered.

Specimens of stromatoporoids from the Middle Devonian limestone at Charlestown, the Falls of the Ohio, and near Logansport, Indiana, are so well preserved there is little to be desired. Specimens from the Middle Devonian limestones of Ohio, Ontario, New York, northern Michigan, Illinois, and Missouri are preserved perfectly by infiltration of calcite, as are specimens from the Upper Devonian limestones of Iowa. Specimens from a locality have their own particular color and hardness, different from the appearance of specimens from other localities.

Many of the poorly preserved stromatoporoids and all of the well-preserved ones have minute flecks of opaque material in the wall tissue. The flecks are much smaller than maculae, many are slightly elongate and angular to subangular. The flecks are so universally present and delimit both the larger and finer details of the laminae, pillars, and dissepiments that the material may be a residue of organic carbon, though it could be some other opaque substance, such as iron oxide. The flecks are always confined to the tissue.

Specimens of stromatoporoids which occur at or near the surface of limestones are weathered considerably, the original calcareous structures usually are modified by leaching and by recrystallization, so that latilaminae, laminae, and pillars may be destroyed. All finer structures are destroyed in the recrystallization of the calcite which made up the skeleton.

Usually specimens were infiltrated before any considerable pressure of overlying rocks developed on them. In some cases the original frail skeleton has been crushed before infiltration, producing a false condition of close laminae and irregular pillars. We have noted such crushed specimens of *Anostylostroma columnare* (Parks) from Marblehead, Ohio, and specimens of *Stromatoporella parasolitaria* from southern Indiana. It seems probable that *Anostylostroma townsendi* (Parks) (1936, pl. 4, fig. 1-3) is a crushed specimen of *A. insulare* (Parks). *A. ohioense* (Parks) is the same species, only slightly crushed; the three species are from the same horizon and locality, Kelleys Island, Ohio.

Stromatoporoids which occur in dolomitic limestone, such as the Silurian of northern Indiana and the Middle Devonian at Petoskey, Michigan, exhibit latilaminae, but most of the finer structure has been destroyed in the dolomitization. Such specimens are unsatisfactory for study, because the histological structures are largely or totally destroyed. Dolomitized specimens usually exhibit a secondary porosity of the tissue. Specimens of *Syringostroma* from the Little Rock Creek limestone at the France Lime and Stone Company quarry near Logansport, Indiana, have been dolomitized partially, though not sufficiently to destroy most of the larger structures; the minute structures, such as maculae, are difficult to distinguish.

Specimens found at the surface of the limestone frequently are in part or wholly silicified, in which case the structures finer than latilaminae are largely or totally destroyed. It is not widely understood that calcareous fossils are silicified during the last stages of weathering and destruction of the limestone containing them. When a specimen is partly weathered, the outside may be silicified all the way around and the inside of the specimen still be more or less in its original condition, as for example, some of the specimens from the Jeffersonville limestone at the Jefferson County quarry near Louisville, Kentucky, and the quarry at Charlestown, Indiana. Incipient silicification is often encountered, in which case, in addition to the siliceous surface, the interior is spotted with small spheres of silica of various size and abundance, depending on the degree of silicification. Both the silicified periphery and the incipient bodies of silica are in the form of amorphous chalcedony, never in the form of crystalline quartz, except in cases of over-silicification. Over-silicification, if carried far enough, should lead to geodization, though we have not seen a geodized stromatoporoid. Specimens of *Aulacera* from the Ordovician at Stoney Mountain, Manitoba, loaned to us by Dr. Alice Wilson, from the Canadian Geological Survey collections, approach a geodized condition. We have specimens of *Labechia huronensis* from the Ordovician Whitewater formation in Indiana, with cavities which have been dissolved and lined with drusy calcite and dolomite, but not geodized. Although the above examples are drawn from Ordovician specimens, similar examples would be expected in weathered and highly silicified Devonian specimens.

Stromatoporoids are mostly so large and massive that when silicification takes place the skeleton is replaced, though the infiltrated calcite in the galleries may either be replaced or dissolved. In the buhrstone, or silicified bed of the basal Jeffersonville limestone, the calcareous matrix and galleries are replaced by silica, the coenostea have been dissolved, and only the molds of *Amphipora* and other fossils remain.

In a few cases, the laminae and pillars are not destroyed by silicification, for example a specimen of *Stromatoporella morelandensis* from Kentucky, *Stromatoporella eriensis* from a quarry near

East Liberty, Ohio, and *Stromatoporella selwyni* from Hanover, Indiana. In such specimens only the outlines of the laminae and pillars are preserved. The finer details of the wall tissue have been destroyed. In the walls of the specimens of *S. morelandensis* and *S. selwyni* there are disassociated clusters of opaque material suggestive of the tissue arrangements in those species of *Stromatoporella* with anastomosing tubules. In such cases the tissue has been greatly altered, and one should be cautious in placing any systematic significance on such highly altered structures.

The general impression that the structures of the skeletons of stromatoporoids are obscure and difficult to decipher comes from studying specimens which were picked up from the soil or the exposed surface and are badly weathered, dolomitized or silicified. Both Nicholson (1886, p. 31, pl. 2, figs. 1-5) and Parks (1910, p. 8) have noted that many specimens are so poorly preserved that the internal structures cannot be made out satisfactorily. It is notable that specimens obtained from glacial drift at Ann Arbor, Michigan, (Parks, 1910, p. 10) are well preserved. Even Devonian pebbles in Triassic conglomerate (Nicholson, 1892, p. 219, pl. 28, figs. 4-6) may contain well-preserved stromatoporoids, and specimens in cores from oil wells are as well preserved as are corals, bryozoans, or other fossils.

Specimens may have been replaced or "injected" by iron oxide, as some of those mentioned by Nicholson (1892, p. 217, pl. 3, figs. 1, 2). The skeletal structures of infiltrated and perfectly preserved specimens have a gray appearance in thin section, whereas the infiltrated calcite in the galleries and pores is nearly transparent. The reverse condition mentioned by Nicholson (1886, p. 32, pl. 2, figs. 3-5), in which specimens are preserved in black limestone, such as the Black River limestone of New York, have dark material in the galleries. The dark appearance is due to carbonaceous material or hydrocarbons in the limestone. The material may have the appearance of clay or carbonaceous clay, but since clay is not soluble in water it could get in only through fractures, not by infiltration. In such cases, the usual appearance is reversed, the galleries are dark and the laminae and pillars are light. Under similar circumstances, one would expect the same type of preservation to be found in younger specimens, but as yet such preservation has not been observed in Devonian stromatoporoids.

In orogenic areas, such as the Appalachians, or Ardennes of Belgium, and the Kitakami Mountainland of Honshu, Japan, specimens have been infiltrated by calcium carbonate and later broken in the folding of the rocks, so that the specimens have veins filled with calcite, but on the whole the structure of the fossil can be made out satisfactorily.

An unusual condition of preservation was brought to our attention by Dr. Madeleine A. Fritz, exhibited in a specimen of *Syringostroma* she collected near a dike, from the Middle Devonian, Upper Abitibi River limestone, at Coral Rapids, Ontario. Part of the specimen was not altered but was preserved by infiltration. The remainder of the specimen had been heated by pneumatolitic action from the intrusive which resulted in a darkening of the skeletal structures. Even the finer structures such as maculae, and the infiltrated calcite remained clear. The skeletal tissue is, therefore, sharply contrasted with the matrix, enhancing the detail of the skeletal structures.

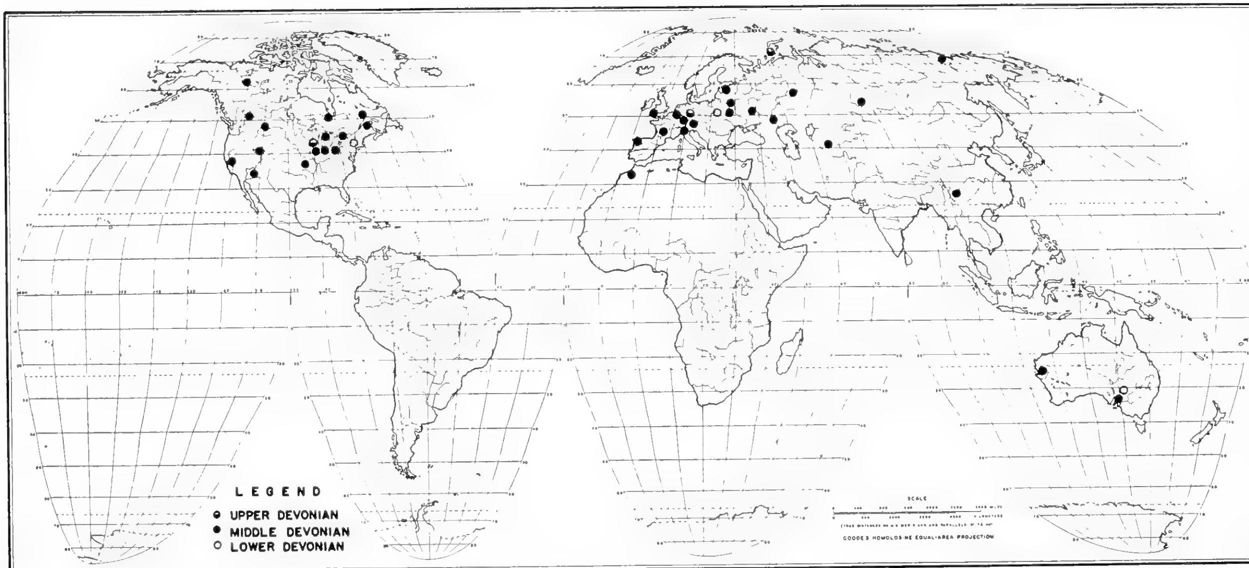
Stromatoporoids from the Falls of the Ohio are solidly infiltrated and have a brown appearance, so that the structures are difficult to see even with a hand lens. In thin section the structures are well preserved. None of the surfaces of the specimens are preserved; the exposed edges are stream polished. Few of the specimens show signs of silicification. On the other hand, the specimens from the Jefferson County quarry, Kentucky, and the road cut on Highway 42, near Prospect, not far from Louisville, Kentucky, as well as at the quarry at Charlestown, Indiana, are silicified on the periphery and part way to the center. They are rarely destroyed completely but are commonly stained reddish brown by iron oxide. The specimens from the Meshberger Stone Company quarry, near Columbus, Indiana, are chalky white in color, incompletely infiltrated, partly leached, and are unusual because some of them are partially silicified, but lack the iron oxide stain which commonly accompanies silicification. Most of the Ohio specimens from the Columbus limestone are excellently preserved, although some of the species with delicate skeletal structure have not been completely infiltrated, resulting in crushing and distortion of the skeleton after burial. Well-preserved specimens from the Logansport limestone at the France Stone Company quarry have a bluish hue due to traces of ferrous iron. At Pipe Creek Falls, where the specimens are obtained from surface exposures of the same formation, the material has a brownish hue on the surface due to the oxidation of the iron. Specimens from the Little Rock Creek limestone are a brownish buff color and have a granular texture as if they were partially dolomitized, though alteration has not been carried far enough to destroy the structures of the skeleton. Many of the specimens have so much iron oxide that it occurs in nodules. Specimens from the same horizon at Bunker Hill, on the other hand, are gray in appearance, apparently lacking the traces of iron oxide stain characteristic at other localities.

In the past it was possible to collect stromatoporoids only from scattered exposures or from stream valleys, as south of Richmond, Indiana, or from sea cliffs as on Anticosti Island. At present it is possible to collect fresh specimens from the hundreds of quarries, railroad cuts and road cuts made accessible by good roads and automobiles. There is, therefore, little excuse for describing new species from silicified or otherwise badly preserved specimens.

GEOGRAPHIC DISTRIBUTION OF DEVONIAN STROMATOPOROIDEA

The geographic distribution of the stromatoporoids, particularly during the Middle Devonian, is of interest. In the Lower Devonian, the stromatoporoids were restricted, reached their maximum distribution and development in the Middle Devonian, decreased in distribution and died out in the Upper Devonian, in North America and apparently everywhere else.

On the Pacific Coast of North America, the only reported Devonian stromatoporoids (Stauffer, 1930) are from the Middle Devonian of northern California. In the Cordillera, only three species have been described, but they have been reported from Arizona to near Fort Norman in the Northwest Territories. The stromatoporoids are widespread in the Mid-Continent region; they are found



DEVONIAN STROMATOPOROID LOCALITIES

Figure 1. Map showing Devonian stromatoporoid localities.

in the Upper Devonian of Iowa, in the Middle Devonian of Missouri, Illinois, southern Indiana, and Kentucky, northcentral Indiana, Michigan, Ohio, Ontario, and Quebec. In New York, the stromatoporoids occur in both the Lower and lower Middle Devonian, and they are found in the Lower Devonian of Maryland, New Jersey, Pennsylvania, and New York, and the Middle Devonian of New Brunswick.

In Europe, the stromatoporoids are equally important and better known because more work has been done on them. They are known from several places in England, especially from the type locality of the Devonian, in Devon (Devonshire). They range throughout most of the Middle Devonian of France, Belgium, Germany, and Austria, and are found in the Upper Devonian, Etroeungt in the north of France, and in the adjacent area in Belgium, as well as near Aachen, Germany. The stromatoporoids are well known from the Middle Devonian, Eifel region of Germany, where they are of particular importance because it was here that Goldfuss (1826) obtained and described *Stromatopora concentrica*, the type species of *Stromatopora*. Stromatoporoids have been described from Galicia in Spain, from the Carnic Alps in Italy and Germany, and from the Middle Devonian of Morocco in northern Africa. They have also been described from the Lower and Middle Devonian in Czechoslovakia, especially in the Middle Devonian of Moravia.

In Russia, the stromatoporoids are abundant. They have been described from the Middle Devonian of the main Devonian Field, near Leningrad, from several localities in the Urals, from the Ukraine, from the Kuznetsk Basin northwest of Mongolia, from Siberia, from Yunnan, China, and questionably from the Upper Devonian on the Arctic islands of Novaya Zemlya. Stromatoporoids are also found in the Middle Devonian of Australia from the west coast, in the State of Western Australia and in the Lower and Middle Devonian from the southeast, in the State of Victoria.

It is of interest to compare the above distribution map with that given by Teichert, (1943, p. 172) for the distribution of the Devonian goniatites. The distribution is almost the same. Teichert pointed out that the goniatites were restricted to back-reef facies.

The stromatoporoids mostly are in the reef facies proper.

It seems odd that no stromatoporoids have been described from the Devonian of South America. We suspect that because these areas are remote, the apparent lack of occurrence is due more to the lack of paleontological investigation than to actual distribution.

STRATIGRAPHIC DISTRIBUTION

The first known stromatoporoids are from the Middle Ordovician, of North America, from the middle Chazy in the Lake Champlain region of Vermont and New York. We are not convinced that Yavorsky's specimens from Russia (1932, p. 613) are from the Cambrian. The stromatoporoids are widespread in the Middle Ordovician and are common in the Black River and Trenton of Tennessee, New York, Vermont, and Kentucky, and are known from the Middle Ordovician of China, Manchuria, and Korea. In the Upper Ordovician, the stromatoporoids are distributed even more widely, occurring in Indiana, Ohio, Kentucky, Tennessee, the Appalachian Mountains, Ontario, Quebec, on Anticosti Island, to the north on the Ungava Peninsula, and on Akpatok and Baffin Islands, from Stoney Mountain in Manitoba, the southern Rocky Mountains, and Alaska. They also occur in the Upper Ordovician of Russia, China, Japan, and Korea.

In the Lower Silurian, the stromatoporoids suffered a great decline, being known only from Anticosti Island, and are found rarely in the Brassfield limestone of Indiana and Ohio. By Middle Silurian time, the stromatoporoids again flourished, being abundant in Niagaran reefs. In the Middle Silurian, they are again worldwide in distribution, being known from midwestern North America to as far east as New York. The stromatoporoids make their first appearance in Europe in the Middle Silurian of Gotland and Estonia, and also are known in Australia, and Japan. At the end of the Silurian, the stromatoporoids suffered another sharp decline so that in North America they are known only from the Upper Silurian, Keyser group of Maryland, New Jersey, and New York.

In the Lower Devonian, Helderbergian, the stromatoporoids are restricted essentially to the same area in North America as they were in the Upper Silurian. They are found also in the Lower Devonian of Czechoslovakia and Australia. By lower Middle Devonian, Onondaga time, the stromatoporoids were again flourishing and world-wide in extent. They reached their maximum geographic range in the Middle Devonian being known on all continents except South America. They occur in great profusion in the marine Devonian. It is significant that almost no stromatoporoids are known from the Middle Devonian south of the Louisville area in Kentucky, only one specimen being known from central Kentucky. The stromatoporoids decline rapidly in the Upper Devonian, occurring only in Iowa, the Etroeungt formation of France, Germany, and Belgium, and questionably from the Novaya Zemlya Islands in the Russian Arctic. The stromatoporoids became extinct after the end of the Upper Devonian, mostly by extermination, although *Actinostroma* may have evolved into the Sphaeractinoidea of the Upper Paleozoic.

The following chart shows the stratigraphic and geographic distribution of the stromatoporoids and their occurrence in either bioherms or biostromes.

POST-DEVONIAN STROMATOPOROIDS

As far as we can determine, no genuine member of the Stromatoporoidea occurs above the Upper Devonian. The extinction of the stromatoporoids at the end of the Devonian is unusual, because they die out soon after reaching their climax. In the Middle Devonian the stromatoporoids reached their maximum abundance, their greatest geographic distribution, and became most diversified. Usually the higher fossil taxonomic categories taper off in abundance and number of genera, and show many indications of phylogerontism, the last forms tending to linger on for some time in the geologic column beyond the acme of development, but the stromatoporoids died off suddenly in the Upper Devonian. References to Upper Paleozoic and Mesozoic stromatoporoids are not to true stromatoporoids, but to the closely related Sphaeractinoidea, which have been described as stromatoporoids by many paleontologists. The stromatoporoids have continuous platelike laminae,

	BIOSTROMES	BIOHERMS
UPPER DEVONIAN	Iowa, France, Belgium, Novaya Zemlya	Iowa
MIDDLE DEVONIAN	Quebec, Ont., Mich., Ohio, Ind., Ill., Mo., Rocky Mts., Calif., England, France, Belgium, Germany, Carnic Alps of Italy, Poland, Czechoslovakia, Urals, S. Russia, Morocco, Australia	James Bay, Ont., N. Y., Mich., Ind., Rhineland, Austria, Carnic Alps, Belgium, Morocco, Australia
LOWER DEVONIAN	Czechoslovakia, New York, Maryland, New Jersey, Australia	Mich., W. Ont., Penn., N. Y., N. J., Md., W. Va.
UPPER SILURIAN	New York, Maryland, New Jersey	
MIDDLE SILURIAN	Quebec, Ont., N. Y., Mich., Ohio, Ind., Ky., Mo., Gotland, Estonia, Australia, Japan	Ohio, Ind., Wisc., Iowa, Gotland
LOWER SILURIAN	Anticosti Island, Indiana, Ohio	
UPPER ORDOVICIAN	Baffin Island, Quebec, Anticosti, Ont., Manitoba, Vt., N. Y., Penn., Va., Ala., Ind., Ohio, Ky., Tenn., N. Mex., Colo., Wyo., Nev., Alaska, Korea, Japan, China, Manchuria	
MIDDLE ORDOVICIAN	N. Y., Vt., Ky., Tenn., Ontario, China, Manchuria, Korea	Vermont, New York

STRATIGRAPHIC AND GEOGRAPHIC DISTRIBUTION OF THE STROMATOPOROIDEA AND BIOSTROMES AND BIOHERMS whereas the sphaeractinoids have horizontal elements composed of trabeculae.

A number of papers, especially in European literature, refer to Carboniferous stromatoporoids. Most of the references concern an alternating marine limestone and shale unit occurring in northern France and in the northern Eifel region near Aachen, Germany, which contains a large stromatoporoid fauna. The beds were described first by J. Gosselet in 1853, for the stratigraphic section exposed in the quarry, du Parcq, near Etroeungt, 6 km. south of Avesnes, France, and are called the Etroeungt formation. Gosselet recognized that the Etroeungt beds were transitional between the Devonian and Carboniferous. The horizon became famous because Gosselet used the transitional nature of the beds as demonstrative proof that the catastrophic doctrine of recreation, adhered to by some of the more famous geologists of that time, was not applicable. Gosselet showed that at Etroeungt there was no major break between the two geologic periods, that the lithology and paleontology are gradational.

After Gosselet's work there was considerable controversy as to the correct age of the Etroeungt formation. Some paleontologists and stratigraphers placed the Etroeungt in the Carboniferous; others placed it in the Devonian, refusing to admit that the beds were transitional. The best and most complete recent work on the Etroeungt is that done by R. Dehée, in 1929, in which he described and figured much of the fauna. Dehée found that the fauna could be divided into three units. The upper unit contains a fauna with only Carboniferous affinities, no species ranging from the Devonian. The lowest unit consists of a fauna with only Devonian affinities, no species ranging into the Carboniferous. The middle paleontologic unit is restricted to the Etroeungt horizon and is of a transitional nature. The fossils from the middle zone are of considerable significance because they give the Etroeungt horizon a paleontological character unique to the stratigraphic unit. They are restricted to this unit and are, therefore, good index fossils. Dehée thought the Etroeungt characteristic enough to consider it a separate unit but did not think it should be considered a stage, as it had become established in the European literature.

In 1933, Dr. Dorothée Le Maître described the stromatoporoids from the Etroeungt at the type locality and from other nearby localities. The stromatoporoids occur in the limestones of the middle and lower Etroeungt beds. Le Maître described the following species:

Actinostroma vastum Počta
Actinostroma squamosum Le Maître
Actinostroma lamellatum Le Maître
Actinostroma stellulatum Nicholson var.
Actinostroma fungiforme Le Maître
Actinostroma sp.
Actinostroma sp.
Clathrodictyon clarum Počta
Clathrodictyon tessellatum Le Maître
Clathrodictyon dehéei Le Maître
Stromatoporella eifeliensis Nicholson
Stromatoporella solitaria Nicholson
Stromatoporella sp.
Stromatopora rugosa Le Maître

Though our understanding of the genera differs considerably from Le Maître's, she implied that the fauna is Devonian and we agree, for all of the previously described species were from Middle Devonian rocks, and the genera had normal Devonian structure. Le Maître was handicapped, as she indicated, by not having any stromatoporoid fauna from comparable horizons with which to compare the Etroeungt specimens. The stromatoporoids should belong with that part of the Etroeungt fauna which has the Devonian affinities as understood by Dehée.

The age of the Etroeungt is of interest to us because the stromatoporoid fauna is a typical Devonian fauna and not Carboniferous, as it has been reported in some of the literature. The stromatoporoids are normal for the Devonian and not more highly evolved, as one would expect if they occurred higher in the column. The last known occurrence of the stromatoporoids from North America is in the Upper Devonian of Iowa which should be compared with the Etroeungt fauna.

Grabau (1922, A Textbook of Geology, D. C. Heath & Co., pt. 2, pp. 459, 460, 462, fig. 1366) considered the Etroeungtian to be basal Mississippian and indicated that it was the beginning of a marine transgression in the early Mississippian similar to that in North America. Moore (1952, Invertebrate Fossils, McGraw-Hill Book Co., Inc. p. 37) also placed the Etroeungtian in the Mississippian. The placing of the Etroeungtian entirely within the Mississippian may lead to errors when such horizons are compared with the North American strata.

There have been additional reports of Upper Devonian-basal Carboniferous stromatoporoid faunas from other localities. In 1932, Riabinin, (p. 1125) described eight species of Labechiidae from the western slopes of the Ural Mountains, and one species of *Clathrodictyon* from the Kirghiz Steppe, all supposedly from the Upper Devonian. Riabinin's generic identifications are essentially correct, though all of his species are typical Ordovician and Silurian species. In 1935 and 1938, I. I. Gorsky described the stromatoporoids and corals from the Novaya Zemlya Islands at the northern extremity of the Ural Mountains in the Arctic Sea. The fauna is puzzling, for it is made up mostly of Ordovician and Silurian genera. Gorsky considered it to be uppermost Devonian or basal Carboniferous, on the basis of a few similar species from the basal Carboniferous in the Urals. We suspect that the collections were made hurriedly and from many localities and horizons, without knowing for certain the correct stratigraphic units. Gorsky was at a disadvantage in not personally visiting the area.

In 1930, Yabe and Sugiyama (p. 59, pl. 22, figs. 5-12) described a new genus, *Pseudolabechia* from the type section of the Middle Silurian, Gotlandian, on the Island of Gotland, in the Baltic. The genus is characterized by imbricating cyst plates and clusters of divergent pillars arranged in columns. *Pseudolabechia* is generically identical with Gorsky's *Stylostroma,* a new genus from the supposed basal Carboniferous or Upper Devonian fauna from Novaya Zemlya. It is unusual that a primitive form belonging to the Ordovician and Silurian family Labechiidae should be found at the top of the Devonian or the base of the Carboniferous. Further, Gorsky's species of *Rosenella* and *Labechia* are typical

Ordovician forms. *Rosenella latevesiculosa* Gorsky is close to *Rosenella woyuensis* described from the Ordovician of Manchuria by Ozaki (1938, p. 215, pl. 30, fig. 2; pl. 31, figs. 1a-d), and other similar species from the Chazy and Black River of North America. It is unusual that only a few of Gorsky's stromatoporoids from Novaya Zemlya resemble Devonian stromatoporoids from anywhere else in the world, and it is also unusual that they, as well as Riabinin's species, are mostly members of the family Labechiidae and closely resemble species of Ordovician and Silurian stromatoporoids from other parts of the world. It must be admitted, however, that the coral faunas described by Gorsky do resemble Devonian and Carboniferous corals. We have sufficient confidence in the reliability of the stromatoporoids, as well as in other fossil groups, and in the world-wide persistence of characters of the stromatoporoids, to suspect that there is something wrong with the age determination of most of Gorsky's and Riabinin's species referred to above. We agree that Gorsky's *Actinostroma contortum*, *A. furcatopilosum*, and *Labechia compacta*, are Devonian stromatoporoids, though we would not agree with Gorsky's understanding of the genera. Gorsky considered the horizon to be equivalent to the Etroeungt of France, but none of the stromatoporoid species are similar to those described by Le Maître.

There have been stromatoporoids described from higher in the Carboniferous by various European workers. In all the instances we have encountered, the authors have mistaken the Carboniferous tabulate corals for stromatoporoids. The corals usually mistaken for stromatoporoids are the genera *Chaetetes* and *Michelinia*, for in vertical section they look a great deal like some members of the Labechiidae, especially if the tabulae are curved to simulate cyst plates, though these corals can usually be distinguished in tangential section by the corallites. Many paleontologists describing "Carboniferous stromatoporoids", have neglected the tangential section, or have de-emphasized it, and though in many cases the tangential section is of little value in distinguishing a species, it is of value in distinguishing a coral from a stromatoporoid. Superficially the tangential sections of stromatoporoids may be somewhat similar, in that the cysts of *Labechia* appear to connect the pillars in a curved polygonal pattern, but a corallite wall of a tabulate coral usually has straight sides, excepting for *Alveolites*.

We are not opposed to having stromatoporoids occur in the Carboniferous and will be interested if authentic specimens are found. The stromatoporoids must have evolved into the sphaeractinoids, and one would expect intermediate forms in the Carboniferous. Speculation would place such forms close in appearance to the genus *Actinostroma*. There is likely some relationship between the laminae of *Actinostroma* which are made up of radial processes and the irregular rodlike trabeculae of the Sphaeractinoidea. The complex Idiostromatidae which occur in the Middle and Upper Devonian probably died out in the Upper Devonian and did not give rise to any Carboniferous forms, though *Amphipora* has been reported from the Upper Carboniferous of the Urals and Timan (Stuckenberg, 1895) and from the Upper Carboniferous of Yunnan (Reed, 1927). The *Amphipora* from the Permian of Japan (Yabe and Sugiyama, 1933) is probably a sponge. The Carboniferous specimens should be carefully checked to see that they are true stromatoporoids.

SYSTEMATIC POSITION OF THE STROMATOPOROIDEA

The biologic relationships of the Stromatoporoidea have been discussed by many authors, and the forms have been placed in many different groups. A good summary of the facts and arguments offered by proponents of the various theories has recently been given by Lecompte (1951, p. 27). It is not intended in the present work to present an extensive discussion of the systematic position of the Stromatoporoidea, but a brief summary of ideas is in order.

There is considerable resemblance between the large, hemispherical, laminated masses of Paleozoic rocks, termed stromatolites (Cloud, 1942, p. 363), or calcareous algae, especially *Cryptozoon*, and the stromatoporoids. But the presence of definite laminae, pillars, galleries, cyst plates, or dissepiments, tabulae, mamelon, astrorhizae, and of fibrous, porous or dotted structures of the laminae, and the obviously more complex and more highly advanced structure of the stromatoporoids, is convincing evidence that the stromatoporoids are not algae and are not in the same kingdom. The stromatoporoids do not have cellular structures as do *Solenopora, Girvanella, Lithothamnium,* and other calcareous algae.

An attempt was made by Hickson (1934, p. 433) to show that the Stromatoporoidea are Foraminifera, by comparing the stromatoporoid structure with that of the Recent "*Gypsina*" *plana* (Carter). In the first place, "*G.*" *plana,* which is an incrustation on corals, is not a *Gypsina,* whose type species is a small, globular form, *Gypsina vesicularis* (Parker and Jones). "*G.*" *plana* is either a degenerate Foraminifera similar to *Acervulina* and *Carpentaria*, or more probably, is a hydroid similar to *Hydractinia.* "*G.*" *plana,* if it is a Foraminifera, is derived from the coarsely perforate Rotaliidae. One should scarcely expect degenerate, Recent organisms to have more than an accidental similarity with the large, but not degenerate, organisms from the Lower Paleozoic. Secondly, there is no similarity between "*G.*" *plana* and any stromatoporoid. A comparison of Hickson's own figures of "*G.*" *plana* with the best examples of stromatoporoids that Hickson could choose, shows their dissimilarity. Thirdly, there is no similarity between either "*G.*" *plana* or the stromatoporoids to the minute Foraminifera in arrangement of chambers or in wall structure, either the hyaline, porcellaneous or arenaceous groups. Fourthly, there are no intermediate or connecting forms between the Lower Paleozoic Stromatoporoidea and any Foraminifera of the Paleozoic, Mesozoic, or the Cenozoic. Fifthly, surely no one would try to show a relationship between the Stromatoporoidea of the Lower Paleozoic and the characteristic Foraminifera of the Upper Paleozoic, the Fusulinidae, nor with the Mesozoic and lower Cenozoic Nummulitidae and Orbitoididae. There is a similarity between *Pseudogypsina* Trauth, 1918, (Denkschr. k. Ak. Wiss. Wien, Math.—Naturw. Cl., vol. 95, p. 244) from the Eocene of Austria and *Stromatopora* which is probably only accidental; *Pseudogypsina* is most likely a hydroid, and related to *Hydractinia,* and would lend itself as a small item of proof that stromatoporoids are hydroids.

Parks (1935, p. 18) also made an unconvincing attempt to show that stromatoporoids are similar in tissue structure ("fibre") and vertical tabulate tubes "like those of the, milleporoid, Stromatoporidae," to the Foraminifera. His arguments were based on hypotheses rather than on facts. A mere cursory comparison of the figures of both Hickson and Parks of "G." *plana* and the supposedly similar stromatoporoids should be sufficient to demonstrate their dissimilarity. It cannot be admitted by anyone who is familiar with Foraminifera (Parks says, p. 19, "having little knowledge of Foraminifera") that there is any comparison between the minute, simple Foraminifera, known definitely only from the Silurian and later, and the massive, laminated bodies of the stromatoporoids of the Ordovician to the Devonian. Nor is the tissue structure of the Stromatoporoidea similar to the wall structure of the Foraminifera, either of the hyaline and porcellaneous or arenaceous or the alveolar (fusulinid), or siliceous (especially Silurian), walls of Foraminifera. The "basal chambers" of Parks (p. 28) are dissepiments, and are remnants of Ordovician ancestors, which were composed essentially of dissepiments. It may be insisted that there is no essential structural similarity, either megascopic, other than that both groups are animals, between the stromatoporoids and the groups of larger Foraminifera, the Fusulinidae, the Acervulinidae, the nummulites, or the orbitoids. Lecompte (1951, p. 31) has refuted Hickson's and Parks' arguments and hypotheses effectively.

The idea that stromatoporoids were sponges was entertained early in the study of the group (D'Orbigny, 1850, Rosen, 1869, Salter, 1873, Nicholson and Murie, 1878), but the thorough work of Carter (1877, 1878) in comparing stromatoporoids with calcareous Hydrozoa has convinced all workers excepting two (Parks and Twitchell), since that time, that the Stromatoporoidea are Hydroza related to the Hydractiniidae and Milleporidae. Carter's statement (1877, p. 73), "All this chain of evidence seems to lead to the conclusion that the whole of these organisms, both recent and fossil, were species of Hydrozoa, and neither Foraminifera nor sponges," is still true. Carter was an important authority on Foraminifera, sponges, and Hydrozoa, so that he could speak from personal knowledge of all three groups, and also of the Stromatoporoidea. Only Twitchell (1929, p. 270) has made a serious effort to prove that the typical stromatoporoids are sponges. He insisted (p. 281) without sufficient knowledge, that "sponges are the only modern forms of life that include foreign organisms in any way analogous to the inclusion of caunopore tubes in the stromatoporoids", admitting with nearly all students that the caunopore tubes were parasitic organisms. He found structures analagous to astrorhizae in the fresh-water sponge *Spongilla fragilis,* but as he admitted (p. 270), analogy is not demonstration. Twitchell considered many other analogies, also unconvincing. His identification of spicules in *"Stromatopora centrotum"* (pl. 25, figs. 1, 2) may be denied, as due to some accident of nature or of man. We do not admit that his specimen is even a stromatoporoid. We can agree with Lecompte (1951, p. 30) that we have seen no example of spicules in a stromatoporoid. The vertical rods in *Parallelopora* have no resemblance to spicules. The total absence of a spicular structure in the stromatoporoids, the absence of a vaselike shape, the absence of an osculum and canals through the body, and the presence of cystose and laminar structure, precludes them from being sponges. They may have evolved from the Cambrian aberrant sponges, the Archaeocyatha, as, *e.g., Exocyathus* (Okulitch, 1943, p. 83, pls. 16, 17).

Many students of hydroids and of stromatoporoids have noted their essential similarity, particularly between the family Hydractiniidae and the family Actinostromatidae. The similarities between the Lower and Middle Paleozoic Stromatoporoidea and Cenozoic and Recent Hydrozoa are not obvious, excepting in shape of coenostea, being constructed of layers, and lacking individual polyps or corallites. The similarities between the tissue of stromatoporoids and the hydroids is scarcely sufficient to divide the Stromatoporoidea into a "hydractinoid" and a "milleporoid" group.

We do agree with Lindström, Carter, Zittel, Steinmann, Bargatzky, Nicholson, Waagen and Wentzel, Počta, Dehorne, Tripp, Kühn, Steiner, Ripper, Yabe and Sugiyama, Ozaki, Yavorsky, Riabinin, Le Maître, Lecompte, and most other students of stromatoporoids of the present century, that stromatoporoids are Hydrozoa.

The Paleozoic stromatoporoids are of the scale of organization of undobuted Hydrozoa, particularly the Hydractiniidae, the Milleporidae, the Milleporidiidae, and the Stromatoporinidae, the Disjectoporidae, and the order Sphaeractinoidea (Kühn, 1939, Bd. 2A).

The Stromatoporoidea evolved into the Disjectoporidae of the

Upper Paleozoic which in turn became the Sphaeractinoidea of the Mesozoic. The Sphaeractinoidea evolved into the Hydrozoa of the Cenozoic and Recent.

It is noteworthy that the Stromatoporoidea do not form a coenosteum in which all the structures form a typical shape or individual or "person", as is true of most sponges, including the Archaeocyatha, and the hydroid families Stylasteridae and the suborder Thecata. The nearest approach to a form which might be called a "person" is represented by *Cryptophragmus, Aulacera,* and the genera of the Idiostromatidae, among the Stromatoporoidea. Nor can a coenosteum of a stromatoporoid be considered a colony of separate individuals as is true of a coral corallum. The soft parts of the animal are wholly unknown.

It would seem that the soft parts were largely undifferentiated soft tissue, which occupied the surface only of the coenosteum, built pillars on the hard stratum, built another stratum and abandoned the galleries and cysts below the surface. The entire coenosteum, with the soft parts mostly confined to the upper surface, constituted a single, living creature, although there surely were individual soft polyps of unknown form (Carter, 1878, p. 304). The forms which had astrorhizae manifestly had some special living structure in the astrorhizae, perhaps reproductive polyps, or even medusae. Astrorhizae occur in the order Sphaeractinoidea (including the family Stromatoporinidae), descendants of the order Stromatoporoidea, and Carter figured (1878, pl. 17, figs. 2, 6, 8) typical astrorhizae in Recent *Hydractinia* and *Millepora.*

The placing of the Stromatoporoidea in the class Hydrozoa rests upon the following considerations: (1) The Stromatoporoidea are higher in organization than are Foraminifera or other Protozoa, more complex in structure, larger in size and wholly unlike any Paleozoic or later Foraminifera in tissue structure, skeleton structure, as well as gigantic size. (2) They lack the spicular structure and vaselike shape of Porifera and have no canals through the body, as do Porifera, and the skeleton was never siliceous nor chitinous, as are many sponges. (3) The scale of organization is similar to that of the Archaeocyatha, differing in the vaselike shape and lacking pores through the walls or skeleton, and lacking septa (parieties). (4) Stromatoporoidea are similar to hydroids, particularly the family Hydractiniidae of the order Hydroidea, in skeletal composition (calcium carbonate), attached form of life, general shape and size, habitat (shallow, warm, marine water), laminar structure, pillars, mamelons and astrorhizae. (5) Stromatoporoids do not form corallites, have no living chambers, nor septa, as do the Anthozoa; they are, therefore, lower in organization than typical corals. The dissepiments of the Rugosa occur inside the corallites and are convex inward, as noted by Billings (1865, p. 405), hence they are only analogous to the cysts of *Aulacera*. (6) The wall structure of the Labechiidae (thin, dense median layer, thin outer flocculent layer and thick inner flocculent layer) is the same as that of *Paleoalveolites*, a coral, indicating close relationship between stromatoporoids and early corals. (7) The presence of typical astrorhizae in the Lower Paleozoic order Stromatoporoidea, the late Paleozoic and Mesozoic order Sphaeractinoidea (including the Stromatoporinidae and Disjectoporidae) and the Recent order Hydroidea, indicates definite relationship between the three orders. (8) The gradation in structure from Stromatoporoidea to the Sphaeractinoidea, including especially the family Stromatoporinidae of the Mesozoic, and on into the Cenozoic and Recent Hydrozoa, is nearly complete, and convincing that Stromatoporoidea are Hydrozoa.

Fossils in the class Hydrozoa include: (1) the order Stromatoporoidea, skeleton calcareous, composed of arcuate plates, laminae, pillars and having astrorhizae; Ordovician to Devonian; (2) the order Sphaeractinoidea, skeleton calcareous, composed of concentric and radial trabeculae and having astrorhizae; Permian to Cretaceous; and (3) the order Hydroidea, skeleton calcareous, mat-like (*Hydractinia*) or upright (*Millepora, Stylaster*), some with astrorhizae; Cretaceous to Recent.

ECOLOGY OF THE STROMATOPOROIDEA

Stromatoporoids are sessile, benthonic, marine organisms, usually associated with corals, particularly tabulate corals. They occur primarily in limestones, rarely in calcareous shales, and probably lived in a clear, shallow, moving water, tropical to subtropical environment.

Stromatoporoids have been reported in large numbers in bioherms (organic reefs), in biostromes (organic limestones) and in "banks" (Riabinin, 1941, pp. 49, 82.). They also may occur as specimens scattered in limestone, as in the late Ordovician of Indiana, Ohio, and Kentucky, and in calcareous shales, as in the Middle Devonian Ferron Point shale of Michigan, and the Hungry Hollow formation of Ontario.

Some of the reefs, especially in the Devonian Traverse of Michigan, contain angular conglomeratic fragments of stromatoporoids (Fenton, M. A., 1931, p. 200, fig. 2), suggesting a local, small scale storm breccia. Such reefs must have been built near the surface of the sea and have been subjected to constant wave action, as are present reefs.

As modern day coral reefs are not composed exclusively of corals, the stromatoporoid reefs are not composed entirely of stromatoporoids. The diversification of kinds of organisms is not so great, however, as in the case of the Recent coral reefs. (Fenton, C. L., 1931, p. 204). The lack of many kinds of organisms in the reefs may be due to the incrusting nature of the stromatoporoids. They grew over each other or over other organisms, thereby completely engulfing whatever they were attached to.

The stromatoporoids not only reflect the general environment in which they existed but also seasonal changes in environment, as in the variable thickness of latilaminae. Thick latilaminae usually composed of zones of widely spaced laminae indicate optimum conditions of clear, warm water, and abundant food and carbonate material. Thin latilaminae, composed of zones of closely spaced laminae indicate adverse conditions, such as muddy water, temperatures above or below normal, lack of sufficient food or insufficient supplies of carbonate. In some cases, zones of clastic material are found associated with thin latilaminae, indicating that the deposits of solid material locally killed part of the organism which under improved conditions grew again over the deposit of mud.

In the Devonian bioherms at Alpena, Michigan, stromatoporoids make the bulk of several reefs, and there are a few corals, *Hexagonaria* and *Emmonsia*. Between reefs, as at the Potter Farm formation, just west of Alpena, stromatoporoids occur with abundant brachiopods and corals. At Petoskey, Michigan, stromatoporoids make bioherms, with few other fossils, and the stromatoporoid head and branches have been broken and tumbled about, making a breccia (Fenton, M.A., 1931, p. 199). The breccia proves that the reefs were in shallow water and were hammered by the breakers. At Bay View, Michigan, two miles northeast of Petoskey, corals and stromatoporoids occur in profusion in the inter-reef facies of thin-bedded limestones.

In the Jeffersonville limestone of Indiana and Kentucky and the Columbus limestone of Ohio, stromatoporoids are found mostly in biostromes. Rarely do they occur in bioherms as at the Falls of the Ohio. They are often associated with many other organisms, such as corals and brachiopods. In the Hamilton of northern Indiana, many of the stromatoporoids occur in biohermal reefs as well as biostromes and are not associated with as many other organisms. For example, at the France Lime and Stone Co. quarry near Logansport, Indiana, the stromatoporoids from the Logansport limestone are in a thick biostrome, whereas, lying unconformably above, the stromatoporoids in the Little Rock Creek limestone are in a biohermal type reef. Ten miles to the southeast, at Pipe Creek Falls, stromatoporoids from the Logansport limestone are in a biohermal type reef. Many of the species from the Logansport limestone at the two localities are identical, indicating that some species can thrive in either a biohermal or biostromal environment. It is possible that the Logansport limestone at the France Lime and Stone Co. quarry may represent a reef flank, with the core either quarried out or not yet exposed, though the beds are uniform in thickness.

Roemer (1880, p. 343) and Nicholson (1866, pp. 110-130) considered the caunopore tubes associated with stromatoporoids to be commensal tabulate corals, as *Aulopora* and *Syringopora,* but since in some cases the corallites are completely engulfed in the coenosteum, Kühn (1939, p. A40) considered it likely that the stromatoporoids parasitized the corals. In our Devonian specimens, practically all of the caunopore tubes display the infundibular tabulae of *Syringopora*. Rarely, the caunopore tubes have no inner structure as in *Trupetostroma warreni* from near Fort Norman in the Northwest Territories, suggesting a worm tube. Buehler (1955, p. 18) made the interesting statement, that in the Silurian, stromatoporoids form the substratum for over 80 percent of the Halysitidae specimens he observed in position, but the coral is never engulfed by the stromatoporoid. He stated that the stromatoporoid was probably dead when the coral settled on it.

The table of some of the stromatoporoid occurrences shows the stratigraphic and geographic distribution of biostromes and bioherms (p. 58.)

Stromatoporoids grew mainly in biostromes until the Lower Silurian, after which they grew primarily in bioherms. The localities cited are in what is now the temperate and colder regions of the world which implies a warmer climate from the Middle Ordovician to the Upper Devonian than now prevails.

It is apparent that stromatoporoids could not compete with corals in a muddy habitat. For example, stromatoporoids are rare in the Devonian Hamilton shale at Thedford, Ontario, which is famous for its coral and invertebrate fauna, and the same is true for the Hamilton shale of western New York. Lecompte (1951, p. 53) noted that in the middle Frasnian, the coral bioherms do not constitute an environment favorable for stromatoporoids, and conversely the rugose and tabulate corals are rare in the stromatoporoid bioherms and biostromes. He pointed out that the lumachel or coquina of disassociated brachiopod valves, and corroded surfaces of colonies, associated with the stromatoporoid bioherms and biostromes, indicate that the stromatoporoids occur in a deeper environment than the coral bioherms. He stated that the sedimentation and succession of the faunas from the Frasnian on the southern edge of the Dinant Basin leads to the same conclusion. The disassociated brachiopod valves and corroded colonies would indicate that the environment was shallow water, in which the material was subjected to strong wave activity.

In summary, stromatoporoids are indicative of a clear, warm, shallow marine environment, and some stromatoporoid bioherms show that they could flourish in water only a few feet deep, though they were subject to the pounding of breakers.

FAUNAS STUDIED

AREA OF INVESTIGATION

The area of investigation is limited to the occurrence of Middle Devonian rocks of Onondaga and Hamilton age from Indiana, Ohio, and Kentucky. In northcentral Indiana, the stromatoporoid material is from the Little Rock Creek limestone of Tully age and the Logansport limestone of Hamilton age. According to the Devonian correlation chart (Cooper, G. A., *et al.,* 1942, Bull. Geol. Soc. America, vol. 53, p. 1770 and Chart no. 4), the Little Rock Creek limestone is correlated with the Tully of New York and the Thunder Bay and Potter Farm limestones in Michigan. On the Chart, the Logansport limestone is correlated with the Four Mile Dam limestone of Alpena County, Michigan, and the Beechwood limestone of southern Indiana and northcentral Kentucky. The northcentral Indiana collections are from a restricted area of 10 to 12 mile radius, though actual distribution probably is greater. Much of the area is covered with glacial drift so that outcrops are few. We have no other stromatoporoids from the Hamilton of Indiana, Ohio or Kentucky, with which to make comparisons, for the Hamilton rocks of those states appear to be barren of stromatoporoids. We have a large collection of undescribed material from the Hamilton Potter Farm formation of Michigan, which, on preliminary examination compares favorably with material from the Little Rock Creek limestone.

The Onondaga outcrops as the Jeffersonville limestone in central and southern Indiana and immediately south of the Ohio River in Kentucky, in the vicinity of Louisville, and as the Columbus limestone in Ohio. The Jeffersonville and Columbus limestones contain few stromatoporoids common to both. Part of the distribution may be due to the influence of the intervening Cincinnati Arch, part to the rarity of specimens or inadequate collections from some of the localities. The stromatoporoids are most abundant from the Jeffersonville limestone near the Ohio River. Northward they are less abundant.

In Kentucky, no authenticated specimen has been described from south of the Louisville area. The Jeffersonville limestone pinches out shortly to the south, and only thin limestones of Hamilton age occur unconformably above the Silurian and below the overlying New Albany shale. One tiny, silicified stromatoporoid has been collected from the Hamilton, Beechwood limestone, but it is so poorly preserved that we cannot identify it. One specimen is purported to be from the Onondaga limestone at Moreland, Lincoln County, Kentucky. If the locality and horizon are authentic, the horizon is the farthest south the Onondaga occurs in Kentucky, and the locality marks the farthest south extent of Devonian stromatoporoids to be reported from midwestern North America. A personal examination (by J. St. Jean, Jr.) of the area showed that Moreland and the surrounding localities are situated on the New Albany shale of Upper Devonian age. Only a few isolated outcrops of limestone occur in the bottoms of stream beds. None of the examined outcrops contained stromatoporoids, and as far as could be told, the limestone was identical with limestone of Hamilton age at nearby localities. By means of automobile, the Hamilton limestones were traced throughout most of their extent in Kentucky, from Louisville southward, around the southern nose of the Cincinnati Arch, with stops made every few miles, but no stromatoporoids were found.

In Ohio, on the east side of the Cincinnati Arch, the Columbus limestone extends almost due north and south through most of the middle of the State, from south of Columbus to Kelleys Island in Lake Ontario.

In Indiana, near the Ohio River, and to the north in Jennings County, the basal Jeffersonville limestone becomes difficult to distinguish from the underlying Geneva dolomite. In Madison County, in central Indiana, the basal siliceous zone of the Jeffersonville limestone is difficult to distinguish from the local Pendleton sandstone. The few stromatoporoids in our collections from such zones have definite Onondaga affinities, suggesting that though they are from siliceous or sandy zones, they probably come from the basal Jeffersonville limestone. The stromatoporoid from Pendleton marks the most northern extent of a stromatoporoid from the Jeffersonville limestone in our collections.

LOCALITIES

The faunas studied are from the Little Rock Creek limestone of Tully age and Logansport limestone of Hamilton age in northcentral Indiana, and from the Jeffersonville or Columbus limestones of Onondaga age from Indiana, Kentucky, and Ohio. The largest collections in the Little Rock Creek and Logansport limestones come from the France Lime and Stone Company quarry near Logansport, Indiana. A substantial collection is from the type section of the Logansport limestone at Pipe Creek Falls. The largest collections from the Jeffersonville limestone come from the Falls of the Ohio and Charlestown, Indiana, in the south, and from the Meshberger quarry to the north in Bartholomew County, Indiana. Only scattered specimens have been collected from other localities. From Ohio, no large collection has been studied. Specimens are mostly from scattered localities extending from Columbus northward. The largest fauna is from Kelleys Island, collected by Dr. M. F. Marple.

The following lists of localities are arranged alphabetically according to state and alphabetically according to the name of the locality within the state. The Indiana localities are divided into two groups, the northcentral Indiana faunas (Tully and Hamilton), and the central and southern Indiana faunas (Onondaga). The stromatoporoids found at each locality are likewise arranged alphabetically, and are included for purposes of comparison of the faunas.

Sampling has not been exhaustive, except at the France quarry near Logansport and at the Falls of the Ohio, so that in many cases the abundance listed after each species may be misleading, especially where only one or two specimens were collected from a single locality. The abundance refers to the number of specimens in our collections or in borrowed collections, "rare" signifies one or two specimens, "common" three to five specimens, and "abundant" more than five specimens.

For purposes of correlation by means of previously described species, one should refer to the localities in the individual synonymies under the systematic descriptions, or to the lists in the section, "significant features of the faunas."

NORTHCENTRAL INDIANA

Bunker Hill, Indiana, one mile north of, on Pipe Creek, Little Rock Creek limestone (Tully age):

Syringostroma fuscum, n. sp., rare

Camden, Indiana (loose in a yard), Logansport limestone (middle Hamilton age):

Stromatoporella huronensis (Parks), rare

Cass Station, Indiana, Logansport limestone:

Stromatopora cumingsi, n. sp., rare

Eel River, upper dam on, six miles northeast of Logansport, Indiana, Logansport limestone:

Clathrocoilona abeona Yavorsky, rare
Stromatopora cumingsi, n. sp., common

France Lime and Stone Company quarry, five miles east of Logansport, Indiana, Little Rock Creek limestone:

Anostylostroma crebricolumnare, n. sp., rare
Anostylostroma microtuberculatum (Riabinin), abundant
Syringostroma bicrenulatum, n. sp., common
Syringostroma fuscum, n. sp., abundant
Syringostroma papillatum, n. sp., rare
Syringostroma perfuscum, n. sp., rare
Syringostroma subfuscum, n. sp., abundant

Logansport limestone:

Actinostroma tyrrelli Nicholson, rare
Anostylostroma humile, n. sp., abundant
Anostylostroma mediale, n. sp., abundant
Anostylostroma pulpitense, n. sp., abundant
Clathrocoilona fibrosa, n. sp., abundant
Clathrocoilona restricta, n. sp., rare
Clathrocoilona subclathrata, n. sp., rare

Hermatostroma logansportense, n. sp., rare
Stromatopora conicomamillatum, n. sp., rare
Stromatopora cumingsi, n. sp., abundant
Stromatopora divergens, n. sp., rare
Stromatopora dubia Lecompte, rare
Stromatopora laminosa Lecompte, abundant
Stromatopora magnimamillata, n. sp., common
Stromatopora pachytexta Lecompte, rare
Stromatoporella solitaria Nicholson, rare
Stromatoporella cryptoannulata, n. sp., common
Syringostroma perdensum, n. sp., rare
Trupetostroma coalescens, n. sp., rare
Trupetostroma raricystosum, n. sp., common

May Sand and Gravel Company quarry, two miles southwest of Fort Wayne, Indiana, Logansport limestone:

Clathrocoilona restricta, n. sp., rare

Monon, Indiana, two miles west of, Logansport limestone or Little Rock Creek limestone:

Stromatopora mononensis, n. sp., rare

Pipe Creek Falls, 10 miles east of Logansport, Indiana, Logansport limestone (type section):

Anostylostroma compactum, n. sp., rare
Anostylostroma confluens, n. sp., common
Anostylostroma mediale, n. sp., rare
Anostylostroma microcolumnare, n. sp., rare
Anostylostroma pipecreekense, n. sp., rare
Anostylostroma pulpitense, n. sp., rare
Clathrocoilona fibrosa, n. sp., common
Clathrocoilona restricta, n. sp., rare
Stromatopora cumingsi, n. sp., common
Stromatopora laminosa Lecompte, common
Stromatopora pachytexta Lecompte, rare
Stromatopora submixta, n. sp., rare
Stromatoporella solitaria Nicholson, rare

Pulpit Rock, Wabash River, three miles east of Logansport, Indiana, Logansport limestone:

Anostylostroma pulpitense, n. sp., rare

CENTRAL AND SOUTHERN INDIANA

Big Spring, two miles west of Hanover, Indiana, Jeffersonville limestone (Onondaga age):

Stromatoporella cf. *cellulosa* (Nicholson), rare

Butlerville, Indiana, two miles northwest of, Jeffersonville limestone, basal siliceous zone, (sandy):

Stromatoporella selwyni Nicholson, rare

Charlestown, Indiana, road metal quarry, Jeffersonville limestone:

Anostylostroma arvense (Parks), rare
Anostylostroma columnare (Parks), rare
Anostylostroma laxum (Nicholson), rare
Gerronostroma excellens, n. sp., rare
Gerronostroma insolitum (Parks), rare
Gerronostroma plectile, n. sp., rare
Parallelopora eumamillata, n. sp., rare
Stictostroma jeffersonvillense, n. sp., rare
Stromatoporella parasolitaria, n. sp., common

Commiskey Cave, Jennings County, Indiana, Jeffersonville limestone:

Syringostroma tuberosum, n. sp., rare

Falls of the Ohio, Jeffersonville, Indiana, Jeffersonville limestone (type section):

Anostylostroma columnare (Parks), abundant
Gerronostroma excellens, n. sp., rare
Gerronostroma insolitum (Parks), rare
Parallelopora eumamillata, n. sp., abundant
Parallelopora typicalis, n. sp., rare

Stictostroma jeffersonvillense, n. sp., abundant
Stromatopora eumaculosa, n. sp., rare
Syringostroma superdensum, n. sp., abundant
Syringostroma radicosum, n. sp., rare

Hartsville, Indiana, two miles south of, Jeffersonville limestone:

Stromatopora obscura, n. sp., rare

Independent quarry, four miles south of Dupont, Indiana, Jeffersonville limestone, basal coralline zone:

Amphipora ramosa (Phillips), abundant
Anostylostroma dupontense, n. sp., rare
Anostylostroma ponderosum (Nicholson), rare
Syringostroma superdensum, n. sp., rare
Syringostroma tuberosum, n. sp., rare

Kent, Indiana, one mile north of, Jeffersonville limestone:

Parallelopora campbelli, n. sp., rare
Syringostroma superdensum, n. sp., rare
Syringostroma tuberosum, n. sp., common

Lancaster, Jefferson County, Indiana, Jeffersonville limestone:

Syringostroma superdensum, n. sp., rare

Louisville Cement Company quarry, Speed, Indiana, Jeffersonville limestone:

Gerronostroma insolitum (Parks), rare
Gerronostroma plectile, n. sp., rare
Stictostroma jeffersonvillense, n. sp., rare

Meshberger Stone Company quarry, two miles northeast of Elizabethtown, Indiana, lower Jeffersonville limestone:

Actinodictyon vagans Parks, rare
Anostylostroma arvense (Parks), rare
Anostylostroma meshbergerense, n. sp., rare
Anostylostroma ponderosum (Nicholson), rare

Atelodictyon intercalare, n. sp., rare
Stromatoporella kirki, n. sp., rare
Syringostroma densum Nicholson, common
Syringostroma tuberosum, n. sp., common

Pendleton, Indiana, lower Jeffersonville limestone:

Actinodictyon vagans Parks, rare

Westport, three miles south of, Decatur County, Indiana, Jeffersonville limestone:

Parallelopora pulchra, n. sp., rare

NORTHCENTRAL KENTUCKY

Jefferson County quarry, 1.2 miles northwest of the Louisville, Kentucky city limits, on U. S. Highway 42, Jeffersonville limestone:

Parallelopora eumamillata, n. sp., common
Stromatoporella perannulata, n. sp., rare
Syringostroma radicosum, n. sp., common

Moreland, Lincoln County, Kentucky (exact locality not known), probably Hamilton limestone:

Stromatoporella morelandensis, n. sp., rare

Prospect, Kentucky, road cut 3.3 miles southwest of, on U. S. Highway 42, lower Jeffersonville limestone:

Anostylostroma arvense (Parks), rare
Anostylostroma laxum (Nicholson), rare
Anostylostroma subcolumnare, n. sp., rare
Stictostroma jeffersonvillense, n. sp., rare
Stictostroma mcgraini, n. sp., rare
Syringostroma radicosum, n. sp., common

OHIO

Columbus, Ohio, upper 20 feet of the Marble Cliff quarry, Columbus limestone (Onondaga age):

Stromatopora larocquei, n. sp., rare

Columbus, Ohio (exact locality not known), Columbus limestone:

Anostylostroma cf. *substriatellum* (Nicholson), rare
Stromatoporella eriensis (Parks), rare

Delaware, Ohio, Columbus limestone:

Parallelopora snoufferensis, n. sp., rare

Dublin quarry, Dublin, Ohio, Columbus limestone:

Anostylostroma columnare (Parks), rare
Anostylostroma laxum (Nicholson), rare
Clathrodictyon confertum Nicholson, rare
Stromatoporella eriensis (Parks), rare

East Liberty, Ohio, 1.2 miles west of, Columbus limestone:

Stromatoporella eriensis (Parks), rare

Kelleys Island, Ohio, north side quarry, Columbus limestone:

Anostylostroma insulare (Parks), common
Anostylostroma substriatellum (Nicholson), rare
Parallelopora campbelli, n. sp., rare
Parallelopora nodulata (Nicholson), rare
Parallelopora ostiolata Bargatzky, rare
Syringostroma densum Nicholson, common

Kelleys Island, Ohio, south side quarry, Columbus limestone:

Anostylostroma insulare (Parks), common
Parallelopora campbelli, n. sp., rare
Stromatopora marpleae, n. sp., rare

Marblehead, Ohio, old quarry, one mile west of, Columbus limestone:

Anostylostroma arvense (Parks), rare
Anostylostroma columnare (Parks), abundant
Anostylostroma substriatellum (Nicholson), common

Snouffer quarry, east bank of the Scioto River, five miles northwest of Columbus, Ohio, Columbus limestone:

Anostylostroma laxum (Nicholson), rare
Parallelopora snoufferensis, n. sp., rare
Stromatoporella columbusensis, n. sp., rare

Sandusky, Ohio (exact locality not known), Columbus limestone:

Syringostroma sanduskyense, n. sp., rare

SIGNIFICANT FEATURES OF THE FAUNAS

Within the area of investigation, we encountered no example of a species which ranged beyond the stratigraphic unit in which it was found. Of those species previously described, only *Stromatopora laminosa* Lecompte ranges beyond a stage. *Anostylostroma microtuberculatum* (Riabinin) found in our Little Rock Creek fauna now extends the range from the Upper to the Middle Devonian. In all of the faunas described, there are a total of 76 species, 53 of which are new, and 15 genera, none of which are new.

The Little Rock Creek limestone was collected at two localities. Seven species belonging to two genera were found; six species are new. *Anostylostroma microtuberculatum* (Riabinin), has been described previously only from the Upper Devonian in the Main Devonian Field, near Leningrad, Russia. *Syringostroma fuscum* is the most widespread and abundant species within the area, being found at both localities. The genus *Syringostroma* is especially characteristic of the horizon.

In the Logansport limestone, 28 species belonging to eight genera are described; 21 species are new. The distribution of the seven species described previously is as follows:

Actinostroma tyrrelli Nicholson. Middle Hamilton, Lake Winnipegosis, Manitoba and Great Slave Lake, Northwest Territories

Clathrocoilona abeona Yavorsky. Middle Devonian, Kuznetsk Basin, Russia, northwest of Mongolia

Stromatopora dubia Lecompte. Middle Devonian, Frasnian, Dinant Basin, Belgium

Stromatopora laminosa Lecompte. Middle Devonian, Givetian and Frasnian, Dinant Basin, Belgium

Stromatopora pachytexta Lecompte. Middle Devonian, Eifelian, Dinant Basin, Belgium

Stromatoporella huronensis (Parks). Hamilton, Alpena, Michigan

Stromatoporella solitaria Nicholson. Middle Devonian, Gerolstein, Germany

The genus *Stromatopora* is the most characteristic both in the number of specimens and in the number of species. The most widespread species within the area are *Stromatopora cumingsi,* found in four of the eight Logansport localities, and *Clathrocoilona restricta,* found in three of the eight localities. The two most abundant species were *Stromatopora cumingsi* and *Clathrocoilona fibrosa;* both were about equally abundant.

Twenty-seven species belonging to 10 genera are described from the Jeffersonville limestone. Twenty of the species are new, the remaining species described previously have been reported in the literature as follows:

Actinodictyon vagans Parks. Columbus limestone, Kelleys Island, Ohio

Amphipora ramosa (Phillips). Middle Devonian of England, France, Germany, Belgium, Italy, Estonia, Russia, China, and Western Australia

Anostylostroma arvense (Parks). Onondaga limestone, Simcoe and southwestern Ontario

Anostylostroma columnare (Parks). Middle Devonian, James Bay, Ontario; Onondaga limestone, Ontario; Columbus limestone, Marblehead and Sandusky, Ohio

Anostylostroma laxum (Nicholson). Middle Devonian, James Bay, Ontario; Onondaga limestone, Port Colborne, Ontario; and Columbus limestone, Kelleys Island and Marblehead, Ohio

Anostylostroma ponderosum (Nicholson). Columbus limestone, Kelleys Island and Marblehead, Ohio

Gerronostroma insolitum (Parks). Columbus limestone, Marblehead, Ohio

Stromatoporella cellulosa (Nicholson). Onondaga limestone, Wainfleet and Port Colborne, Ontario; Eifelian?, Ardennes, Belgium

Stromatoporella selwyni Nicholson. Onondaga limestone, Port Colborne and Selkirk, Ontario

Syringostroma densum Nicholson. Columbus limestone, Kelleys Island, Ohio

One can see from the foregoing, that even though we found only four species in common between the Jeffersonville and Columbus limestones, the Jeffersonville fauna correlates well with previously described species from the Columbus and Onondaga limestones of Ohio and Ontario. In the Jeffersonville limestone the faunas are diversified, especially as to the prominence of any particular genus. *Anostylostroma* is represented by slightly more species than several other prominent genera, and *Syringostroma* is represented by the greatest abundance of specimens, with *Anostylostroma* second. Within the area studied, *Stictostroma jeffersonvillense* is the most widespread species, occurring in 4 of the 11 faunas. *Amphipora ramosa* (Phillips) is the most abundant in numbers of specimens, for the small coenostea form layers from which a small sample may contain hundreds of specimens. Of the larger stromatoporoids, *Syringostroma superdensum* is the most abundant species.

From the Columbus limestone, 16 species belonging to 6 genera are described, of which 6 species are new. The previously described species have the following distribution:

Anostylostroma arvense (Parks). Onondaga limestone, Simcoe, Ontario

Anostylostroma columnare (Parks). Middle Devonian, James Bay, Ontario; Onondaga limestone, Ontario; and Columbus limestone, Marblehead and Sandusky, Ohio

Anostylostroma insulare (Parks). Columbus limestone, Kelleys Island, Ohio

Anostylostroma laxum (Nicholson). Middle Devonian, James

Bay, Ontario; Onondaga limestone, Port Colborne, Ontario; and Columbus limestone, Kelleys Island and Marblehead, Ohio

Anostylostroma substriatellum (Nicholson). Columbus limestone, Marblehead, Ohio

Clathrodictyon confertum Nicholson. Middle Devonian, Dartington, England

Parallelopora nodulata (Nicholson). Columbus limestone, Kelleys Island, Ohio

Stromatoporella eriensis (Parks). Columbus limestone, Marblehead, Ohio

Syringostroma densum Nicholson. Columbus limestone, Kelleys Island, Ohio

In the Columbus limestone, both *Stromatoporella eriensis* (Parks) and *Anostylostroma substriatellum* (Nicholson) are about equally abundant and widespread, slightly more so than some of the other common species. *Anostylostroma* is the most prominent genus in numbers of specimens and, as in the case of the Jeffersonville limestone, it is the most prominent genus in numbers of species.

Within the area of investigation, stromatoporoids have been previously described only from Ohio. For that reason, it is easiest to establish a correlation of faunas with the Jeffersonville limestone of Indiana and Kentucky. Only a few species have been described previously from the middle and upper Hamilton so the correlations are more difficult because there are not many stromatoporoid species for comparison. The best correlation of the Logansport limestone is with those species described by Lecompte from the Givetian and Frasnian of Belgium. The correlation is established even better on the basis of homologous or closely related species. We do not have sufficient material from the Little Rock Creek limestone for correlation and no previously described material with which it can be compared, so that additional work is needed on the stromatoporoids from that limestone as well as additional studies on stromatoporoids of probably similar age from other areas.

SUMMARY

The foregoing report is preliminary in nature because the stromatoporoids have been little known and little studied, especially from North America. Most of our efforts in the work have been concentrated on the systematic part. One must first know what species and genera he is dealing with before practical studies can be of value. We have tried to make known the characters of many genera and species, for we find that the tendency in the past has been to wander so far from the type of a genus that many species are assigned to the wrong genus. The best example is *Clathrodictyon* and *Anostylostroma*. About 90 percent of the species commonly referred to *Clathrodictyon*, based on the characters of the type species, have the characteristics of *Anostylostroma*. This has entailed considerable work in trying to obtain the literature, and as many type species as possible. We have been reluctant to name so many species, for we are opposed to the tendency in paleontology at the present time to reduce genera to specific characters and to base species on individual characteristics. In the taxonomic work we have made an effort to see as much of the literature as possible in order to be sure that the species have not been described. Our objective has been to describe genera and species in a brief concise form in order that they may be understood by others.

We believe the stromatoporoids are of practical value in age determination and have constantly had their usefulness in mind. E. O. Ulrich (1917, Kentucky Geol. Surv., p. 190) indicated a method of stratigraphic correlation which, when applied to stromatoporoids, makes them especially useful index or zone fossils— ". . . I have applied all verified means of correlating geological formations . . . . particularly of subordinate mutations of complexly constructed organic remains". The stromatoporoids changed rapidly in time, and because they are defined specifically on the basis of microscopic structure, the species are closely drawn. High magnifications are neither necessary nor desirable.

We hope that the work may prove to be a basis for other similar works in other areas in order that faunas may be compared properly. The stromatoporoids should make as good zone fossils for the marine Devonian as the trilobites are for the Cambrian and graptolites for the Ordovician. The stromatoporoids should be of considerable value for purposes of inter-continental, as well as local, correlations. For that reason, we hope that paleontologists and stratigraphers will not neglect the foreign literature, especially in systematic works.

The most important economic application of the stromatoporoids is to the petroleum industry, for the stromatoporoids make up a large part of the reef reservoirs in the subsurface from which oil is obtained. The stromatoporoids are of further value in that they not only reflect clearly their environment, they also show marked differences due to the change of their environment during the life span represented by their coenostea. Usable samples of stromatoporoids may be recovered in cores. Also, the stromatoporoids make up a large part of some of the reefs which are quarried for road metal, agricultural lime, and chemical lime.

The main disadvantage of the stromatoporoids is that they require two oriented thin sections from each specimen in order to be identified accurately. The difficulty is no greater than it is for the calcareous algae, bryozoans, or some of the massive corals. We believe that the usefulness of the stromatoporoids far outweighs the disadvantage. We have also found that when a person becomes acquainted with the stromatoporoids from a particular horizon and area, he can recognize the species from hand specimens or from polished surfaces, though for accuracy thin sections are preferable.

SYSTEMATIC DESCRIPTIONS

Phylum **COELENTERATA**

Class **HYDROZOA**

Order **STROMATOPOROIDEA** Nicholson and Murie, 1878

Section *Stromatoporoidea* Nicholson and Murie, 1878, Jour. Linn. Soc. London, Zool., vol. 14, p. 241.
Order *Stromatoporoidea* Nicholson, 1886, Palaeont. Soc., vol. 39, p. 73; Kühn, 1939, in Schindewolf, Handbuch Paläozoologie, Band 2A, p. A36.

Coenosteum originally calcareous and secreted as a skeleton by the animal; laminar, massive, cylindrical or dendroid, some with basal peritheca, usually latilaminate. Coenosteum composed of outwardly curved plates arranged in strata, or of thin or thick laminae, or rarely of cavernous tissue, usually with vertical or radial short or long pillars, with or without vertical, superposed galleries, not composed of trabeculae. Skeletal tissue compact or minutely vesicular, tubulate, or maculate, without spicules. The horizontal and vertical structures are discrete or amalagamated. Astrorhizae present or absent. Some with symbiotic, tubular organisms.

Occur in shallow, warm water, marine limestones, less commonly in shales, with corals and other marine organisms, frequently making bioherms and biostromes.

Ordovician, Silurian and Devonian, not definitely known from the Mississippian; Upper Paleozoic and Mesozoic forms belong in the Order Sphaeractinoidea. Forms reported from the Cambrian of Siberia by Obrutschew (1926, Fortschr. Geol. Palaeont., vol. 5, no. 15, p. 86, *et seq.*) are not described and may be stromatolites; those reported by Yavorsky (1932, p. 613) from the Cambrian of western Siberia, seem to belong to Jurassic and Devonian genera.

DIAGNOSTIC CHARACTERS OF FAMILIES AND GENERA OF STROMATOPOROIDEA*

The following diagnoses of the families and genera of the Stromatoporoidea is a synopsis of a classification prepared, after many years of study, by the senior author, Dr. J. J. Galloway, and will be presented by him in greater detail in his paper on the structure and classification of the stromatoporoids, now nearing completion. The classification is based on original descriptions and figures of type specimens, and wherever feasible, original or topotype specimens have been studied. The following diagnoses of characters of families and genera is the basis on which the systematic descriptions are organized in the present work.

Family **LABECHIIDAE**

Tissue compact; skeleton composed of overlapping convex plates, without or with pillars; coenostea laminar, massive or columnar.

Genus unpublished. Coenosteum massive; cysts arcuate, small; pillars absent.

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* See footnote under heading Check List of Devonian Genera and Species of Stromatoporoidea.

CRYPTOPHRAGMUS. Coenosteum a column of hemispherical cysts, with short villi; outer sheaths usually absent, if present a foreign organism.

AULACERA. Coenosteum columnar; cysts small; pillars absent in young, long, round in adult.

SINODICTYON. Coenosteum columnar; axis of variable cysts; denticles conical, round.

PSEUDOSTYLODICTYON. Coenosteum massive; curved plates broad, crinkled; pillars absent.

ROSENELLA. Coenosteum massive; curved plates broad; denticles conical.

LABECHIA. Coenosteum massive; cysts arcuate; pillars long, round.

PSEUDOLABECHIA. Coenosteum massive; cysts small; pillars long, in groups.

LABECHIELLA. Coenosteum massive; cysts in young, laminae in adult; pillars long, round.

STROMATOCERIUM. Coenosteum massive; cysts broad and low; pillars long, broad.

DERMATOSTROMA. Coenosteum a thin encrustation, of laminae and pillars.

Family CLATHRODICTYIDAE

Tissue compact, fibrous or porous, not maculate; cysts side by side or with laminae; pillars short; coenostea laminar or massive.

CLATHRODICTYON. Skeleton composed of layers of small cysts, not of laminae and pillars.

ANOSTYLOSTROMA. Laminae regular; pillars separate from laminae, spreading upward.

ATELODICTYON. Pillars with radial processes; tangential section areolate.

STICTOSTROMA. Tissue transversely porous; ring-pillars absent or incipient.

STROMATOPORELLA. Tissue transversely porous; many ring-pillars.

Family ACTINOSTROMATIDAE

Tissue compact, fibrous or porous; laminae regular; pillars long or regularly superposed.

LOPHIOSTROMA. Pillars large, superposed, with upturned laminae.
ACTINOSTROMA. Pillars continuous with radial processes.
GERRONOSTROMA. Pillars superposed; laminae thick, transversely porous.
TRUPETOSTROMA. Pillars superposed; laminae with thin primary layer; secondary tissue with vacuoles.

Family STROMATOPORIDAE

Tissue maculate; laminae and pillars fused; coenosteum laminar to massive.

STROMATOPORA. Interlaminar spaces largely filled with secondary, maculate tissue, leaving small galleries and pseudozooidal tubes; pillars usually indefinite.
SYRINGOSTROMA. Pillars large, long and short; galleries small; like *Stromatopora* except for the large, long pillars.
PARALLELOPORA. Pillars large, long, with vertical tubules and rods; maculae very coarse.
HERMATOSTROMA. Pillars large, superposed, with outer light zones.
CLATHROCOILONA. Pillars short; laminae of three layers.
SYNTHETOSTROMA. Pillars superposed; laminae thick, composed of microlaminae.
ACTINODICTYON. Skeleton made of cysts and long and short pillars; some spherical cysts.

Family IDIOSTROMATIDAE

Tissue compact, fibrous and porous; coenosteum ramose, mostly with axial tube.

CLAVIDICTYON. Coenosteum caespitose, without axial tube or column; pillars short, round.
IDIOSTROMA. Laminae thickened; pillars continuous.

DENDROSTROMA. Laminae thickened; pillars short.
STACHYODES. Tissue nearly filling interlaminar spaces; laminae transversely tubulate.
AMPHIPORA. Coenosteum of small stems, composed of tubes with triple walls; outer zone of large vesicles.

KEY TO FAMILIES OF THE STROMATOPOROIDEA

1a. Tissue compact, fibrous, tubulose or flocculent, not maculate
  2a. Skeleton composed of dissepiments, mostly with pillars .... LABECHIIDAE
  2b. Skeleton composed of laminae, with dissepiments and pillars
    3a. Coenosteum massive, tuberose or laminar
      4a. Pillars short, confined between two laminae .... CLATHRODICTYIDAE
      4b. Pillars continuous or definitely superposed .... ACTINOSTROMATIDAE
    3b. Coenosteum ramose, mostly with axial tube .... IDIOSTROMATIDAE
1b. Tissue maculate; pillars long, short or absent .... STROMATOPORIDAE

Family **CLATHRODICTYIDAE** Kühn, 1939

Clathrodictyonidae, nov. fam., Kühn, 1939, Zentralbl. Min., Geol. Paläont., Abt. B, p. 341.

Familia *Clathrodictyonidae* Kühn, 1939, in Schindewolf, Handbuch Paläozoologie, Bd. 2A, p. A42.

Coenosteum laminar to massive, composed of cysts side by side in concentric layers, or of laminae which are in general parallel. Galleries higher than the laminae are thick. Foramina may occur between superposed galleries. Pillars usually present, confined between two laminae, but may be incidentally superposed. Tissue compact, fibrous or tubulous, especially the primary laminae, the secondary tissue on the laminae and pillars either compact, finely tubular or containing globular vacuoles, not maculate. Astrorhizae present or absent.

Ordovician and Silurian, one genus; Devonian abundant; post-Devonian absent.

The plural of *dictyon* is *dictya,* the stem is *dicty,* hence the family name is Clathrodictyidae.

KEY TO GENERA OF CLATHRODICTYIDAE

1a. Horizontal structures are cysts, in crumpled layers .... CLATHRODICTYON
1b. Horizontal structures composed of regular laminae
  2a. Laminae transversely fibrous
    3a. Pillars without radial processes, but expanding upward, many dividing .... ANOSTYLOSTROMA
    3b. Pillars with radial processes .... ATELODICTYON
  2b. Laminae transversely porous
    3c. Without ring-pillars, may have rare rings in tangential view .... STICTOSTROMA
    3d. With regular ring-pillars made of upturns of laminae .... STROMATOPORELLA

Genus **CLATHRODICTYON** Nicholson and Murie, 1878

Type species, *C. vesiculosum* Nicholson and Murie, 1878, Jour. Linn. Soc. London, Zoology, vol. 14, p. 220, pl. 2, figs. 11-13 (Mid. Silurian, Yellow Springs, Ohio); Nicholson, 1886, Palaeont. Soc. vol. 39, p. 77; vol. 42, p. 147, pl. 17, figs. 10, 11; 1887, Ann. Mag. Nat. Hist. ser. 5. vol. 19, p. 1, figs. 1-3; Twenhofel, 1927, Canada Dept Mines, Geol. Surv. Mem. 154, No. 135, p. 107; Ripper, 1937, Proc. Roy. Soc. Victoria, new ser., vol. 50, p. 1; Kühn, 1939, in Schindewolf, Handbuch Paläozoologie, Bd. 2A, p. A42; Lecompte, (part), 1951, Inst. Roy. Sci. Nat. Belgique, Mém. 116, p. 129.

Coenosteum massive or laminar; surface granular or vermicular, usually without mamelons; astrorhizae generally present; skeleton not composed of regular laminae and definite pillars, but of imperfect, cyst plates, which are placed side by side or end to end, rather than in an imbricating manner (as is true of the Labechiidae) forming vesicles, and having much the same appearance right side up or upside down; plates typically thin, and galleries or vesicles oval, small, 4 to 6 in 1 mm., vertically; pillars short, generally oblique, not superposed. The tops of the cysts atypically are in lines, like laminae, and the down-turned ends of the cyst serve as pillars. Interlaminar plates common. Tissue compact.

Late Ordovician, rare, Estonia and Anticosti Island; Silurian abundant, America, Europe, Asia, Australia, and Russia; Devonian rare, England and Ohio. About 14 species and 17 doubtful species.

Forms with regular laminae, and pillars formed separately from the laminae which include most Devonian forms previously placed in *Clathrodictyon,* belong in *Anostylostroma,* whether there are columns or not. Columns constitute a specific character of many genera, but are not a generic character. We do not consider that the species from the Permian of Japan (Yabe and Sugiyama, 1933, p. 22) is a stromatoporoid, certainly not a species of *Clathrodictyon.*

Clathrodictyon vesiculosum Nicholson and Murie Pl. 1, figs. 1a, b

Clathrodictyon vesiculosum Nicholson and Murie, 1878, Jour. Linn. Soc. London, Zoology, vol. 14, p. 220, pl. 2, figs. 11-13 (Mid. Sil., Yellow Springs, Ohio); Nicholson and Etheridge, 1880 Mon. Sil. Foss. Girvan, p. 238, pl. 19, fig. 2 (Mid. Sil., Girvan, Scotland); Nicholson, 1887, Ann. Mag. Nat. Hist., ser. 5, vol. 19, p. 1, pl. 1, figs. 1-3 (Mid. Sil., Ohio; Wenlock ls., England); 1889, Palaeont. Soc. London, vol. 42, p. 147, pl. 17, figs. 10-13; pl. 18, fig. 12 (Mid. Sil., Ohio; Wenlock ls., England); Parks, 1908, Univ. Toronto Studies, Geol. Ser. No. 5, p. 14, pl. 7, fig. 1; pl. 8, figs. 2, 4 (Mid. Sil., Ont.); 1909, *ibid.,* No. 6, p. 28; 1933, *ibid.,* No. 33, p. 9, pl. 2, fig. 2 (Mid. Sil., Port Daniel, Quebec).

Coenosteum cakelike up to 7 cm. high and 24 cm. in diameter; surface undulating but without mamelons; small scattered astrorhizae, 2 to 4 mm. in diameter, may be seen on the polished surface; latilaminae 2 to 4 mm. thick.

Vertical section.—The skeleton consists of round to oblong vesicles arranged in general horizontal but irregular and undulating lines, with irregular laminae 0.04 to 0.06 mm. thick, 14 to 18 in 2 mm. The laminae are composed of compact tissue, dusty in appearance, tending to be transversely fibrous and porous, but not maculate. The pillars are of the same thickness and composition as the laminae, and continuous with them, mostly oblique, extending through only one interlaminar space, and not superposed. Some galleries are 1 or 2 mm. long without pillars. Astrorhizal canals 0.15 to 0.2 mm. in diameter are scattered throughout the section, and the astrorhizae do not make columns. Dissepiments are common, mostly convex upward, many oblique, and some concave. There are no pseudozooidal tubes. The section has the same appearance right side up or upside down, a feature characteristic of the genus *Clathrodictyon*.

Tangential section.—The pillars are in part round, 0.1 mm. in diameter, but are mostly irregularly stellate and joining others and connected by dissepiments, making an irregular network. Astrorhizal tubes are vague, 2 to 3 mm. long, and some of our specimens have *Syringopora* tubes.

This species, the type of the genus *Clathrodictyon*, is characterized by the small, oblong vesicles in undulatory lines, but not in zigzag lines as in *C. fastigiatum* Nicholson.

Occurrence.—We have two well-preserved specimens from 2.8 mi. southeast of Marshall, Highland County, Ohio, in the Lilley formation, collected by R. S. Bowman. The species is of widespread occurrence: the Lower Silurian of Anticosti Island, and in the Brassfield limestone near Richmond, Indiana. It occurs in the Middle Silurian of Ontario, Quebec, England, Scotland, Estonia, Germany, and the Arctic.

Plesiotypes.—Indiana University Paleontological Collections, from the Louisville limestone, Charlestown, Ind., slides 303-65, 66. Cat. No. 5365.

The genus *Clathrodictyon*, with its vesicular character, has been confused with *Anostylostroma* which has definite laminae and vertical, short pillars. The description and figures of typical examples of the type species of *Clathrodictyon* are here included to emphasize the true characters of the genus.

Clathrodictyon confertum Nicholson Pl. 1, figs. 2a, b

Clathrodictyon confertum Nicholson, 1889, Palaeont. Soc. London, vol. 42, p. 154, pl. 18, figs. 13, 14 (Mid. Dev., Dartington, England).

Coenosteum massive, 4 cm. high and 9 cm. in diameter. The surface is smooth, without mamelons or papillae. Although astrorhizae are observed in tangential section, they were not detected on the surface of the specimen. Latilaminae are 2 to 3 mm. thick.

Vertical section.—Laminae are thin, 0.03 to 0.06 mm. thick, 16 to 20 in 2 mm., and undulatory, turning down into short pillars.

Pillars coalesce with the laminae, and are 0.03 to 0.06 mm. broad, 7 to 9 in 2 mm. The laminae are rows of closely appressed cyst plates, composed of a single layer of compact tissue, spotted with many irregular minute flecks of dark material, tending to be transversely fibrous and porous, but not maculate. The galleries are subrectangular to vesicular, 0.06 to 0.10 mm. high and 1 to 6 times as broad. Astrorhizal tubes or canals are scarcely distinguishable from large galleries.

Tangential section.—The pillars are round, 0.06 to 0.10 mm. in diameter, 0.05 to 0.11 mm. apart; some are connected by one or more thin, radial rods, 0.01 to 0.02 mm. broad. The tissue of the pillars is compact, dusty, and radially fibrous. The astrorhizae are composed of a few long, sinuous, radial canals 0.13 to 0.17 mm. broad, which bifurcate once or twice, with a central tube about 0.2 mm. in diameter.

Clathrodictyon confertum is characterized by the large number of laminae and pillars in 2 mm. Our specimen differs from the type in having astrorhizae, though Nicholson said that the specimen from Dartington was so poorly preserved that details were difficult to determine. It differs from *C. vesiculosum* in the smaller and more closely appressed cysts. The above described specimen is the only Devonian genuine *Clathrodictyon* known from North America.

Occurrence.—The specimen was borrowed from the Ohio State University Museum collections and is reported to be from the Middle Devonian, Columbus limestone at Dublin, Ohio.

Plesiotype.—Indiana University Paleontological Collections, slides 305-97, 98, Cat. No. 5394; Ohio State University Museum Collections, specimen 3760, and 2 slides.

Genus **ANOSTYLOSTROMA** Parks, 1936

Type species, *A. hamiltonense* Parks, 1936, Toronto Studies, Geol. Ser., No. 39, p. 44 (Mid. Dev., Traverse gr., Long Lake, Mich.).

Clathrodictyon (part) of authors, including forms with definite laminae and pillars.

Stylodictyon Parks (not Nicholson and Murie, 1878), 1908, Univ. Toronto Studies, Geol. Ser., No. 5, p. 29, pl. 12, figs. 1, 2; Kühn, 1939, in Schindewolf, Handbuch Paläozoologie, Bd. 2A, p. A43, fig. 60; Shimer and Shrock, 1944, Index Fossils N. A., p. 61, pl. 18, fig. 23, 24.

Coenosteum flat to massive, composed of definite laminae and separate pillars; laminae thin to medium, transversely fibrous or porous, and containing small vacuities in typical species; pillars in vertical section short, expanding, dividing and becoming vacuolate or Y-shaped at the top, or breaking into many secondary pillars, rarely superposed; pillars in tangential section round, elongate, vermicular, branching and confluent, or ringlike; galleries high, frequently with dissepiments; pillars transversely fibrous; skeleton without or with columns formed by superposed uparched laminae and thicker pillars; astrorhizae present or absent.

Middle Devonian, America, Europe, Asia, Africa, and Australia. Fifty or more species. The most abundant Middle Devonian genus.

Anostylostroma includes forms with vacuoles in the heads of expanding pillars, as *A. hamiltonense* Parks, forms with pillars breaking into strands, as *A. substriatellum* (Nicholson), and forms with thin laminae and pillars, as *A. laxum* (Nicholson). *Anostylostroma* includes most Devonian and some Silurian species heretofore assigned to *Clathrodictyon,* those composed of laminae and short pillars rather than of cysts; it also includes Lecompte's "Group II" (1951, p. 133).

KEY TO SPECIES OF ANOSTYLOSTROMA FROM MIDWESTERN NORTH AMERICA

1a. Mamelons present, some small as papillae, not mere undulations
  2a. Mamelons small, 1 to 5 mm. in diameter, 2 to 10 mm. apart
    3a. Mamelons making continuous columns
      4a. Laminae complete, continuous
        5a. Columns 1 to 8 in 1 sq. cm.
          6a. Columns 6 to 8 in 1 sq. cm. .... *A. columnare* (Parks)
          6b. Columns 3 to 5 in 1 sq. cm. ......*A. mediale,* n. sp.
        5b. Columns 10 to 16 in 1 sq. cm.
          6c. Pillars round to oval in tangential section
            7a. Coenosteum hemispherical

8a. Pillars thick .... *A. pulpitense,* n. sp.
8b. Pillars thin, rodlike *A. subcolumnare,* n. sp.
7b. Coenosteum nodular ....*A.* undescribed, n. sp.
6d. Pillars mostly confluent in tangential section ....*A. confluens,* n. sp.
5c. Columns 16 to 25 in 1 sq. cm.
6e. Pillars rodlike, not Y-shaped ....*A. crebricolumnare,* n. sp.
6f. Pillars Y-shaped ....*A. papillatum* Parks
5d. Columns about 30 in 1 sq. cm. ....*A. microcolumnare,* n. sp.
4b. Laminae intermittently developed horizontally
5e. Columns about 1 mm. in diameter ....*A. microtuberculatum* (Riabinin)
5f. Columns about 3 mm. in diameter ....*A. microtuberculatum* (Riabinin)
3b. Mamelons not making continuous columns
4c. Two mamelons in 1 sq. cm.; laminae close, 6 to 10 in in 2 mm. ....*A. compactum,* n. sp.
4d. Three mamelons in 1 sq. cm.; laminae far apart, 4 to 5 in 2 mm. ....*A. dupontense,* n. sp.
2b. Mamelons large, 5 to 15 mm. in diameter, 10 to 20 mm. apart
3c. Mamelons irregular, 2 to 5 mm. high
4e. Laminae regular
5g. Dissepiments scarce ....*A. arvense* (Parks)
5h. Dissepiments abundant ....*A. ponderosum* (Nicholson)
4f. Laminae irregular, crumpled ....*A. insulare* (Parks)
3d. Mamelons regular, low, 1 to 2 mm. high *A. humile,* n. sp.
1b. Mamelons normally absent, not counting irregular undulations
2c. Pillars not dividing into strands, may be Y-shaped
3e. Pillars without median dark line; no rings like ring-pillars ....*A. laxum* (Nicholson)

3f. Pillars with median dark line; some rings resembling ring-pillars .... *A. meshbergerense*, n. sp.

2d. Pillars dividing upward into strands

3g. Pillars not superposed

4g. Pillars thin, largely not confluent .... *A. substriatellum* (Nicholson)

4h. Pillars thick, confluent in tangential section .... *A. hamiltonense* Parks

3h. Pillars normally superposed .... *A. pipecreekense*, n. sp.

Anostylostroma columnare (Parks) **Pl. 1, figs. 3a, b**

Clathrodictyon laxum columnare Parks, 1936, Univ. Toronto Studies, Geol. Ser., No. 39, p. 16, pl. 9, figs. 5, 6 (Columbus ls., Marblehead, Ohio).

Coenosteum a large, flat mass, up to 20 cm. in diameter and 15 cm. thick; surface with small, domal mamelons, 2 mm. in diameter and 4 to 5 mm. apart, from center to center, 6 to 8 in 1 sq. cm., and small papillae, the ends of pillars; astrorhizae absent; latilaminae obscure, 2 to 3 mm. thick.

Vertical section.—The skeleton is delicate, composed of thin laminae and thin, short pillars, making a loose network, and small columns, 2 mm. in diameter, with thicker laminae and thicker pillars. The laminae are variably spaced, 4 to 7 in 2 mm., 0.04 mm. thick between columns and up to twice as thick in the columns. The laminae are composed of only one layer of transversely fibrous tissue, in places appearing porous, but not maculate. The pillars are 1 to 2 times as thick as the laminae, are short, rarely superposed, some reaching only part way across the interlaminar space from the floor or the ceiling. The pillars are mostly straight, expanding upward, some dividing upward and becoming Y-shaped. The pillars are variably spaced, from 0.2 to 2 mm. apart, averaging 5 in 2 mm. The galleries are in general rectangular. In the columns the laminae rise at angles up to 45° and thicken. The pillars are much thickened, divergent and anastomose in the columns. The tissue of the pillars is darker, more compact and homogeneous than that of the laminae, and transversely fibrous. In the centers of some of the columns there is a tube up to 0.7 mm. in diameter, with thick walls and thin, straight and curved diaphragms. Dissepiments are common but unequally distributed. In specimens which have been crushed before fossilization the laminae make a confused mass of laminae and pillars; the denser columns are also crushed.

Tangential section.—The columns make conspicuous, concentric rings of two to six laminae, the centers being occupied by thick, radiating pillars separated by oblong galleries; in some columns there is a small axial tube, 0.17 mm. in diameter, and rarely a large tube up to 0.7 mm. in diameter. Between the columns the pillars are in part round, 0.08 to 0.12 mm. in diameter, in part making short, straight or curved lines, which may join, and some are joined by curved dissepiments. There are no astrorhizae.

The structure of the skeleton of *A. columnare* is more open and delicate than that of most other stromatoporoids, expecting the closely related species *A. laxum* (Nicholson), which lacks columns, and *A. arvense* (Parks), which has larger but less regular mamelons and columns. The structure is coarser than that of *A. subcolumnare,* which may be confused with it; the columns are larger and the laminae and pillars thinner and farther apart in *A. columnare.*

Occurrence.—Common in the Columbus limestone of Marblehead, Kelleys Island, and Dublin, Ohio. Reported by Parks (1936, p. 17) from Williamsville, N. Y., presumably from the Onondaga limestone. Abundant in the Jeffersonville limestone at the Falls of the Ohio, Jeffersonville, Ind., Charlestown, Ind., and in the quarry of the Scott County Stone Company, two miles south of Blocher, Ind.

Plesiotype.—Indiana University Paleontological Collections, slides 282-24, 25, 63, 64, 65, 66, 67, 68, 69, 70; 297-26, 27, 28, from the Columbus limestone, quarry at Marblehead, Ohio. Cat. No. 5395. Jeffersonville limestone, Charlestown, Ind., slides 285-1, 2, 3, 4, 5; Falls of the Ohio, 272-9, 10; 275-24, 25; 295-28, 29, 40, 41, 42, 43, 46, 47, 50, 51, 52, 53, 68, 69, 70, 71; 304-96, 97; 305-3, 4.

Anostylostroma mediale Galloway and St. Jean, n. sp., Pl. 1, figs. 4a, b

Coenosteum a flat or hemispherical head, at least 13 cm. in diameter and 10 cm. high; surface with close-set, variable, low mamelons, 2 to 5 mm. in diameter, 1 to 2 mm. high, and nearly touching at their bases, about 3 to 5 in 1 sq. cm.; also with low, round and elongate papillae; astrorhizae were not observed; latilaminae conspicuous, 3 to 5 mm. thick.

Vertical section.—The skeleton is composed of strong laminae and strong, short pillars. The laminae rise into the mamelons, some of which have an axial tube 0.2 to 0.3 mm. in diameter, and have thicker, diverging pillars. The laminae are rather thick and variable from lamina to lamina, 0.06 to 0.12 mm. thick, consisting of a light-colored, transversely porous layer, below which there may be a secondary, gray layer derived from the pillars and in places a thin upper, gray layer, also derived from the pillars; there are five or six laminae in 2 mm. The pillars are thick, 0.1 mm. or more, expanding upward, rarely becoming Y-shaped, five or six in 2 mm., rarely superposed, and do not pierce the laminae. The tissue of the pillars is gray in color, and transversely fibrous. The galleries are vaulted to triangular in shape, rarely with a foramen between superposed galleries, but there are no pseudozooidal tubes. Many mamelon columns have a tubular axis 0.2 to 0.3 mm. in diameter. Dissepiments are rare to absent.

Tangential section.—Pillars are round in part but are mostly oval, elongate, bent, and some join others. The laminae make eccentric curves around the mamelons, and continuous contours between the mamelons, best seen with a hand lens. The tissue of the laminae is yellowish in color and made up of small polygons. The tissue of the pillars is gray in color, and radially or transversely fibrous. Astrorhizae were not observed on large surfaces nor in sections of six specimens. Many mamelons have a single, round tube, 0.2 to 0.3 mm. in diameter. Dissepiments are rare.

The species has smaller mamelons than *A. humile* and inconspicuous mamelon columns, and larger mamelons than *A. pulpitense* and lacks as well-defined mamelon columns. The columns are larger and less regular than they are in *A. columnare,* and laminae and pillars are thicker. It lacks the confluent pattern of the pillars of *A. confluens.* It differs from *A. dupontense* in the thicker laminae, thicker pillars which are not superposed, and less definite mamelon columns.

Occurrence.—Abundant in the lower 10 feet of the Logansport limestone in the France Lime and Stone Company quarry, 5 miles east of Logansport, Ind., and in the Logansport limestone, Pipe Creek Falls, 10 miles southeast of Logansport, Ind.

Holotype.—Indiana University Paleontological collections, slides 304-5, 6. Cat. No. 5324.

Paratypes.—Slides 285-86, 88, 89; 294-2, 3, 6, 7; 303-53, 54, 59, 60, 71, 72; 305-5, 6.

Anostylostroma pulpitense Galloway and St. Jean, n. sp. Pl. 2, figs. 1a, b

Coenosteum massive, hemispherical to high domed, up to 10 cm. high and 16 cm. in diameter. The surface has small, low, domal mamelons, 1.5 to 2 mm. in diameter, 0.7 mm. high, and about 3 mm. apart from center to center, 10-16 per square centimeter; papillae are small, low, domes. Astrorhizae apparently absent; latilaminae 2 to 3 mm. thick.

Vertical section.—The skeleton is composed of undulatory laminae, short pillars and small columns. The laminae are light in color, transversely fibrous, variable in thickness, 0.05 mm. to 0.09 mm. They turn smoothly into the mamelon columns, which are 2.0 mm. in diameter and 1 to 5 mm. apart. There are seven laminae in 2 mm. in the type specimen and from 5 to 9 in 2 mm. in other specimens. The pillars expand upward but are not Y-shaped are short, straight, and 0.07 mm. in average diameter, but vary from 0.03 to 0.11 mm. in diameter and are thicker and divergent in the mamelon columns. The pillars are transversely fibrous, superposed in a few places over a distance of as much as five or six laminae. Dissepiments are rare to absent. The galleries are round or oval to rectangular, tending to be mostly round in the mamelon columns, averaging 0.22 mm. high and about 1.5 times as broad.

Tangential section.—The columns are composed of a few rings of laminae and thick radial pillars, are about 2 mm. thick and 3 mm. apart. The pillars are round to vermicular, from 0.03 to 0.11 mm. in diameter, averaging 0.07 mm., and do not become confluent with other pillars. The galleries represent about 60 percent of the area of the thin section, and are continuous around the pillars.

This species is characterized by the small mamelon columns, about 12 per square centimeter, by the upward broadening pillars, by the almost total lack of dissepiments, and by the compact, transversely fibrous tissue in the laminae and pillars. It differs from *A. humile*, the most closely related form, in the regular, small columns, and from *A. confluens* in the lack of regularly confluent pillars, both of which occur with it. *A. pulpitense* differs prominently from *A. columnare* (Parks) in the smaller, more numerous mamelon columns and the thicker pillars.

Occurrence.—*Anostylostroma pulpitense* occurs in the lower 10 feet of the Logansport limestone at Pulpit Rock, 3 miles east of Logansport, Ind., for which locality the species is named. It is rare in the same horizon at Pipe Creek Falls, 10 miles southeast of Logansport, and abundant in the same horizon at the France Lime and Stone Company quarry, 5 miles east of Logansport. A very similar form occurs in the limestone above the Dock Street clay in the Thunder Bay quarry, Alpena, Mich.

Holotype.—Indiana University Paleontological Collections, slides 278-10; 303-51, 52. Cat. No. 5343.

Paratypes.—Slides 275-18; 285-86, 87; 294-1, 34, 35, 42, 43, 44, 45, 46; 295-83, 84; 303-57, 58, 84, 85.

Anostylostroma subcolumnare Galloway and St. Jean, n. sp.
Pl. 2, figs. 2a, b

Stylodictyon columnare Parks, (not Nicholson) 1908, Univ. Toronto Studies, Geol. Ser. No. 5, p. 29, pl. 12, figs. 1, 2 (Mid. Dev., Jeffersonville ls., Louisville, Ky.); Kühn, 1928, Foss. Cat., Hydrozoa, p. 37; 1939, in Schindewolf. Handbuch Paläozoologie, Bd. 2A, p. A43, fig. 60 (not Sil., but Dev.); Shimer and Shrock, 1944, Index Fossils N. A., p. 61, pl. 18, figs. 23, 24 (not Traverse, but Jeffersonville ls.).

Coenosteum massive, 6 cm. high, 13 cm. in diameter. The surface has small high mamelons or papillae, 1 mm. in diameter, 1 mm. high, 2 to 3 mm. apart from center to center, 14 in 1 square centimeter. Astrorhizae are absent; latilaminae are 1 to 2 mm. thick.

Vertical section.—The laminae are thin, seven to eight in 2 mm., and turn sharply into the mamelon columns at angles up to 60°. The laminae are composed of a single layer of compact, transversely fibrous tissue, 0.03 mm. thick. The pillars are narrow but flare slightly toward the top, twice as thick as the laminae, 0.06 mm. broad, five to six in 2 mm., rarely superposed, considerably thickened, close together and divergent in the small mamelon columns, which are about 1 mm. in diameter. Galleries are rectangular, many are vertically elongate, 0.17 mm. high and 0.21 mm. broad, varying considerably in breadth. Dissepiments are rare, irregular in size and shape, convex upward, 0.013 mm. thick. There are small vacuities in the thickened tissue.

Tangential section.—The skeletal tissue represents about 30 percent of the thin section. The pillars are round between the laminae, 0.06 mm. in diameter, many becoming elongate and joining near the laminae. The columns are outlined by two to four annuli, and radial pillars; the columns have one to several axial tubes.

Anostylostroma subcolumnare is characterized by the thin laminae, small, round pillars, and small, closely spaced columns. It differs from *A. columnare* (Parks) in having smaller, more closely spaced columns and closer laminae and pillars.

Parks (1908, p. 29) described as "*Stylodictyon columnare,*" a specimen in the U. S. National Museum collections, reported to be from the Middle Silurian from near Louisville, Ky. He expressed doubt as to its being Silurian and as to its being Nicholson's *Stylodictyon columnare.* It is not Silurian but is from the Jeffersonville limestone which occurs near Louisville. Parks' illustrations indicate that the columns are small and close together, as in *A. subcolumnare,* n. sp., but not as in *A. columnare* (Parks). Shimer and Shrock (1944, p. 61) correctly placed the U. S. National Museum specimen in the Devonian, but it is from the Jeffersonville limestone rather than from the Traverse group. It cannot be *Stylodictyon columnare* (Nicholson), which is a species of *Syringostroma,* different from *Anostylostroma.* The mistaken identification of *Stylodictyon columnare* by Parks has caused much confusion.

Occurrence.—One good specimen was collected from the Middle Devonian, Jeffersonville limestone, on Highway 42, at 3.3 miles southwest of Prospect, near Louisville, Ky., by Mr. Preston McGrain and Mr. F. H. Walker of the Kentucky Geological Survey.

Holotype.—Indiana University Paleontological Collections, slides 305-34, 35. Cat. No. 5387.

Anostylostroma confluens Galloway and St. Jean, n. sp. Pl. 2, figs. 3a, b

Coenosteum head-shaped, more than 8 cm. high and 15 cm. in diameter. The surface has small monticules, 1 to 1.5 mm. in diameter, 0.5 mm. high, and 2 to 3 mm. apart from center to center. The surface is also covered with minute papillae and punctae, representing pillars and galleries. Astrorhizae are absent. Latilaminae, 2 to 8 mm. thick, are conspicuous on both the freshly cut and the weathered surface. The laminae are more finely undulatory than the latilaminae and curve up into the monticules, forming vertical columns.

Vertical section.—The laminae are moderately thick, averaging about 0.08 mm., seven to nine in 2 mm. The tissue of the laminae is compact but light in color, and contains many fine, transverse pores. The columns are straight, continuous, about 1.5 mm. in diameter, and are made by upturned laminae, and thick, divergent pillars. The galleries are oval or lobed, especially in the columns, and about four times as high as the laminae are thick. In the intercolumnar area the galleries become much wider and tend to be rectangular. Superposed galleries are rare, and may be connected by large pores.

The pillars are short, thick and expand upward, many are unbranched, but some are Y-shaped and many divide into strands producing the confluent small pillars as seen in tangential section. There is an average of eight pillars in 2 mm. The pillars are thicker and more divergent in the columns than in other areas. Occasionally a pillar does not extend the whole interlaminar distance, which is due to cutting the flare of the pillar. The pillars are darker in color, denser in structure than the laminae, and are composed of transversely fibrous tissue. The pillars are not superposed. There are a few cyst plates passing diagonally through the galleries.

Tangential section.—The columns appear as rings, 1 to 1.5 mm. in diameter, filled with round, radial or confluent pillars. There are no tubes in the columns. The pillars are round when cut beneath the upward expansion, and highly vermicular and coalescing when cut in the upper branched part, the pattern becoming finer and finer as the laminae are approached. The larger pillars are about 0.1 mm. in diameter and about 0.2 mm. apart. The tissue in the pillars is darker colored than in the laminae and is tranversely fibrous, and radially fibrous in round pillars. There are a few short, curved dissepiments. No astrorhizae occur either at the surface or in sections.

The confluent pillars may form closed rings in tangential section, but the rings differ from those in *Stromatoporella* in that they are formed entirely by the confluent pillars, whereas in *Stromatoporella* the ring-pillars are produced by upturned laminae.

The confluent pillars are the most diagnostic characteristic of the species. It differs from *A. papillatum* Parks (1936, p. 50) in the greater display of confluent pillars and geometric patterns as seen in tangential section. The name *A. confluens* refers to the confluent nature of the pillars as seen in a tangential section.

Occurrence.—The type specimen is from the Logansport limestone at Pipe Creek Falls, 10 miles southeast of Logansport, Indiana, where it occurs commonly, and is perfectly preserved by infiltration of calcite.

Holotype.—Indiana University Paleontological Collections, slides 285-24, 25, 26. Cat. No. 5352.

Paratypes.—Slides 295-85; 305-3, 4.

Anostylostroma crebricolumnare Galloway and St. Jean, n. sp.
Pl. 2, figs. 4a, b

Coenosteum massive, a fragment is 8 cm. high and 15 cm. in diameter. Surface with sharp, conical mamelons, 1.5 to 2 mm. in diameter, 2 mm. high and 2 to 3 mm. apart from center to center, and 16 to 20 in 1 sq. cm. Astrorhizae absent; latilaminae vague, 3 to 5 mm. thick.

Vertical section.—The skeleton appears as a complex, lacy network, composed of sharply undulose laminae, short rodlike pillars, strong columns, and dissepiments. The laminae are 0.05 mm. thick, 4 to 5 in 2 mm., and are discontinuous in most of the columns. The pillars are short and stout, many do not extend across the interlaminar spaces, are four to five in 2 mm. and are thicker and closer together in the mamelons. The dissepiments are large, thin, highly arched, larger and more obvious in the galleries between the columns. The galleries are large, 0.35 to 1.5 mm. long and 0.2 to 0.7 mm. high, rectangular, or curved. The columns are long, narrow, 1.5 to 2 mm. thick, and closely spaced, 1 to 2 mm. apart, composed of sharply upturned laminae and thickened pillars. Some of the columns have tabulate tubes, up to 0.4 mm. broad. One or a few rows of superposed galleries, which are not vertical tubes, separate the mamelon columns. The tissue is compact, transversely fibrous, and dusty in appearance.

Tangential section.—The tissue occupies about one-quarter of the thin section. The columns are indicated by a confused radial arrangement of thick, branching pillars; some columns are marked by an annulus or two of laminae, but in most of the section, laminae are not discernible. The pillars between columns are round, 0.06 to 0.12 mm. in diameter. There is a tube in about one-tenth of the columns, from 0.11 to 0.28 mm. in diameter. The galleries are oval or rectangular where laminae are developed, or irregular. Dissepiments join some of the pillars but are inconspicuous. Astrorhizae absent.

Anostylostroma crebricolumnare is characterized by the sharp, small mamelons, closely spaced columns of upturned laminae and pillars, the rodlike pillars, and the file of galleries between two columns. The Latin *creber,* means close together, referring to the closely spaced columns. *A. crebricolumnare* differs from *A. subcolumnare,* n. sp. in the fewer laminae in 2 mm. and the thicker, discontinuous laminae.

Occurrence.—This species occurs in the Middle Devonian, Hamilton group, Little Rock Creek limestone, 10 to 30 feet above the Silurian—Devonian contact, at the France Lime and Stone Company quarry, 5 miles east of Logansport, Indiana.

Holotype.—Indiana University Paleontological Collections, slides 294-85, 86. Cat. No. 5344.

Paratype.—Slides 294-83, 84.

Anostylostroma microcolumnare Galloway and St. Jean, n.sp.
Pl. 3, figs. 1a, b

Coenosteum a large head, 15 cm. in diameter and 10 cm. high.

The surface has small, regular mamelons or papillae, scarcely 1 mm. in diameter and 0.25 mm. high, 2 mm. from center to center, and about 30 in 1 sq. cm. Astrorhizae absent; latilaminae 2 to 3 mm. thick.

Vertical section.—The laminae are fairly uniform in thickness, composed of only one layer, 0.05 to 0.07 mm. thick, about six or seven in 2 mm., the tissue light-yellow in color, and finely fibrous transversely. The pillars are thick, 0.12 to 0.15 mm. broad, 3 to 6 in 2 mm., gray in color, transversely fibrous, and expand upward, but do not split into fibers, few are Y-shaped, and only incidentally superposed. The columns are small, mostly less than 1 mm. wide, and 2 mm. from center to center; they are made of smooth upturns of the laminae and thicker, diverging pillars. Galleries are mostly arched, higher than wide, but some are 1 mm. or more wide. Superposed galleries do not have foramina between; dissepiments are exceedingly rare.

Tangential section.—The columns are small, 1 mm. in diameter, but conspicuous, composed of one annular lamina, with thick, close-set, oval or elongate pillars which tend to have a radial arrangement. Between the columns the pillars are mostly round, 0.1 mm. in diameter, but some are oval, few are elongate, and rarely join other pillars. Dissepiments are practically absent. Astrorhizae absent.

This species is characterized by the small columns, suggesting its name, the broad pillars which do not divide and are rarely superposed in longitudinal section and do not become confluent in tangential section, and the scarcity of dissepiments. The columns are much smaller than they are in *A. pulpitense,* with which it occurs.

Occurrence.—One specimen was collected from the Middle Devonian Logansport limestone at Pipe Creek Falls, 10 miles southeast of Logansport, Ind.

Holotype.—Indiana University Paleontological Collections, slides 304-87, 88, 89. Cat. No. 5353.

Anostylostroma microtuberculatum (Riabinin) Pl. 3, figs. 2a, b

Stromatopora microtuberculata Riabinin, 1941, U. S. S. R. Acad. Sci., Palaeont. Inst., Moscow, vol. 1, p. 108, pl. 4, figs. 2-4 (U. Dev., Chudova beds, Kharlopekova village, Main Devonian Field, Russia).

Coenosteum a flat mass, 4 cm. thick and 14 cm. in diameter. Surface with small, conical mamelons, 3 mm. in diameter, 4 mm. high, and averaging 4 to 5 mm. from center to center, seven to nine in 1 sq. cm. Astrorhizae small, 3 mm. in diameter, with three to five short, radiating canals; latilaminae scarcely discernible.

Vertical section.—The skeleton consists of thin laminae, thick, short pillars and small columns. The laminae are thin, 0.03 mm. thick, eight in 2 mm., and missing in much of the section, their position being indicated by the concordant bases of the pillars. Pillars short and broad, six in 2 mm., many superposed, especially in the columns, mostly appearing as large dots, especially between the columns. Galleries vaguely round, many confluent horizontally, superposed in the columns, making pseudozooidal tubes. The laminae undulate regularly, upward in the columns and downward between columns. Dissepiments rare. In the columns the pillars are larger, superposed and diverge strongly. The axes of the columns are mostly occupied by astrorhizal tubes, 0.4 to 0.6 mm. in diameter, with astrorhizal canals extending diagonally downward. The tissue is compact, gray, transversely fibrous and dusty in appearance, but not maculate.

Tangential section.—The columns are about 3 mm. in diameter, 3 to 5 mm. apart, and composed of a darker central part, each with an oval or lobed axial tube; the columns are composed of radiating pillars and vague, concentric laminae. The astrorhizal canals are short, and scarcely extend beyond the columns, and branch sparingly. Between the columns the pillars are mostly oval, many joining others. The tissue is compact and transversely fibrous, but not maculate. Dissepiments rare or absent.

This species is characterized by the small columns, undulating discontinuous laminae, and short and thick pillars. It is similar to *A. retiforme,* but has larger columns, higher undulations of the laminae, and the axial tubes are not round.

The Indiana form seems to be identical with Riabinin's Upper Devonian form from Russia, excepting that the mamelons are larger, 3 instead of 2-2.5 mm. in diameter. The name *microtuberculatum* is scarcely appropriate; there are many forms with smaller mamelons in various genera. It is not a *Stromatopora,* for the tissue is not maculate.

Occurrence.—Abundant in the Middle Devonian, Little Rock Creek limestone, 10 to 30 feet above the base, in the France Lime and Stone Company quarry, 5 miles east of Logansport, Ind.

Plesiotype.—Indiana Paleontological Collections, slides 294-50, 51, 53, 55, 60, 61, 65, 72, 73, 89, 90, 97, 98; 303-22, 23, 80, 81. Cat. No. 5345.

Anostylostroma compactum Galloway and St. Jean, n. sp., Pl. 3, figs. 3a,b

Coenosteum massive, 5 cm. high and 9 cm. in diameter; the holotype is attached to a specimen of *Anostylostroma pulpitense.* Surface with low, domal mamelons, 4 to 5 mm. in diameter, 1 to 2 mm. high, 5 to 8 mm. apart, about two in 1 sq. cm.; astrorhizae absent; latilaminae 2 to 5 mm. thick.

Vertical section.—The laminae are strong, undulating, 0.07 to 0.10 mm. thick, 6 to 10 in 2 mm. and curve smoothly into the mamelons; the laminar tissue is light in color, compact or flocculent in appearance, and composed of fine, transverse fibers, without visible pores. The mamelons rise and disappear within a latilamina and do not make continuous columns. The pillars are mostly straight, expanding slightly upward, from 0.07 to 0.1 mm. thick, fairly evenly spaced, about five in 2 mm., a little thicker and more flaring in the mamelons, rarely superposed. The pillar tissue is darker than that of the laminae, finely fibrous transversely, in some pillars with a darker median line. The laminae and pillars make a rather regular brickwork. The galleries are generally rectangular, twice as broad as high. Dissepiments are rare, long and convex upward.

Tangential section.—The pillars are mostly round with fuzzy outlines, about 0.1 mm. in diameter, dark gray and radially fibrous, some oval, but are rarely vermicular or confluent, as is common for the genus. The laminae are light in color, and composed of a finely granular and fibrous mosaic.

A. compactum is characterized by the low mamelons, closely spaced laminae, round pillars and rare dissepiments. The name *compactum* refers to the compact appearance of the polished edge.

A. compactum is similar to *A. clarum* (Počta, 1894, p. 150, pl. 18, figs. 7, 8), but Počta gives no tangential section, so we cannot tell what shape the pillars have. Le Maître (1933, p. 16) studied Počta's type and considered the Etroeungt specimens to be identical, but she figured (pl. 19, figs. 1-5) astrorhizae and vermicular and confluent pillars, which the Indiana form does not have.

Occurrence.—One specimen from the Middle Devonian, lower Logansport limestone of Pipe Creek Falls, 10 miles southeast of Logansport, Indiana, attached to *Anostylostroma pulpitense*, n. sp.

Holotype.—Indiana University Paleontological Collections, slides 305-48, 49. Cat. No. 5354.

Anostylostroma dupontense Galloway and St. Jean, n. sp., Pl. 3, figs. 4a, b

Coenosteum massive, laminar, a fragment is 15 mm. high, 85 mm. in diameter. The surface has mamelons 4 to 5 mm. in diameter, 1.5 to 2 mm. high, 6 mm. apart from center to center, three in 1 sq. cm. Papillae are small, round to irregular prominences on a weathered surface. Latilaminae 2 to 3 mm. thick; astrorhizae absent.

Vertical section.—The laminae are variable in thickness, turn gently into the mamelons, are composed of a single layer of light, transversely fibrous tissue, 0.03 to 0.16 mm. thick, averaging 0.09 mm., four to five in 2 mm. The pillars are thick and flare upward, though few are Y-shaped, and are superposed in many places, averaging 0.13 mm. broad, four to five in 2 mm. The pillars are darker in color than the laminae, are transversely fibrous, and are the same in the mamelons as in the intermamelon areas. The galleries are subrectangular, and irregular, tending to be higher than broad, especially in places where the pillars are predominantly superposed, averaging 0.26 mm. broad and 0.28 mm. high. The dissepiments are rare, small, convex upward, transverse, or oblique. An occasional mamelon column has a tube 0.2 mm. in diameter.

Tangential section.—The skeletal tissue represents about 50 percent of the thin section. The pillars are round to vermicular and confluent, forming rings in some places, especially near the laminae, due to the upward splitting of the pillars. The pillars average 0.11 mm. in diameter and are about 0.12 mm. apart, and the tissue is radially or transversely fibrous. The galleries anastomose about the pillars. There are no astrorhizae. Dissepiments are absent in most of the section but common in places.

Anostylostroma dupontense is characterized by low mamelons, thick to thin, widely spaced laminae, thick, flaring pillars which are superposed in many places, and by the lack of astrorhizae. *A. dupontense* is nearly identical with *A. mediale,* having thicker, more widely spaced laminae, superposed pillars, and less definite mamelon columns.

Occurrence.—One specimen was collected by Mr. W. E. Craig, from the Middle Devonian, Jeffersonville limestone in the Independent quarry, 4 miles south of Dupont, Indiana.

Holotype.—Indiana University Paleontological Collections, slides 305-40, 41. Cat. No. 5366.

Anostylostroma arvense (Parks) Pl. 4, figs. 1a, b

Clathrodictyon arvense Parks, 1936, Univ. Toronto Studies, Geol. Ser., No. 39, p. 23, pl. 3, figs. 1-4 (M. Dev., Onondaga ls., Simcoe, Ont.)

Coenosteum flat massive, up to 60 mm. thick; surface undulating, with large, irregular mamelons, 5 to 8 mm. in diameter, 5 mm. high, and 10 to 15 mm. apart; astrorhizae absent; latilaminae 3 to 4 mm. thick.

Vertical section.—The laminae are thin, 0.05 to 0.06 mm. thick, and variously spaced, four to six in 2 mm., consisting of one layer, which is light in color and transversely fibrous. Pillars darker than the laminae, transversely fibrous, narrow, 0.06 to 0.08 mm. wide, some enlarging upward but not Y-shaped, variable in arrangement, mostly straight, diverging in the mamelons, and frequently superposed. Galleries quadrangular, narrow or wide transversely, some connected by foramina through the laminae. Dissepiments common, arched upward or oblique. Mamelons irregularly developed, continuing through several latilaminae, a few with an axial tube, and some with thick, diverging pillars.

Tangential section.—The pillars are mostly round, 0.08 to 0.15 mm. in diameter, radially fibrous but not maculate, many joined by curved dissepiments. In the mamelon axes the pillars are vermicular, angled and many join others. Laminae are thin, light in color, transversely fibrous, and make large annuli in the mamelons, in which there is an occasional irregular tube.

A. arvense lacks the regular, small columns of *A. columnare,* and has more mamelons of various sizes than *A. laxum,* and is intermediate between the two, with which it occurs; the superposed pillars are common, whereas in *A. columnare* and *A. laxum* they are rare. We have studied Parks' type, and find it, as Parks stated (1936, p. 24), much like *A. laxum,* but still distinguishable from it. *A. arvense* is scarcely distinguishable from *A. ponderosum,* having thinner laminae, and may well be the same species.

Occurrence.—Onondaga limestone, Simcoe, Ont.; Columbus limestone, Marblehead, Ohio, (slides 282-72, 73, 74); Jeffersonville limestone of Charlestown, Ind., (282-9), Meshberger quarry in Bartholomew Co., Ind., and elsewhere in Clark Co., Ind., and Jefferson County near Louisville, Kentucky. It should occur at the Falls of the Ohio, but we have no specimen in a large collection.

Plesiotypes.—Indiana University Paleontological Collections, slides 272-15, 16; 282-9, 72, 73, 74; 302-64, 65; 303-77, 92, 93; 305-19, 20. Cat. No. 5396.

Anostylostroma ponderosum (Nicholson) Pl. 4, figs. 2a, b

Stromatopora ponderosa Nicholson, 1875, Geol. Surv. Ohio, vol. 2, pt. 2, p. 246, pl. 24, figs. 4, 4a, 4b (M. Dev., Columbus ls., Kelleys Island, Ohio).

Clathrodictyon ponderosum Parks, 1936, Univ. Toronto Studies, Geol. Ser., No. 39, p. 42, pl. 5, figs. 5, 6 (Columbus ls., Kelleys Island and Marblehead, Ohio).

Coenosteum large, massive, hemispherical, up to 15 cm. in diameter. We have a nearly complete specimen 10 cm. in diameter and 25 cm. high, growing around a rugose coral. Surface with large mamelons of variable size, 5 to 10 mm. in diameter, 2 to 4 mm. high and 10 to 15 mm. apart. Astrorhizae not apparent. Surface papillate, the outer ends of round pillars. The papillae are not perforate, as figured by Nicholson, (fig. 4a), which figure looks like that of a *Stromatoporella.* There are numerous round openings at the surface in our specimens, 1 to 1.5 mm. in diameter, which are calices of an infesting coral, *Syringopora.* It is most likely that the holes shown in Nicholson's fig. 4, from 1.5 to 4 mm. in diameter, are also those of a parasitic coral. Latilaminae are obscure.

Vertical section.—The laminae are rather thick, about 0.12 mm., undulating up into the mamelons, and composed of light-colored, transversely fibrous tissue. There are six to eight laminae in 2 mm., although Nicholson gives nine. The pillars are separate from the laminae, dark gray in color and transversely fibrous; they are nearly straight-sided, only a few expand upward, and several are superposed through two or three interlaminar spaces. There are about 7 pillars in 2 mm., and they are 0.1 to 0.12 mm. in diameter. The mamelons extend through two or three latilaminae and then stop; they are not superposed, do not make continuous columns, and do not contain pillars which are noticeably larger than the pillars between the mamelons; some sections do not show mamelons, as the figures by Nicholson (pl. 24, fig. 4b), and by Parks (pl. 5, fig. 5). The mamelons may contain several tabulate, astrorhizal canals, but there is no large axial tube. The galleries are rectangular to oval; some are superposed, a few with foramina between. Dissepiments irregularly developed, scarce in places and abundant in other places.

Tangential section.—The laminae are thick, mostly curved, and annular in the mamelons. The pillars are 0.1 to 0.2 mm. in diameter, mostly round or oval, and a few are short, vermicular, and radial in the mamelons where they are cut obliquely. Some of the pillars are joined by curved dissepiments. In some of the mamelons there is a cluster of oval tubes which seem to be unusual astrorhizae, with vertical to highly oblique, tabulate canals, rather than horizontal and branching ones (Pl. 4, fig. 2a). Our specimen had grown around a cyathophylloid coral, 15 mm. in diameter, and most of the coenosteum is infested with *Syringopora* tubes 0.6 mm. in diameter.

A. ponderosum is characterized by the large coenosteum, large, unequal mamelons which do not make continuous columns, the thick laminae and round pillars which tend to be superposed. Our specimens fit the description of Nicholson, excepting for laminae being farther apart, and they agree with Parks' understanding of the species.

Occurrence.—Reported from the Columbus limestone of Kelleys Island and from Marblehead, Ohio. Our specimen is from the lower part of the Jeffersonville limestone, coral bed above the Geneva dolomite, from the Independent quarry, 4 miles south of Dupont, Jefferson County, Indiana, and from the same horizon at the Meshberger Stone Company quarry, 8 miles southeast of Columbus, Indiana.

Plesiotype.—Indiana University Paleontological collections, slides 285-51, 52, 74, 75, 76, 77; 304-91, 92; 306-10, 11, 12. Cat. No. 5367.

Anostylostroma insulare (Parks) Pl. 4, figs. 3a-d

Clathrodictyon ohioense Parks, 1936, Univ. Toronto Studies, Geol. Ser., No. 39. p. 24, pl. 3, figs. 5, 6 (Mid. Dev., Columbus ls., Kelleys Island, Ohio).
Clathrodictyon townsendi Parks, 1936, Univ. Toronto Studies, Geol. Ser., No. 39, p. 26, pl. 4, figs. 1-5 (Mid. Dev., Columbus ls., Kelleys Island, Ohio).
Clathrodictyon insulare Parks, 1936, Univ. Toronto Studies, Geol. Ser., No. 39, p. 29, pl. 3, figs. 7, 8 (Mid. Dev., Columbus ls., Kelleys Island, Ohio).

Coenosteum massive to thick, laminar, 3 cm. thick, 20 cm. in diameter. The surface has asymmetrical conical mamelons 10 to 15 mm. in diameter, 3 to 5 mm. high, and 10 to 20 mm. apart from center to center. Papillae are small, round to irregular. Large, indistinct astrorhizae, 20 mm. in diameter, consist of a few broad, branching canals. Latilaminae 2 to 6 mm. thick.

Vertical section.—The laminae are distinct, thin, irregular, and wrinkled, 0.01 to 0.03 mm. thick, five to seven in 2 mm., with occassional intercalated, vague, straight layers up to 0.05 mm. thick. The laminae turn sharply into the high, conical mamelons. The pillars are short, 0.05 to 0.12 mm. broad, two to seven in 2 mm., irregular and indistinct in the mamelons, obscured by thick tissue bounding mamelon tubes, rarely superposed. The pillars and laminae are conspicuous on a polished, vertical surface, and of about the same distinctness. In thin section, the pillars are much reduced in sharpness as compared with the crumpled laminae. The galleries are subrectangular to irregular, 0.04 to 0.09 mm. high, one to five times as broad. The pillar tissue and the upward and downward inflections of the laminae join in many places to form spheroidal vesicles, 0.1 to 0.17 mm. in diameter making rings in both vertical and tangential sections. The rings are not ring-pillars, but cut spheroidal vesicles, and the species is not a *Stromatoporella*. The laminar and pillar tissue is compact, not transversely fibrous as is usual in *Anostylostroma*. Large, multiple mamelon tubes are 0.4 to 0.7 mm. broad, divided by broad, arcuate tabulae. Incomplete, horizontally joined, cystose plates, which vary greatly in size and shape, form some of the crumpled laminae, so that the structure approaches that of *Clathrodictyon*, but the laminae and pillars are more like those of *Anostylostroma*. Dissepiments are scarce, but in a few places they are numerous, strongly convex, and large.

Tangential section.—The laminae are thin. The pillars are mostly round or oval, 0.07 to 0.16 mm. broad, some irregular to coalescent. Numerous, hollow rings of many sizes occur in and adjacent to the laminae, but the vertical section shows that they are due to wrinkles in the laminae joined with pillars or are spheroidal vesicles and are not ring-pillars. The multiple tubes in the mamelons are irregular, 0.5 to 0.8 mm. in diameter. The astrorhizae are large, and not well formed, with broad, bifurcating, tabulate canals, 10 mm. long and 0.23 to 0.45 mm. broad near the base. The tissue of laminae and pillars is compact. Dissepiments are rare.

Anostylostroma insulare (Parks) is characterized by large, asymmetrical mamelons with astrorhizae, thin, wrinkled laminae, without fibres or pores, and round pillars. Parks (p. 26, 29) mentioned irregular, cyst-appearing laminae but did not figure them. He noted the close similarity of *A. insulare, A. ohioense,* and *A. townsendi,* all from the same locality and horizon, but distinguished them on the basis of the irregular arrangement of pillars and laminae; such irregularities are not of systematic value. We retain the name *A. insulare* for the species, even though Parks described *A. ohioense* first in his paper, because it is the least distorted of the three species, and is named for the island where it occurs. The type specimen of *Clathrodictyon ohioense* Parks (1939, p. 24) from which we have sections, has the same structure and has laminae close together, as in our specimen (Pl. 4, fig. 3c).

Occurrence.—Two specimens were collected by Dr. Mildred F. Marple, of Ohio State University, from the Middle Devonian, Columbus limestone, one from just north of the old quarry dump on the north shore, the other from the base of the south side quarry, on Kelleys Island, Ohio.

Plesiotypes.—Indiana University Paleontological Collections, slides 305-64, 65, 66, 67, 68, 79, 80, 81; 306-45. Cat. No. 5397. Part of the two specimens and two unnumbered slides of each were returned to Ohio State University.

Anostylostroma humile Galloway and St. Jean, n. sp. Pl. 5, figs. 1a, b

Coenosteum hemispherical to high domed, up to 12 cm. in diameter. Surface with large, low, arched, typically regular mamelons, 6 to 10 mm. in diameter, 1 to 2 mm. high, 10 mm. apart, and six in 4 sq. cm. Between the mamelons there are low papillae. Astrorhizae are rare, an occasional small one occurs where there is an axial tube in a mamelon. Latilaminae 3 to 6 mm. thick.

Vertical section.—The skeleton is composed of thick, gently undulating laminae and broad, short pillars. The mamelons do not usually make mamelon columns, and may not show in vertical section, but there may be indefinite columns through one latilamina. The laminae are 0.07 to 0.09 mm. thick, consisting of a primary, clear, transversely fibrous layer, usually with a secondary, gray layer derived from the pillars, and rarely with an upper, gray layer, also derived from spreading of the pillars. There are five or six laminae in 2 mm., being much closer together near the junction of the latilaminae. The pillars average about 0.12 mm. thick, many thinner, and some two or three times that thick, where they broaden upward. The pillars flare upward and join others, but few are Y-shaped with a gap between the branches. There are about five pillars in 2 mm. Pillars may be superposed through 3 to 10 interlaminar spaces but they are not continuous, therefore, do not pierce the laminae. The tissue of the pillars is gray and transversely crystalline. None of the tissue is maculate. Some of the galleries have dissepiments, tending to occur in horizontal zones. In a few places there are foramina between superposed galleries, but there are no pseudozooidal tubes.

Tangential section.—The tissue occupies about half of the section. The pillars are in part round, but mostly are oval, elliptical, bent, subtriangular, and some join others. In the laminae the pillars are smaller and close together, making a pattern like leopard spots. The pillars do not increase in diameter upward, but broaden and divide. The tissue of the round pillars is radially fibrous, and in the broad pillars is transversely fibrous; none of the tissue is maculate. Astrorhizae are scarce, small ones occurring rarely where there is an astrorhizal tube in a mamelon. Some of the pillars are joined by curved dissepiments. The mamelons ordinarily show as one ring in tangential section.

This species is characterized by the large, low mamelons, thick laminae, broad, flaring pillars and scarcity of astrorhizae and dissepiments. Specimens with smaller mamelons and broad, discontinuous columns in the mamelon axes, are named *A. mediale,* and are intermediate between *A. humile* and *A. pulpitense,* which has strong, continuous mamelon axes 2 mm. in diameter. The mamelon axes which do occur in some specimens of *A. humile* are not continuous. The vertical section is much like that of *A. confluens* which has smaller and more continuous columns, but in tangential section the pillars do not consistently join others as they do in *A. confluens.*

Occurrence.—Abundant in the lower 10 feet of the Logansport limestone at the France Lime and Stone Company quarry, 5 miles east of Logansport, Ind., and at Pipe Creek Falls, 10 miles southeast of Logansport, Ind.

Holotype.—Indiana University Paleontological Collections, slides 294-4, 5. Cat. No. 5325.

Paratypes.—Slides 278-7; 285-61, 62, 90, 91; 294-2, 3, 6, 7, 47, 48; 303-59, 60, 98, 99.

Anostylostroma laxum (Nicholson) Pl. 5, figs. 2a, b

Clathrodictyon laxum Nicholson, 1887, Ann. Mag. Nat. Hist., ser. 5, vol. 19, p. 12, pl. 3, figs. 4, 5 (M. Dev., Onondaga ls., Port Colborne, Ont.); Parks, 1936, Univ. Toronto Studies, Geol. Ser.. No. 39, p. 13, pl. 1. figs. 1-8; pl. 2, fig. 4 (Onondaga ls., Ont.).

Coenosteum massive to laminar, up to 50 mm. or more thick;

surface smooth, or with large, sporadic mamelons; astrorhizae apparently absent; latilaminae inconspicuous, 3 to 5 mm. thick.

Vertical section.—The laminae are thin, consisting of only one layer, 0.03 to 0.04 mm. thick, light in color, transversely fibrous, and porous in places, but without foramina, six to seven in 2 mm., irregularly undulating. Pillars narrow, 0.06 to 0.08 mm., short, rarely superposed, some bent and diagonal, few enlarging upward, rarely Y-shaped, 6 to 10 in 2 mm., darker than the laminae, transversely fibrous but not porous. Galleries quadrangular, many narrower transversely than vertically, some wider transversely. Dissepiments few to common, arched upward. None of the tissue is maculate. Mamelons occur sporadically, each with an axial, tabulate tube, 0.35 mm. in diameter, confined to one latilamina. The laminae bend up into and over the axial tube, and the mamelon fades out in the next overlying latilamina.

Tangential section.—The laminae make eccentric curves about the mamelons but not concentric annuli, as do forms with regular columns. Laminae compact, light in color, transversely fibrous, and making a fine mosaic where cut parallel to the laminae. Pillars mostly round, in part vermicular, some joining, and some joined by curved dissepiments, radially fibrous and darker than the laminae. A sporadic tube, 0.3 to 0.4 mm. in diameter may occur in the section. Astrorhizae appear to be absent.

This species is characterized by the lack of regular mamelons and columns, by the one-layered, continuous laminae, the short rodlike pillars which are not superposed, and few dissepiments. It differs from *A. columnare* (Parks), with which it is associated, in the lack of regular mamelon columns. It differs from *A. arvense* (Parks) in the lack of mamelon columns of upturned laminae, and the pillars are not superposed.

Occurrence.—Onondaga limestone, Ontario; abundant in the Columbus limestone, Kelleys Island and Marblehead, Ohio; in the Columbus limestone, Snouffer's quarry, east bank of the Scioto River, 5 miles northwest of Columbus, Ohio, common in the Jeffersonville limestone, Charlestown, Ind., and one specimen was loaned from the Ohio State University Museum Collections by Dr. Mildred F. Marple, from the Columbus limestone at Dublin, Ohio.

Plesiotype.—Indiana University Paleontological Collections, from Snouffer's quarry, Columbus limestone, slides 282-8, 52, 53; 305-38, 39; 306-25, 26. Cat. No. 5399.

Anostylostroma meshbergerense Galloway and St. Jean, n. sp.
Pl. 5, figs 3a, b

Coenosteum massive, 5 cm. high, 7 cm. in diameter. Mamelons and astrorhizae absent; latilaminae 4 to 8 mm. thick.

Vertical section.—The laminae are 0.8 to 0.14 mm. thick, four to five in 2 mm., and zigzag up and down; they are composed of light-colored, compact tissue which is finely fibrous transversely, with indications of tubular pores, but without maculae and without a median or upper or lower line. The pillars are narrow and rodlike, and attached to the upturns on the upper sides and to the downturns on the lower sides of the laminae. The pillars have a thin, dark core; the pillar tissue is darker in appearance than it is in the laminae, and coarsely fibrous transversely, but has no tubules. The pillars are 0.1 to 0.2 mm. thick with five or six in 2 mm., some of which are incidentally superposed in a few places. The zigzag points are not high enough to be called ring-pillars. The galleries are rectangular, mostly higher than they are broad, 0.4 to 0.5 mm. high. Dissepiments are common, irregular in size, shape and occurrence, some making closed cysts. There are no indications of mamelons or astrorhizae.

Tangential section.—The skeletal tissue represents about 40 percent of the area of the thin section. The solid pillars are mostly round 0.1 to 0.2 mm. in diameter, some vermicular, many coalescent, with a fine dark central dot or line. The closed cysts make thin-walled rings; where the upturns of the laminae are cut, rings appear, 0.2 to 0.3 mm. in diameter with lumina 0.05 to 0.1 mm. in diameter but they do not have porous walls and are not typical enough to be called real ring-pillars, such as those of *Stromatoporella*. The galleries are irregular in shape.

Anostylostroma meshbergerense is characterized by the lack of mamelons and astrorhizae, the widely spaced, zigzag laminae, short, closely spaced pillars with dark cores, solid pillars which are round or vermicular with dark cores, and occasional rings. *A. meshbergerense* has the fibrous wall tissue typical of *Anostylostroma,* but the presence of rings is unusual for the genus. The tissue is not porous as it is in *Stromatoporella*, but the zigzag laminae and presence of rings shows the close relationship of the two genera. The species is unusual further in the thin, dark, median cores of the solid pillars. Some of the pillars are vermicular plates, but rarely do they flare or divide. The laminar tissue is lighter in color than the pillar tissue, as is usual in *Anostylostroma.*

Occurrence.—One specimen was collected by Dr. H. H. Murray and Mr. Robert Blakely, from the Middle Devonian, lower Jeffersonville limestone, 2 feet above the Geneva dolomite, in the Meshberger Stone Company quarry, 8 miles southeast of Columbus, Indiana.

Holotype.—Indiana University Paleontological Collections, slides 299-18, 19, 20; 304-90, 93. Cat. No. 5368.

Anostylostroma substriatellum (Nicholson) Pl. 5, figs. 4a, b

Stromatopora substriatella Nicholson, 1875, Geol. Surv. Ohio, vol. 2, pt. 2, p. 248, pl. 24, figs. 5, 5a (M. Dev., Columbus ls., Marblehead, Ohio).
Clathrodictyon substriatellum Parks, Univ. Toronto Studies Geol. Ser., No. 39, p. 18, pl. 2, figs. 1-8; pl. 2, figs. 7, 8.

Coenosteum subhemispherical to tuberose, up to 25 cm. in diameter. The surface is smooth and without astrorhizae. Latilaminae are 2 to 3 mm. thick.

Vertical section.—The skeleton is composed of eccentric laminae and short, dividing, radial pillars. The laminae are smoothly continuous, moderately thick, 0.05 to 0.06 mm., normally five in 2 mm., closer near the upper borders of the latilaminae, many appearing double, rarely eight or nine in 2 mm., as stated by Nicholson and Parks. Tissue compact and transversely fibrous, but not visibly perforate, light in color, with a thin upper and lower dark layer derived from the pillars. The pillars, four to six in 2 mm., 0.06 to 0.08 mm. in diameter, become Y-shaped upward and divide into two to six smaller pillars; pillars are mostly straight, some lean or curve, but are not superposed, with many incomplete intercalated pillars, especially at the tops of the galleries; the tissue is compact, darker in shade than in the laminae and transversely fibrous. Dissepiments are scarce, being more common in the highest galleries of a latilamina, curve upward, and tend to be parallel to the laminae. In a few places there are large, vertical, tabulate tubes, 0.7 mm. in diameter, extending through one lamina; the laminae arch upward to and over the tube.

Tangential section.—The cut laminae appear yellowish in color, finely crystalline with darker spots, indicating the pillars. The pillars, near their bases, are round and from 0.07 to 0.12 mm. in diameter. At the upper ends the pillars divide, are smaller, 0.03 to 0.05 mm. thick, some are round but mostly they are vermicular, many divide and some join. The galleries occupy three-fourths of the section. Some pillars are joined by curved dissepiments. The pillar tissue is dusty, but not maculate.

A. substriatellum is characterized by the high, subhemispherical shape, smooth surface, lack of columns, and especially by the pillars which divide upward into strands. Our description is drawn largely from two well-preserved topotypes. There is some doubt as to what Nicholson really named, his figure 5a is not from a thin section and is of little value; it shows oval galleries, so the pillars expand upward, but they do not show division into strands. The round holes in Nicholson's figure 5 are probably *Syringopora;* and the "fin-like or vermicular perforations" are galleries. We agree with Parks in his identification of Nicholson's species. This species is not an *Atelodictyon,* for the pillars lack radial processes.

Occurrence.—Abundant in the Middle Devonian Columbus limestone at Marblehead, Ohio, where it is splendidly preserved. One specimen and one questionable specimen encrusting on *Stromatoporella eriensis* (Parks) were loaned from the Ohio State University Museum by Dr. Mildred F. Marple. The specimen was collected from the Columbus limestone at Marblehead, Ohio; the questionable specimen is from the same horizon at Columbus, Ohio.

Plesiotypes.—Indiana University Paleontological Collections, Cat. No. 5398; slides 282-55, 56, 57, 61, 62, 71; 303-62, 63; 306-21, 23, 24; Ohio State University Museum Paleontological Collections, specimens No. 3855 and 7002 (and 4 unnumbered slides).

Anostylostroma pipecreekense Galloway and St. Jean, n. sp.

Pl. 6, figs. 1a, b

Coenosteum massive, 20 cm. in diameter; surface without mamelons, but slightly undulating; astrorhizae absent; latilaminae conspicuous, 2 to 4 mm. thick.

Vertical section.—Laminae rather thick, 0.06 to 0.1 mm., about six in 2 mm., nearly straight but rising over many pillars, light in color, finely fibrous and porous transversely with small vacuities, not maculate, with lower irregular layer derived from the pillars. Pillars darker in color than the laminae, transversely fibrous, four or five in 2 mm., expanding and dividing upward, forming an obconical, spongy clump of smaller pillars. The pillars do not pierce the laminae; many are spool-shaped, and mostly are superposed through several latilaminae. The vertical rows of pillars increase by bifurcation. Curved plates are rare to common in the galleries, and where the skeleton was injured the absence of laminae and pillars is filled with upward curved, imbricating plates. Galleries oval and elongate horizontally, some superposed with large foramina between them. There are no mamelons, columns of upturned laminae, nor astrorhizae.

Tangential section.—The laminae are light in color, porous and flocculent in appearance, but not maculate. The pillars are mostly angular and vermicular, especially near their bases, confluent, variable in size, many forming round or odd-shaped masses of pillars with an outer, more compact border, made by the division of the large pillars into a clump of smaller pillars. The pillars are 0.06 to 0.12 mm. in thickness, and are frequently joined by dissepiments. The pillars are dark gray in color, and are transversely fibrous.

The species is characterized by the coarse texture made by laminae and pillars, the flaring and superposed pillars, and complex, round pattern made by the pillars in tangential section. It differs from *A. confluens,* with which it occurs, in the coarser texture, superposed pillars and lack of columns. This species is much like *Gerronostroma* and *Trupetostroma* in the superposed pillars, but is included in *Anostylostroma* because of the pillars dividing into clumps beneath the laminae.

Occurrence.—Lower part of the Logansport limestone at Pipe Creek Falls, 10 miles southeast of Logansport, Indiana.

Holotype.—Indiana University Paleontological Collections, slides 304-61, 62. Cat. No. 5355.

Genus **ATELODICTYON** Lecompte, 1951

Type species, *A. fallax* Lecompte, 1951, Inst. Roy. Nat. Belgique, Mém. 116, p. 124, pl. 15, figs. 1, 2 (Mid. Dev., Couvinian, Dinant Basin, Belgium).

Coenosteum laminar, discoidal or globular, some latilaminate; surface smooth or undulate; astrorhizae well developed; laminae definite, regular; cyst plates common; pillars short, confined to one interlaminar space, with intercalated, incomplete pillars, some superposed but not vertically continuous; in tangential section the pillars are round, with or without lumina, and joined in the laminae by processes, forming areolae and chainlike groups; tissue compact.

Middle Devonian, Belgium, and Indiana. Four species.

Atelodictyon differs from *Actinostroma* in lacking continuous pillars. It is close to *Anostylostroma.*

We give the original figures and a description of the type species to show the diagnostic characters of the genus, and for convenience of reference.

Atelodictyon fallax Lecompte Pl. 6, figs. 2a, b

Atelodictyon fallax Lecompte, 1951, Inst. Roy. Sci. Nat. Belgique, Mém. 116, p. 125, pl. 15, figs. 1, 1a-d (Mid. Dev., Couvinian, Belgium).

Coenosteum massive, globular to laminar, more than 2.7 cm. high and 3.5 cm. in diameter, 2 to 4 mm. high and 4 to 10 mm. apart from center to center. The astrorhizae are small, 3.5 mm. in diameter, located in the mamelon centers composed of a few short, simple radial canals. The latilaminae are 4 to 10 mm. thick.

Vertical section.—The laminae are well formed, undulatory into the mamelons, composed of a single layer of compact tissue, 0.05 to 0.10 mm. thick, five to seven in 2 mm., some bordered by a thin, dark layer. The pillars are short, thin, 0.05 to 0.1 mm. broad, 9 to 14 in 2 mm., many superposed, with small intercalated pillars. The galleries are rectangular, mostly higher than wide, 0.1 to 0.5 mm. high and 1/3 to 2 times as broad. Dissepiments are common, low broad arches.

Tangential section.—The pillars are mostly joined by strong processes next to the laminae, forming polygonal or chainlike patterns. In the centers of most of the pillars there are small lumina. The astrorhizae have short, simple canals, 0.1 to 0.2 mm. broad at the base.

Atelodictyon fallax Lecompte, the type species, is characterized by the small mamelons, the simple astrorhizae, the thin, closely spaced, superposed pillars, mostly with lumina, and joined by processes to form chainlike groups in tangential section. *A. fallax* somewhat resembles *A. intercalare* in our faunas, differing in having mamelons, in the more prominent laminae, and larger and fewer dissepiments. The above description and the figures are based on the description and figures of the type and paratype given by Lecompte and are included to authenticate the genus and species.

Occurrence.—The holotype and paratype are from the Middle Devonian, Couvinian at Couvin in Belgium; one other specimen, not described or figured by Lecompte, is from the Middle Devonian, Givetian at Surice, Belgium.

Atelodictyon intercalare Galloway and St. Jean, n. sp. Pl. 6, figs. 3a, b

Coenosteum massive, a fragment is 2 cm. high and 8 cm. in diameter. The surface is smooth. Astrorhizae obvious only on cut surfaces and in thin sections, composed of large, radial canals with centers 13 to 20 mm. apart. Latilaminae are 1 to 4 mm. thick.

Vertical section.—Laminae in general straight, many discontinuous or vague, 0.06 to 0.09 mm. thick, five to seven in 2 mm., composed of a single, transversely fibrous layer. The pillars are short, thin, 0.04 to 0.07 mm. broad, 7 to 10 in 2 mm., straight or flaring, some superposed and some dividing upward into two or more strands. Several short incomplete, pendant pillars are intercalated between the regular pillars in many places. Galleries, oval to irregular, 0.18 to 0.26 mm. high and one to three times as broad, many superposed with foramina between. The pillar tissue is compact, slightly darker than that of the laminae, with finer transverse fibers than in the laminae, distinct from the laminae, as in *Anostylostroma*. Lumina in the pillars are rarely observable in vertical sections. Dissepiments are abundant, short and thin, nearly straight to highly arched upward, a few convex downward. Astrorhizal canals are oval and larger than the galleries.

Tangential section.—The galleries are irregular in shape. The pillars are vermicular and branching, rarely round, confluent around the galleries, joining in the laminae to form areolae and a chain-like network pattern. Many of the pillars have small lumina but are not hollow. The transverse fibers in the pillar tissue are more prominent than in the vertical section. Foramina, seen in the darker laminae, are round or irregular in shape, 0.1 to 0.3 mm. in diameter. The astrorhizae are large, composed of long, broad, rarely bifurcating radial canals, 0.2 to 0.3 mm. broad at the base, without tabulae or definite boundaries.

Atelodictyon intercalare is characterized by the lack of mamelons, the incomplete laminae, the incomplete intercalated short pillars, for which the species is named, and by the large number of irregular dissepiments. It is similar to *A. fallax* Lecompte, but has larger astrorhizae, more dissepiments, and a more variable network of laminae and pillars.

Occurrence.—One specimen was collected by Mr. G. D. Foley, from the Middle Devonian, Jeffersonville limestone at the Meshberger Stone Company quarry, 8 miles southeast of Columbus, Indiana.

Holotype.—Indiana University Paleontological Collections, slides 300-7, 8. Cat. No. 5369.

Genus **STICTOSTROMA** Parks, 1936

Type species (first species, here selected), ***Stictostroma mamilliferum,*** new name=***Stromatopora mammillata*** Nicholson (not Schmidt, 1858), 1873, Ann. Mag. Nat. Hist., ser. 4, vol. 12, p. 94, pl. 4, fig. 4 (Mid. Dev., Port Colborne, Ont.); Nicholson, 1874, Rep. Pal. Prov. Ont., p. 17, pl. 1, fig. 4; Nicholson and Murie, 1878, Jour. Linn. Soc. London, Zool., vol. 14, pl. 1, fig. 10.

Stictostroma Parks, 1936, Univ. Toronto Studies, Geol. Ser. No. 39, p. 78, pl. 14, figs. 3-6.

Coenosteum a thin crust, cake-shaped or massive, composed of thin laminae, which in favorable sections shows a thin, transversely porous, light median layer, with thinner darker, transversely fibrous and porous layers on each side. Pillars short, spool-shaped, confined to one interlaminar space, rarely superposed; pillars in tangential sections mostly round, rarely hollow rings, but not well-formed ring-pillars. Galleries wider than the laminae, with a few dissepiments, rarely superposed with foramina between. Surface smooth to mamillate. Astrorhizae absent or present.

Middle Devonian, Onondaga and Hamilton groups, Ontario. Five species described, *S. mamilliferum,* n. name, *S. problematicum* (Parks), *S. alpenense* (Parks), *S. elevatum* (Parks), and *S. kayi* (Parks). The second group in Parks' original description of the genus, in which the tissue is compact and there are hollow ring-pillars, obviously cannot be included in the genus *Stictostroma,* and is removed to *Stromatoporella,* which includes also *S. eriense* (Parks), and *S. huronense* (Parks). *Stictostroma insolitum* Parks is placed in the genus *Gerronostroma.*

Stictostroma differs from *Stromatoporella* in lacking typical ring-pillars, but small rings may occur; it is much like *Anostylostroma,* but has porous tissue; it is intermediate between the two genera. *Stromatopora mammillata* Nicholson, 1873, is a homonym of *S. mammillata* Schmidt, 1858, and invalid, even if Schmidt's species is now considered to be a synonym of *Anostylostroma striatellum* (d'Orbigny), 1850.

KEY TO MIDDLE DEVONIAN SPECIES OF STICTOSTROMA FROM INDIANA AND ADJACENT AREAS

1a. Astrorhizae absent .... *S. mamilliferum,* new name
1b. Astrorhizae in mamelon columns
  2a. Laminae 7 in 2 mm. .... *S. jeffersonvillense,* n. sp.
  2b. Laminae 11 in 2 mm. .... *S. mcgraini,* n. sp.

Stictostroma mamilliferum Galloway and St. Jean, new name
Pl. 6, figs. 4a, b

Stromatopora mammillata Nicholson, 1873 (a homonym of *S. mammillata* Schmidt, 1858), Ann. Mag. Nat. Hist., ser. 4, vol. 12, p. 94, pl. 4, fig. 4 (Mid. Dev., Onondaga ls., Port Colborne, Ont.); 1874, Rept. Paleont. Prov. Ontario, p. 17, pl. 1, fig. 4; Nicholson and Murie, 1878, Jour. Linn. Soc. London, Zool., vol. 14, pl. 1, fig. 10; Dawson, 1879, Quart. Jour. Geol. Soc. London, vol. 35, p. 58, pl. 4, figs. 5, 6.
Stictostroma mammillatum Parks, 1936, Univ. Toronto Studies, Geol. Series, No. 39, p. 78, pl. 15, figs. 3-6 (Mid. Dev., Onondaga ls., Ont.).

Coenosteum in thin, flat expansions, 2 cm. thick and up to 18 cm. or more in diameter. The surface has regularly spaced mamelons of moderate size, 3 to 7 mm. in diameter, 2 mm. high and 7 to 12 mm. apart from center to center. Astrorhizae are absent. Latilaminae are 1 to 2 mm. thick.

Vertical section.—The laminae are thin, closely spaced, 11 to 13 in 2 mm., undulatory, turning smoothly into the mamelons, composed of a single, fine, transversely porous layer, 0.03 to 0.06 mm. thick. The mamelons do not form mamelon columns. The pillars are short, partly with straight sides, partly flaring toward the top, and partly spool-shaped, but not dividing upward, incidentally superposed in places, transversely porous, four to seven in 2 mm., 0.02 to 0.2 mm. broad, not significantly different in the mamelons. Some pillars are oblique, but there are few double upturns, indicating ring-pillars. The galleries are rectangular or oval, 0.08 to 0.19 mm. high and one to four times as broad. Dissepiments are common, small, thin, arched obliquely across the galleries. There are a few foramina through the laminae, but no pseudozooidal tubes.

Tangential section.—The pillars are round, 0.09 to 0.12 mm. in diameter, 0.04 to 0.23 mm. apart. The mamelons are marked by the laminae forming many concentric annuli, in the center there are one or several tubes 0.16 to 0.38 mm. in diameter. Astrorhizae are absent. The dissepiments are abundant tying many pillars together, and make elongate patterns between mamelons, scarcely resembling astrorhizal canals. There are some rings which may be incipient ring-pillars but which can be scarcely recognized in vertical sections.

Stictostroma mamilliferum is characterized by the flat growth, by the moderately large, regular mamelons, and by the thin, closely spaced laminae and pillars, and oblique dissepiments. *S. mamilliferum* differs from *S. mcgraini* in having more regular mamelons and in having thinner, more closely spaced laminae and fewer dissepiments.

Stromatopora mammillata Nicholson, 1873, now considered to be a *Stictostroma,* is a homonym of *Stromatopora mammillata* Schmidt, 1858. Parks (1936, p. 79) said that because both species were now assigned to different genera, Nicholson's name could be retained. According to Article 36 of the International Rules of Zoological Nomenclature, a rejected homonym can never be used again. We, therefore, propose the name *Stictostroma mamilliferum* for Nicholson's *Stromatopora mammillata.*

Occurrence.—Our specimen is from the Middle Devonian, Onondaga limestone, at Ashton's quarry, Gorrie, Ontario, the same quarry from which Parks obtained the specimens upon which he based his genus *Stictostroma.*

Plesiotype.—Indiana University Paleontological Collections, slides 300-89, 90, 91, 92. Cat. No. 5400.

Stictostroma jeffersonvillense Galloway and St. Jean, n. sp.
Pl. 7, figs. 1a, b

Coenosteum massive, up to 11 cm. high and 16 cm. in diameter. The surface has irregular mamelons 5 to 10 mm. in diameter, 2 to 3 mm. high, and 10 to 15 mm. apart from center to center. Latilaminae are 2 to 4 mm. thick. Astrorhizae are visible only on corroded or polished surfaces and in sections.

Vertical section.—The laminae are rather thick, 0.07 to 0.1 mm., seven or eight in 2 mm., are composed of a single, transversely fibrous and porous layer; they rise smoothly into the mamelons. Pillars are thick, short, transversely fibrous, 0.09 mm. broad, four in 2 mm., superposed in a few places, and are thicker in the mamelons. Some pairs of pillars bend together and form rings, but ring-pillars formed by upbends of the laminae, as in *Stromatoporella,* do not occur. The mamelon columns contain two to three vertical tubes. Galleries are rectangular, 0.15 mm. high, 0.39 mm. broad, regular in height, but vary in breadth. Overlying galleries are connected in some places by large foramina in the laminae to underlying galleries; there are no pseudozooidal tubes. Dissepiments are sporadic, broad, low arches.

Tangential section.—The laminae are thick, transversely fibrous and porous in places. The pillars are round, radially fibrous, 0.10 to 0.12 mm. in diameter and average about 0.14 mm. apart; many coalesce and are joined by dissepiments. The galleries are large, connected and irregular in shape. The mamelons have three or four annuli of laminae and three to eight axial tubes. There are occasional rings next to the laminae, but they are neither as well formed nor as abundant as they are in *Stromatoporella.* Astrorhizae small, composed of a few short, thick, nonbranching radial canals, 0.25 mm. broad at the base.

Stictostroma jeffersonvillense is characterized by the mamelons, the thick laminae, and coarse network of laminae, pillars and dissepiments. *S. jeffersonvillense* differs from *S. mcgraini* in having thicker, more widely spaced laminae.

Occurrence.—Seven specimens were collected from the Falls of the Ohio, at Jeffersonville, Indiana; two specimens are from the limestone quarry, east of Charlestown, Indiana; two specimens are from the Louisville Cement Company quarry at Speed, Indiana; and one specimen is from a roadcut on Highway 42, 3.3 miles southwest of Prospect, Kentucky, near Louisville.

Holotype.—Indiana University Paleontological Collections, slides 304-75, 76, from Jeffersonville, Ind., Cat. No. 5360.

Paratypes.—Slides 282-7, 17; 295-2, 21, 22, 26, 27, 34-36, 38, 39, 44, 45, 65; 304-100; 305-32, 33.

Stictostroma mcgraini Galloway and St. Jean, n. sp. Pl. 7, figs. 2a, b

Coenosteum massive; the type is a fragment 10 cm. high and 8 cm. in diameter. Surface, with irregular mamelons, 5 to 10 mm. in diameter, 2 to 7 mm. high, and 7 to 15 mm. apart from center to center. Astrorhizae are large, with broad, non-branching canals; latilaminae 1 to 2 mm. thick.

Vertical section.—The laminae are thin, 0.04 mm. thick, close together, 11 in 2 mm., have distinct, fine, transverse pores, 0.014 mm. in diameter. The pillars are short, straight, inclined or spool-shaped, 0.10 mm. in diameter, four in 2 mm., with no indication of ring-pillars, and are rarely superposed. The galleries are quadrangular, 0.40 mm. broad and 0.11 mm. high, rarely connected by foramina. Dissepiments are small, low to high arched, many oblique, common, but sporadic in occurrence, prominent in damaged areas and in the mamelons. Astrohizal canals are large, forming astrorhizal cylinders.

Tangential section.—The pillars are mostly round, 0.09 mm. in diameter, 0.1 to 0.2 mm. apart. There are a few small rings, but no definite ring-pillars. The galleries occupy three to four times as much area as the pillars, and have many curved dissepiments which join the pillars. The astrorhizae are large, up to 10 mm. or more in diameter, composed of large, unbranched, radial canals 0.62 mm. broad, with large dissepiments. The canals may appear short because they are located in the mamelon centers and follow the steeply dipping slopes of the mamelons.

Stictostroma mcgraini is characterized by the large mamelons, thin, closely spaced, porous laminae, round pillars, abundant small but sporadic dissepiments, and large, simple astrorhizal canals. It differs from *S. mamilliferum* in being massive rather than laminar and in having astrorhizae. This species is near *Clathrodictyon,* differing in having definite and porous laminae. It is also close to *Anostylostroma,* differing in having larger laminar pores and less well-developed pillars. It emphasizes the close relationship of the three genera. It is similar to *Anostylostroma insulare,* differing in the porous, noncrumpled laminae and smaller but more numerous dissepiments, and round pillars.

Occurrence.—One specimen from the Middle Devonian, Jeffersonville limestone was collected by Mr. P. McGrain, for whom the species is named, and Mr. F. H. Walker, from 3.3 miles southwest of Prospect, Ky., on Highway 42, near Louisville.

Holotype.—Indiana University Paleontological Collections, slides 305-27, 28, 29, 30. Cat. No. 5389.

Genus **STROMATOPORELLA** Nicholson, 1886

Type species, *Stromatopora granulata* Nicholson, 1873, Ann. Mag. Nat. Hist., ser. 4, vol. 12, p. 94, pl. 4, fig. 3 (Mid. Dev., Arkona, Ont.).

Stromatoporella Nicholson, 1886, Palaeont. Soc., vol. 39, p. 92, pl. 1, figs. 4, 5, 15; pl. 4, fig. 6; pl. 7, figs. 5, 6; 1891, vol. 44, p. 202, pl. 26, fig. 1 (*S. granulata* restricted to form from the Hamilton fm. of Arkona, Ont.); Parks, 1907, Univ. Toronto Studies, Geol. Ser., No. 4, p. 29; 1936, No. 39, p. 90, pl. 16, figs. 1-7; Kühn, 1939, in Schindewolf, Handbuch Paläozoologie, Bd. 2A, p. A45; Yavorsky, 1943, Acad. Sci. U. S. S. R., Compte Rendu (Doklady), vol. 39, No. 9, p. 369; 1950, Voprosy Paleontol., vol. 1, pp. 243-263, pls. 1-7 (In Russian); ?Lecompte, 1951, Inst. Roy. Sci. Nat. Belgique, Mém. 116, p. 152.

Coenosteum laminar, massive or subramose, composed of thick laminae and wide interspaces which are traversed by short pillars of three kinds, (1) small, round, (2) large, hollow, cylindrical or oval pillars making thick-walled rings in tangential section, mostly formed by sharp upturns of the laminae, and (3) irregular. Pillars not regularly superposed. Dissepiments frequent. Superposed galleries may be connected by large foramina. Tissue coarsely to finely porous and fibrous transversely, not maculate. Astrorhizae largely developed.

Silurian, rare; Devonian, abundant; Europe, North America, Asia, Australia, ?Carboniferous, Poland. About 80 species.

Stromatoporella is similar to *Stictostroma* in vertical section, but differs in having abundant ring-pillars; from *Anostylostroma* it differs in the more porous tissue and the ring-pillars. The ring-pillars made of upturned laminae are the diagnostic feature of the genus. *S. eriensis* (Parks) and *S. huronensis* (Parks) have porous tissue, but the pores are difficult to detect; they have prominent ring-pillars.

KEY TO DEVONIAN SPECIES OF STROMATOPORELLA FROM MIDWESTERN NORTH AMERICA

1a. Mamelons present
  2a. Mamelons prominent, 8 or less in 4 sq. cm.
    3a. Tubules in laminae anastomosing
      4a. Laminae 8 to 10 in 2 mm.
        5a. Papillae close-set; with astrorhizae .... *S. granulata* Nicholson
        5b. Papillae distant; no astrorhizae .... *S. granulata distans* Parks
      4b. Laminae 5 to 6 in 2 mm. .... *S. morelandensis*, n. sp.
    3b. Tubules transverse, straight
      4c. Laminae distinctly porous
        5c. Laminae 5 to 7 in 2 mm.; ring-pillars abundant
          6a. Dissepiments rare .... *S. selwyni* Nicholson
          6b. Dissepiments abundant
            7a. Mamelons low, domal .... *S. kirki*, n. sp.
            7b. Mamelons high, conical .... *S. solitaria* Nicholson
        5d. Laminae 9 to 10 in 2 mm., ring-pillars scarce .... *S. parasolitaria*, n. sp.

4d. Laminae transversely fibrous,
indistinctly porous ....*S. huronensis* (Parks)
2b. Mamelons small, more than 8 in 4 sq. cm.
3c. Ring-pillars obscure, but large ......*S. cryptoannulata*, n. sp
3d. Ring-pillars abundant, of moderate
size ....*S. perannulata*, n. sp.
1b. Mamelons absent
2c. Ring-pillars not superposed
3e. Ring-pillars, 0.2 to 0.3 mm.
in diameter; laminar pores common ....*S.* cf. *cellulosa* (Nicholson and Murie)
3f. Ring-pillars, 0.3 to 0.4 mm.
in diameter; laminar pores scarce ....*S. eriensis* (Parks)
2d. Ring-pillars superposed ....*S. columbusensis*, n. sp.

Stromatoporella granulata (Nicholson) Pl. 7, figs. 3a, b

Stromatopora granulata Nicholson, 1873, Ann. Mag. Nat. Hist., ser. 4, vol. 12, p. 94, pl. 4, figs. 3, 3a. (Included two species. *Stromatoporella granulata*, Hamilton age, and *Stromatoporella selwyni*, Onondaga age).

Stromatoporella granulata (Nicholson), 1886, Ann. Mag. Nat. Hist., ser. 5, vol. 18, p. 10 (Mid. Dev., Hamilton fm., Ont.); 1886, Palaeont. Soc., vol. 39, p. 93, pl. 1, figs. 4, 5, 15; pl. 4, fig. 6; pl. 7, figs. 5, 6; 1892, Palaeont. Soc. vol. 46, p. 202, pl. 26, fig. 1. (Restricted species to Mid. Dev., Hamilton fm., Arkona, Ont.); Parks, 1936, Univ. Toronto Studies, Geol. Series, No. 39, p. 95, pl. 15, figs. 6, 7; pl. 16, figs. 1-7 (Mid. Dev., Hamilton fm., Arkona, Ont.).

Coenosteum laminar, nonencrusting with wrinkled peritheca, irregular in shape, 0.2 to 3 cm. thick and up to 30 cm. in diameter. The surface has low, round or conical mamelons, 3 or 4 mm. in diameter, 0.7 to 1 mm. high and 5 to 12 mm. apart from center to center, and papillae, many with openings in the centers, the ring-pillars. Astrorhizae small, composed of simple canals radiating from the mamelon centers. Latilaminae 2 to 5 mm. thick.

Vertical section.—Laminae irregular, 0.05 to 0.14 mm. thick, 8 to 10 in 2 mm., composed of a single, thick layer of tissue with a clear median line and many anastomosing tubules. The laminae turn smoothly into the mamelons and sharply into the ring-pillars. Pillars are short, thick spools, 0.12 to 0.20 mm. broad, three to five in 2 mm. The laminar and pillar tissues are confluent and alike. Galleries are round to oval or subrectangular, 0.08 to 0.19 mm. high and one to six times as broad. Dissepiments common, thin to thick, broad to nearly flat, oblique, most common in the mamelons.

Tangential section.—Pillars are round, or are thick rings, and variable in development. The round pillars are ordinarily more abundant than the ring-pillars. Ring-pillars in the interlaminar spaces have radially arranged tubules, the rings in or near the laminae have tubules perpendicular to the plane of the thin section, so that they appear as clear, round dots, as they do in the solid pillars. The solid pillars are 0.09 to 0.12 mm. in diameter, the ring-pillars are 0.25 to 0.31 mm. in diameter, with lumina 0.07 to 0.10 mm. in diameter. Both ring-pillars and solid pillars are connected in many places by curved dissepiments. No definite astrorhizae were observed in the mamelons in the tangential section, but there are tabulate astrorhizal canals in the mamelons in vertical section, where the canals are 0.23 to 0.34 mm. broad.

Stromatoporella granulata is characterized by the thin, irregular, laminar coenosteum, with small, widely spaced mamelons and astrorhizae. *S. granulata* differs from *S. granulata distans* Parks in having more papillae and in having astrorhizae.

Occurrence.—We have a good specimen from the Middle Devonian, Hungry Hollow formation at the George Coultis and Son's Brick and Tile Company clay pit, Thedford, Ontario.

Plesiotype.—Indiana University Paleontological Collections, slide 282-38. Cat. No. 5390.

We include a description and figures of the type species to emphasize the generic characters of *Stromatoporella,* the ring-pillars and porous tissue.

Stromatoporella morelandensis Galloway and St. Jean, n. sp.
Pl. 7, figs. 4a, b

Coenosteum massive, a fragment is 3 cm. thick, and 14 cm. in diameter; composed of latilaminae 2 to 3 mm. thick. Surface with conical mamelons, 3 to 5 mm. in diameter, 3 to 5 mm. high, 6 to 10 mm. apart from center to center. Papillae abundant, moderately large, high cones. Astrorhizae small, vague. The specimen has been silicified, but the structures are discernible.

Vertical section.—The tissue is coarsely porous with anastomosing tubules, typical of *Stromatoporella*. The laminae are thick, 0.1 to 0.2 mm., five or six in 2 mm., and rise sharply into the mamelon columns. The pillars are thick, spool-shaped, 0.2 to 0.4 mm. broad, five to six in 2 mm., composed of tubulose tissue which coalesces with the laminar tissue. The ring-pillars are not prominent because of the thick laminae and pillars. Galleries are round to oval, 0.2 to 0.4 mm. high, one to three times as broad as they are high. Oblique dissepiments are common.

Tangential section.—The skeletal tissue represents 70 or 80 percent of the area of the thin section. The solid pillars are round, 0.3 to 0.4 mm. in diameter; the ring-pillars are common, thick-walled, 0.2 to 0.6 mm. in diameter, with lumina 0.1 to 0.2 mm. in diameter. Astrorhizae are small and simple, with short, broad canals 0.2 to 0.3 mm. wide near the base.

Stromatoporella morelandensis is much like *S. solitaria* Nicholson, but has smaller mamelons, thicker laminae and larger ring-pillars. It differs from *S. selwyni* Nicholson, in having mamelons and the laminae are thicker, and from *S. tuberculata* in having mamelons.

Occurrence.—The specimen was loaned by Professor B. F. Howell, of Princeton University and was reported to him as having come from the "Onondaga limestone" at Moreland, Lincoln County, Kentucky. The junior author made a search at Moreland and elsewhere in Lincoln County, but found no specimens; all the limestone observed in the area is of Hamilton age.

Holotype.—Princeton University Paleontological Collections, specimen 830. Indiana University Paleontological Collections, slides 300-10, 11, 12, 13, 14. Cat. No. 5388.

Stromatoporella selwyni Nicholson Pl. 8, figs. 1a, b

Stromatoporella granulata Nicholson, (part) 1886, Palaeont. Soc., vol. 39, pl. 1, fig. 14 (Mid. Dev., Onondaga ls., Ont.).

Stromatoporella selwyni Nicholson, 1892, Palaeont. Soc., vol. 46, p. 205, pl. 26, figs. 2-4 (Mid. Dev., Onondaga ls., Port Colborne, Ont.); Parks, 1936, Univ. Toronto Studies, Geol. Ser. No. 39, p. 101, pl. 16, fig. 8; pl. 17, figs. 1, 2 (not figs. 5, 6) (Mid. Dev., Onondaga ls., Selkirk, Ont.).

Coenosteum massive, 5 cm. high, 12 cm. in diameter. The surface is not exposed, although large, irregular mamelons 8 to 10 mm. in diameter, 4 to 6 mm. high and 20 to 30 mm. apart from center to center are apparent on vertical surfaces and in thin section. No astrorhizae were observed. The latilaminae are 3 to 6 mm. thick.

Vertical section.—The laminae are thick, 0.1 mm., six in 2 mm., turn smoothly into the large mamelons and sharply into abundant ring-pillars. The round pillars are confined to one interlaminar space, are thin, thick and spool-shaped, 0.1 to 0.2 mm. broad, three to five in 10 mm., and separate from the laminae. The laminar and pillar tissue is altered and partly destroyed by silicification, but the tissue was typical for the genus *Stromatoporella,* with numerous transverse tubules in pillars and laminae. The galleries are oval to rectangular, 0.2 to 0.3 mm. high, 1 to 2 times as broad. Simple, straight, tabulate tubes, 0.3 to 0.4 mm. broad are situated in the center of the mamelons. Dissepiments are few, thin and convex, horizontal to inclined.

Tangential section.—The round, solid pillars are 0.15 to 0.2 mm. in diameter and the hollow ring-pillars are thick-walled and abundant, 0.28 to 0.43 mm. in diameter, with lumina 0.1 to 0.2 mm. in diameter. The mamelon tubes are simple, round, 0.4 to 0.5 mm. in diameter. The galleries occupy about three times the area of the pillars. The laminae are conspicuously porous.

Stromatoporella selwyni Nicholson is characterized by large, irregular mamelons, coarse meshwork of thick laminae and pillars, thick-walled ring-pillars and scarce dissepiments. It differs from *S. eriensis* (Parks) in having thicker laminae and pillars and larger but less numerous ring-pillars.

Occurrence.—One large specimen was collected by Mr. Guy Campbell from the Middle Devonian, basal Jeffersonville limestone, one mile northwest of Hanover, Indiana, and one specimen from the same horizon, two miles northwest of Butlerville, Indiana, was collected by Dr. William J. Wayne.

Plesiotypes.—Indiana University Paleontological Collections, slides 295-58; 305-83. Cat. No. 5373.

Stromatoporella kirki Galloway and St. Jean, n. sp. Pl. 8, figs. 2a, b

Coenosteum massive, 3 cm. high and 4 cm. in diameter. Surface covered, but thin sections indicate that it has large mamelons 10 mm. in diameter, 1 to 2 mm. high, and 10 to 15 mm. apart from center to center; astrorhizae absent; latilaminae are vague, 1 to 8 mm. thick.

Vertical section.—The laminae are in general straight, composed of a single fibrous layer, 0.07 to 0.17 mm. thick, five to seven in 2 mm., turning smoothly into the mamelons. The solid pillars are somewhat spool-shaped, rarely superposed, 0.1 to 0.3 mm. broad, four to seven in 2 mm. Upturns of the laminae making ring-pillars are common, and the hollow usually extends only part way across the interlaminar space, the rest of the pillar above the lumen is solid, about the same size as the solid pillars. Pores are difficult to distinguish, but are vertical in laminae, round pillars and in ring-pillars. The galleries are oval to rectangular, 0.14 to 0.26 mm. high and 1/2 to 2 times as broad. There are some foramina between galleries in adjacent rows, but no pseudozooidal tubes. Dissepiments are highly arched and abundant.

Tangential section.—The ordinary pillars are 0.15 to 0.20 mm. in diameter, 0.09 to 0.21 mm. apart, and are round or oval, and many are tied by dissepiments. Ring-pillars are only about one-tenth as abundant as the ordinary pillars, 0.22 to 0.29 mm. in diameter, with lumina 0.06 to 0.14 mm. in diameter. The pores in the tissue are much more distinct than they are in vertical section, appearing as clear, round dots about 0.02 mm. in diameter in the ordinary pillars, laminae and ring-pillars; the dots are not maculae, but pores. The pores are radial in the ring-pillars of most species of *Stromatoporella*. No typical astrorhizae were observed, though some of the mamelons show indications of radial canals. The cut dissepiments make thin-walled rings.

Stromatoporella kirki is characterized by the abundance of small dissepiments and by the pores in the laminae, round pillars and ring-pillars, which appear as clear, round dots in tangential section rather than as radial lines. *S. kirki* differs from *S. selwyni* Nicholson in the abundant dissepiments; it differs from *S. solitaria* Nicholson in having large, low domal mamelons rather than high conical mamelons and has larger ring-pillars and more dissepiments.

Occurrence.—We have one specimen collected from the Middle Devonian, Jeffersonville limestone, at the Meshberger Stone Company quarry, eight miles southeast of Columbus, Indiana, by Mr. R. E. Kirk, of Indiana University, for whom the species is named.

Holotype.—Indiana University Paleontological Collections, slides 306-15, 16, 17, 18. Cat. No. 5370.

Stromatoporella solitaria Nicholson Pl. 8, figs. 3a, b

Stromatoporella eifeliensis Nicholson (part), 1886, Ann. Mag. Nat. Hist., ser. 5, vol. 17, p. 235. pl. 8, figs. 5, 7 (not 6).

Stromatoporella solitaria Nicholson, 1886, Palaeont. Soc. London, vol. 39, text fig. 7, pl. 7, fig. 4; 1892, vol. 46, p. 210, pl. 27, figs. 4-7, text fig. 28 (Mid. Dev., Gerolstein, Germany).

Coenosteum flat, massive, up to 5 cm. high and 12 cm. in diameter. The surface has large, high, conical mamelons, 4 to 8 mm. in diameter, 2 to 5 mm. high, and 5 to 10 mm. apart from center to center, one or two per sq. cm. Astrorhizae small, obscure, in the mamelon axes. Latilaminae 1 to 4 mm. thick.

Vertical section.—The laminae are thin, strongly undulating into the mamelons and intermamelon areas, and are bent upward at sharp angles into abundant, distinct, moderate-sized ring-pillars. The laminae are transversely fibrous as ordinarily seen, but are coarsely porous in places, 0.05 to 0.07 mm. thick, five to seven laminae in 2 mm., and may have foramina between galleries. The solid pillars are rodlike, 0.08 to 0.12 mm. thick, two to three in 2 mm.; the ring-pillars are 0.2 to 0.3 mm. broad, with large hollow centers, about two in 2 mm. A thin, straight, tabula is located at or near the base of the hollow center of some of the larger ring-pillars. The ordinary pillars are transversely fibrous and the ring-pillars have the same kind of fibrous and porous tissue as the laminae. The galleries are rectangular, averaging 0.18 mm. high and variable in width. Dissepiments are few, broad and sporadic. Large tabulate tubes, 0.3 to 0.5 mm. broad, occur in the axes of some of the mamelon columns.

Tangential section.—The skeletal tissue represents about 30 percent of the thin section. Round pillars are few and average 0.11 mm. in diameter. Ring-pillars are abundant, and have an average outer diameter of 0.2 to 0.3 mm., with an inner diameter of half as much; some are C-shaped. Both laminae and ring-pillars are transversely fibrous and in places coarsely perforate. The galleries are irregular in form and anastomose about the solid and ring-pillars. Astrorhizae are nontypical, appearing as large, stellate pores, 0.4 to 0.6 mm. in diameter in some of the mamelon axes. Astrorhizal canals do not seem to be developed. Dissepiments are few.

Stromatoporella solitaria is characterized by large, conical mamelons, small, stellate astrorhizae, axial tubes lacking definite astrorhizal canals, and abundant ring-pillars. The Indiana specimens appear to be identical, structure by structure, with the German type. It is similar to *S. eriensis* (Parks), differing in the presence of mamelons.

Occurence.—Middle Devonian, Logansport limestone, France Lime and Stone Company quarry, five miles east of Logansport, Indiana. A specimen with surface well preserved is from Pipe Creek Falls, 10 miles southeast of Logansport.

Plesiotype.—Indiana University Paleontological Collections, slides 285-84, 85; 295-97, 98; 303-3, 4, 5, 6, 7. Cat. No. 5326.

Stromatoporella parasolitaria Galloway and St. Jean, n. sp.
Pl. 8, figs. 4a, b

Coenosteum flat; fragments are up to 4 cm. high and 20 cm. in diameter. The surface has conical mamelons 5 mm. in diameter, 2 to 3 mm. high and 10 to 15 mm. apart from center to center, and small, sporadic astrorhizae, with short, radial canals. Latilaminae vague, 2 to 4 mm. thick.

Vertical section.—Laminae are closely spaced, 9 to 10 in 2 mm., 0.06 mm. thick, with light-colored median, transversely porous layer, and thin, upper and lower layers which are darker in color than the median layer; the laminar structure is nearly identical with that of *S. granulata* (Nicholson, 1886, pl. 1, fig. 5). The laminae turn smoothly into the mamelons, and are inflected into low ring-pillars. Short, straight or spool-shaped pillars, five to eight in 2 mm., 0.07 mm. broad, are transversely fibrous and do not thicken in the mamelons. The galleries are oval to rectangular, 0.15 mm. high, and variable in breadth. Astrorhizal canals occur sporadically throughout the section, recognizable by their large size. They may be superposed, and a few mamelons have an axial tube. Dissepiments are common, mostly small, convex upward, and commonly oblique to the laminae. There are a few foramina through the laminae.

Tangential section.—The solid pillars are abundant, round, oval to elongate, 0.12 mm. in diameter, four to eight in 2 mm.; the ring-pillars are rare to common, 0.3 mm. in diameter, with an inside diameter of 0.13 mm., and may be missing in most of the section, but both kinds of pillars are more numerous than the illustrated section shows (pl. 8, fig. 4b). The pillars, of both kinds, are in places tied together by dissepiments. The galleries constitute about twice the area of the pillars. The astrorhizae are sporadically developed but are indicated by a few large, simple, broad, bifurcating canals, about 0.5 mm. broad at their base. The tissue of the round pillars is finely, radially fibrous; the tissue of the ring-pillars is both radially fibrous and radially porous.

Stromatoporella parasolitaria is characterized by irregular mamelons, small astrorhizae, close-set, tripartite laminae, and few ring-pillars. Because of the paucity of ring-pillars in many places, it may be mistaken for *Stictostroma,* especially since sporadic rings occur in some species of *Stictostroma.*

S. parasolitaria differs from *S. solitaria* Nicholson (1886, pl. 7. fig. 4; 1892, p. 210, pl. 27, figs. 4-7) in having more closely spaced laminae, 9 to 10 instead of 6 in 2 mm., and much fewer ring-pillars. It differs from *S.* cf. *cellulosa* (Nicholson) in having sporadic mamelons, and the laminae are closer together. Excepting for mamelons, *S. parasolitaria* seems to be identical with *Clathrodictyon amygdaloïdes subvesiculosum* Lecompte (1951, p. 143, pl. 18, figs. 3, 3a, 3b), which is a *Stromatoporella,* showing ring-pillars in both vertical and tangential sections; but in the absence of sections for comparison, we hesitate to identify the two forms. The bases of some of the specimens were crushed before infiltration having precisely the appearance of *"Clathrodictyon" townsendi* Parks (1936, pl. 4, figs. 1, 2, 3).

Occurrence.—Three specimens were collected from the Middle Devonian, Jeffersonville limestone at Charlestown, Indiana, one highly infested with *Syringopora.* One fine specimen like *S. solitaria* but having closer laminae, was collected from the Middle Devonian Onondaga limestone on the school road at Ridgemont, Ontario, by Mr. John Sargent of The Buffalo Society of Natural Sciences.

Holotype.—Indiana University Paleontological Collections, slides 282-18, 19; 305-50. Cat. No. 5374.

Paratypes.—Slides 282-1, 2, 3, 4, 5, 6, 20, 21; 285-68, 69; 305-63.

Stromatoporella huronensis (Parks) Pl. 9, figs. 1a-d

Stictostroma huronense Parks, 1936, Univ. Toronto Studies, Geol., Ser., No. 39, p. 83, pl. 7, figs. 1-3 (Mid. Dev., Traverse, Long Lake, Alpena Co., Mich.).

Coenosteum massive, lenticular, 22 cm. in diameter, 7 cm. thick. Surface with large, unequal, domal mamelons, 5 to 15 mm. in diameter, 2 to 8 mm. high. The mamelons are mostly terminated by a large, round pore. Astrorhizae absent. Papillae abundant, many have terminal pores, identifying them as ring-pillars. Latilaminae 3 to 5 mm. thick.

Vertical section.—The laminae are straight or gently curved, in part curving downward into solid pillars, more commonly curving abruptly upward into ring-pillars, and curving strongly into the mamelons. In places there are long galleries without pillars. There are a few foramina through the laminae. The laminae are 0.03 to 0.08 mm. thick, seven or eight in 2 mm. The tissue is mostly transversely fibrous, and porous in places. Pillars less regular than the laminae, averaging eight in 2 mm., 0.05 to 0.08 mm. broad, becoming thicker in the mamelons, especially where the pillars are adjacent to mamelon tubes. Laminae and pillars are made of the same transversely fibrous tissue. Dissepiments are common, especially where the laminae are farthest apart or have been damaged. A single, straight, wall-less tube, 0.4 to 0.5 mm. broad, traversed by curved tabulae, is located in the center of each mamelon.

Tangential section.—The solid pillars are round, 0.08 to 0.13 mm. in diameter, a few are oblong. The ring-pillars are 0.2 to 0.3 mm. in diameter, with lumina 0.07 to 0.11 mm. in diameter, and some are C-shaped and some are small. The ring-pillars tend to open outward and the solid pillars to turn inward on the flanks of the mamelons where they are cut obliquely. The mamelon tubes are irregular, 0.5 to 0.8 mm. in diameter, surrounded by a thick irregular mass of fibrous tissue. Some long dissepiments connect the pillars to each other and to the laminae.

Stromatoporella huronensis is characterized by the large, domal mamelons, moderate number of ring-pillars of average size, and fibrous laminae. Our specimen agrees well with Parks' description, though the vertical section has ring-pillars more the size of those in *S. eriensis* than that illustrated by Parks (1936, pl. 7, fig. 1). Parks' illustration may be somewhat atypical. *S. huronensis* resembles *S. solitaria,* differing in the size of the mamelons, and the lack of astrorhizae. It differs from *S. eriensis* (Parks) (1936, p. 81, pl. 5, figs. 1-4) in having mamelons and fewer ring-pillars. The species differs from *S. basilii* Yavorsky (1950, p. 262, pl. 7, figs. 4, 5), also in having mamelons and fewer ring-pillars, which is nearly identical with *S. eriensis.* We place this species in *Stromatoporella* on account of the ring-pillars which are generally lacking in *Stictostroma.* Parks did not see the transverse tubules in the laminae, which his type specimen has. Although our specimen seems to fit Parks' description well, our figures show more upturns into ring-pillars, and our specimen may not belong to *S. huronensis* Parks, from the Traverse of Michigan.

Occurrence.—A single, finely preserved specimen was found in a yard at Camden, Carroll County, Indiana, by Mr. G. O. Winston. There are no outcrops at Camden, which is underlain by glacial drift. The specimen is preserved in a similar fashion and has the general appearance of other specimens from the Logansport limestone. Since the Logansport limestone occurs beneath the glacial drift within a mile of Camden, to the northeast, and since stromatoporoids occur in Logansport limestone beds near the city of Logansport, to the northeast of Camden, we feel sure that the specimen came originally from bedrock near Camden, Indiana. We did not find this species at Logansport.

Plesiotype.—Indiana University Paleontological Collections, slides 282-88, 89, 90, 91. Cat. No. 5375.

Stromatoporella cryptoannulata Galloway and St. Jean, n. sp.
Pl. 9, figs. 2a, b

Coenosteum massive, up to 7 cm. high and 19 cm. in diameter. The surface has small mamelons 2 to 3 mm. in diameter, 0.5 mm. high and 3 to 4 mm. apart from center to center. Small astrorhizae are located in the mamelon axes, with many short, radial canals which appear to coalesce with the canals from adjacent astrorhizae. Latilaminae are 1 to 3 mm. thick.

Vertical section.—The laminae are thick, 0.1 to 0.15 mm., seven to eight in 2 mm., and turn up into mamelon columns, and also turn up into the overlying laminae in simple pillars and obscure ring-pillars. The laminae are transversely fibrous and flocculent, with a complicated system of anastomosing tubules, making swirls, especially where the laminae merge into pillars, giving the identical appearance of that of *Stromatoporella eifeliensis* Nicholson (1886, pl. 11, figs. 1, 2, 3). The swirls are not shown well in our figure because the section is too thick. The pillars are thick, spool-shaped averaging nearly 0.3 mm. broad but vary greatly, made of the same material and structure as the laminae, not superposed except in the mamelon columns. The galleries are oval and elongate horizontally, about as high as the laminae are thick. A few galleries are joined by foramina with overlying galleries. There are no pseudozooidal tubes. Dissepiments are rare. The mamelon axes have several subparallel, nearly vertical astrorhizal tubes. Astrorhizal canals are round in cross section, located mostly on the flanks of the astrorhizal columns, and are slightly larger than the galleries, up to 0.2 mm. in diameter.

Tangential section.—The skeletal tissue represents about 70 percent of the area of the thin section. The laminae make broad rings about the mamelons. The pillars are in part round, radially fibrous and porous, and are in part thick rings which are obscure because they coalesce with the laminar tissue and with other ring-pillars. The solid pillars are 0.13 mm. in diameter. The ring-pillars are large and thick-walled, have an outside diameter of 0.3 to 0.4 mm. and an inside diameter of 0.15 mm. The galleries are small and irregular. Tubes in the mamelons are multiple, up to nine tubes in some mamelons, 0.15 mm. in diameter. The mamelon tubes may be confused with coalescent ring-pillars for they have much the same diameter. The astrorhizae are small, with broad, frequently branching canals which average 0.15 mm. broad near the base. The laminae and pillars being composed of the same tissue of radial fibers and anastomosing tubules, are largely amalgamated, but the tissue is not maculate.

Stromatoporella cryptoannulata is a typical *Stromatoporella* in tissue structure. It is characterized by small mamelons, thick laminae with anastomosingly porous, fibrous tissue; multiple tubes in the mamelon columns; large, obscure, ring-pillars; few dissepiments; and small irregular astrorhizae. The species is named for the hidden nature of the ring-pillars which can be distinguished with difficulty in vertical section and which are easily overlooked in tangential section. *S. cryptoannulata* resembles *S. eifeliensis* Nicholson (1892, p. 208) in tissue structure but differs in many other respects. It resembles *S. damnoniensis* Nicholson (1892, p. 207) but differs in the stronger mamelons with multiple, tubular axes.

Occurrence.—Two specimens were collected from the Middle Devonian lower Logansport limestone, at the France Lime and Stone Company quarry, five miles east of Logansport, Indiana.

Holotype.—Indiana University Paleontological Collections, slides 278-8, 9; 294-8, 9. Cat. No. 5327.

Paratype.—Slides 303-75, 76.

Stromatoporella perannulata Galloway and St. Jean, n. sp.
Pl. 9, figs. 3a, b

Stromatoporella cellulosa Parks, 1936, (not Nicholson), Univ. Toronto Studies, Geol. Ser., No. 39, p. 108, pl. 4, figs. 6, 7. (Mid Dev., Onondaga drift, Simcoe, Ont.).

Coenosteum massive, fragments are 2.5 cm. high, 8 cm. in diameter. The surface, based on vertical and tangential sections, has irregular mamelons, 4 to 6 mm. in diameter, 1 to 2 mm. high, and 10 mm. apart from center to center. Latilaminae are difficult to distinguish, about 1.5 to 2 mm. thick. Astrorhizae absent.

Vertical section.—The skeleton has a lacy appearance and is composed of thin, strongly undulating laminae which are crenulate and turn sharply into the abundant ring-pillars. The laminae are transversely porous, and tripartite in many places with a clear, transversely porous, median layer and thin, upper and lower, darker layers. The laminae are about 0.07 mm. thick, five to six in 2 mm. The solid pillars are 0.08 mm. broad, three to eight in 4 mm.; the ring-pillars are nearly twice as abundant as the solid pillars. Both laminae and pillars are transversely porous and fibrous. The galleries are subrectangular averaging 0.26 mm. high and 0.41 mm. broad. The dissepiments are broadly curved and irregular, common to abundant.

Tangential section.—The skeletal tissue represents about thirty percent of the thin section. The solid pillars are abundant, round, about 0.1 mm. in diameter, some coalescent, about as numerous as the ring-pillars. The ring-pillars are striking in their abundance, about six occur in a field 2 mm. in diameter. They have an outside diameter of 0.2 to 0.4 mm. and an inside diameter of 0.15 to 0.2 mm. The tissue of the round pillars is radially fibrous; that of the ring-pillars is radially porous. The laminar tissue is mostly fibrous and is tubulose in a few places. Dissepiments connect many of the solid and ring-pillars.

Stromatoporella perannulata is characterized by irregular mamelons, thin, undulating and crenulate laminae, and a great abundance of ring-pillars with large lumina relative to their outer diameter. *S. perannulata* differs from *S. cellulosa* (Nicholson and Murie) in having smaller, and a far greater number of ring-pillars for a given area. *S. perannulata* is exactly the same as the specimen identified by Parks (1936, pl. 4, figs. 6, 7) as *S. cellulosa* (Nicholson and Murie). It differs from *S. solitaria* Nicholson in the greater abundance of ring-pillars and dissepiments. From *S. eriensis* (Parks) (1936, pl. 5, figs. 1-4) *S. perannulata* differs in having mamelons, thinner less regular laminae, and more dissepiments.

Occurrence.—Two specimens were collected by Mr. Preston McGrain and Mr. F. H. Walker, from the Middle Devonian, Jeffersonville limestone at the Jefferson County quarry, 1.2 miles northeast of the Louisville, Kentucky city limits on U. S. Highway 42.

Holotype.—Indiana University Paleontological Collections, slides 305-42, 43, 52. Cat. No. 5391.

Paratypes.—Slides 305-44, 45.

Stromatoporella cf. **cellulosa** (Nicholson and Murie) Pl. 10, figs. 1a, b

Clathrodictyon cellulosum Nicholson and Murie, 1878, Jour. Linn. Soc. London, Zool., vol. 14, p. 221, pl. 2, figs. 6-10 (Mid. Dev., Onondaga ls., Wainfleet, Ont.); Nicholson, 1886, Palaeont. Soc., vol. 39, p. 43, 78, text figs. 2, 11; 1887, Ann. Mag. Nat. Hist., ser 5, vol. 19, p. 11, pl. 2, figs. 7, 8 (Mid. Dev., Onondaga ls., Port Colborne, Ont.).

Stromatoporella cellulosa Parks, 1936, Univ. Toronto Studies, Geol. Series, No. 39, p. 108, pl. 4, fig. 8. (After Nicholson. Not figs. 6, 7=*S. perannulata,* n. sp.)

Clathrodictyon aff. *cellulosum* Lecompte, 1951, Inst. Roy. Sci. Nat. Belgique, Mém. 116, p. 140, pl. 17, figs. 2, 2a (Mid. Dev., Couvinian, Ardennes, Belgium).

Coenosteum massive, a fragment is 1.5 cm. high and 5 cm. in diameter. Mamelons and astrorhizae are absent. The latilaminae are 2 to 5 mm. thick.

Vertical section.—The laminae are thin, 0.04 to 0.06 mm. thick, six to eight in 2 mm. and turn up into many ring-pillars. The pillars are in part short and rodlike, and in part open, truncated conical, not superposed. The solid pillars are 0.08 to 0.10 mm. broad, four in 2 mm., and transversely fibrous. Ring-pillars are abundant, 0.1 to 0.2 mm. broad. The tissue of the laminae and ring-pillars is transversely tubulose but irregularly developed. The galleries are oval or elongate, 0.1 to 0.3 mm. high with a breadth one to four times the height; the cellular appearance of the vertical section is due to the abundant upturns of the ring-pillars. Dissepiments are rare, usually broad.

Tangential section.—The skeletal tissue represents about 50 percent of the thin section, and shows the large galleries rather than chambers or cells. The round pillars are 0.11 mm. in diameter, the ring-pillars are abundant, some are C-shaped, 0.2 to 0.3 mm. in diameter with lumina 0.06 to 0.07 mm. in diameter, and connected by long dissepiments. Astrorhizae absent. The specimen is strongly infested with tubes of *Syringopora,* 1 mm. in diameter, which have infundibular tabulae; this specimen demonstrates that caunopore tubes are the corallites of the coral *Syringopora.* The laminae are damaged and dip down to the coral.

Stromatoporella cf. *cellulosa* (Nicholson and Murie), as we understand it, is characterized by the lack of mamelons and astrorhizae, by thin laminae, thin closely spaced pillars, the cell-like galleries, abundant ring-pillars, and few dissepiments. Nicholson and Murie's original description of the species is not adequate, even for the identification of the genus, nor are Nicholson's figures in his monograph, (text figs. 2A, B). No rings were mentioned or figured but in his last publication of the species (Nicholson, 1887, pl. 2, fig. 8), several large rings are clearly figured, as well as long dissepiments connecting the pillars. Parks (1936, p. 109, figs. 6, 7) described and figured a specimen from the Onondaga drift at Simcoe, Ontario, which has much more irregular and thinner laminae, and more numerous and smaller ring-pillars than Nicholson's specimen. We have placed Parks' form in our new species, *Stromatoporella perannulata.* Our species appears to be different from Nicholson's last description and figure of *S. cellulosa* in that the ring-pillars are smaller and more numerous, and the laminae are closer together. The species is similar to *S. amygdaloides subvesiculosa* (Lecompte) (1951, p. 143, pl. 18, figs. 3, 3a, b) which shows ring-pillars in both vertical and tangential sections, but our species has no astrorhizae. There is much doubt as to what Nicholson and Murie's species is.

Occurrence.—One small fragmentary specimen was collected from the Middle Devonian, Jeffersonville limestone at Big Spring, two miles west of Hanover, Indiana, by Mr. Guy Campbell.

Plesiotype.—Indiana University Paleontological Collections, slides 295-56, 57; 305-51. Cat. No. 5376.

Stromatoporella eriensis (Parks) Pl. 10, figs. 2a, b

Stictostroma eriense Parks, 1936, Univ. Toronto Studies, Geol. Ser., No.

39, p. 81, pl. 5, figs. 1-4 (Mid. Dev., Columbus limestone, Marblehead, Ohio).

Coenosteum massive, up to 4 cm. high and 10 cm. in diameter; surface broadly undulatory, without mamelons, astrorhizae or papillae; latilaminae thin, 2 to 3 mm. thick.

Vertical section.—Laminae thin, broadly curved, 0.02 to 0.05 mm. thick, six to eight in 2 mm., sharply inflected into abundant, high, cylindrical ring-pillars, which extend through one interlaminar space. Galleries polygonal to elongate, with a few foramina through the laminae. Two to six solid pillars and ring-pillars in 2 mm. Tissue compact, finely fibrous transversely, with transverse pores in places. Dissepiments are rare but occur where growth has been interfered with.

Tangential section.—The solid pillars are round, 0.10 to 0.15 mm. in diameter and 0.1 to 0.4 mm. apart. The ring-pillars are round, with an inner diameter of 0.08 to 0.15 mm., and an outer diameter of 0.3 to 0.4 mm., 0.1 to 1.2 mm. apart, more abundant than the solid pillars, and a few are tied by dissepiments.

Stromatoporella eriensis is characterized by the lack of mamelons and astrorhizae, by abundant, cylindrical ring-pillars and solid pillars in about equal numbers, and by the fibrous tissue in which the transverse pores are easily overlooked. The species differs from *S. huronensis* (Parks) in lacking mamelons, and in having larger and more abundant ring-pillars. It belongs in *Stromatoporella,* rather than *Stictostroma* which does not have ring-pillars. Our vertical section has coarser structure than is normal in the specimen and in the species, but it is like the type sections, which we have examined. The main difference between *S. eriensis* and our understanding of *S.* cf. *cellulosa* is in the finer and fewer pores in the laminae, the more widely spaced laminae, and the fewer dissepiments of *S. eriensis.*

Occurrence.—The figured specimens are from the Columbus limestone at Columbus, Ohio, obtained in exchange with Ohio State University; at the Dublin quarry, Dublin, Ohio, collected by Prof. A. LaRocque; and 1.2 miles west of East Liberty, Ohio, collected by Dr. W. J. Wayne. One specimen from the same horizon at Columbus, Ohio, was loaned to us from the Ohio State University Museum by Dr. Mildred F. Marple.

Plesiotypes.—Indiana University Paleontological Collections, slides 282-48, 49, 50; 303-8, 9; 305-31, 59, 60; 306-21, 22; Cat. No. 5401. Ohio State University Museum Paleontological Collections, specimen 3855, and two unnumbered slides.

Stromatoporella columbusensis Galloway and St. Jean, n. sp.
Pl. 10, figs. 3a, b

Coenosteum massive, a fragment is 5 cm. high and 11 cm. in diameter. The surface, based on thin sections and polished surfaces, is smooth, lacking mamelons or astrorhizae. Latilaminae are thin, 1 to 3 mm. thick.

Vertical section.—The laminae are straight, thin, 0.03 to 0.05 mm. thick, six or seven in 2 mm., and are strongly porous transversely. Solid pillars are short, thin, widely spaced, rodlike, many pendant from the lower sides of the laminae or flaring toward the top, 0.1 mm. broad, up to six in 2 mm. The laminae turn up into ring-pillars, 0.3 mm. broad, two to three in 2 mm., many of which are superposed. The galleries are rectangular, 0.17 to 0.5 mm. high, and up to 3 mm. broad. Dissepiments are broadly arched, rare to common.

Tangential section.—The laminae are pierced by a close set meshwork of round, elongate and anastomosing pores, not maculae. The pillars are in part round, but largely branching, vermicular and confluent plates near the laminae, formed by the pendant pillars, and largely ring-pillars between the laminae. The round pillars are 0.1 mm. in diameter, the platelike pillars are 0.1 mm. thick, up to 0.8 mm. long, transversely fibrous, and the ring-pillars are 0.3 mm. apart, 0.2 mm. in diameter, radially porous with lumina 0.1 mm. in diameter. Dissepiments are rare.

Stromatoporella columbusensis is characterized by the lack of mamelons and astrorhizae, by the thin, porous laminae, the superposed ring-pillars, and the branching, platelike, pendant pillars.

Occurrence.—One specimen was collected from the Middle Devonian, Columbus limestone, at Snouffer's quarry on the east bank of the Scioto River, five miles northwest of Columbus, Ohio.

Holotype.—Indiana University Paleontological Collections, slide 282-54. Cat. No. 5402.

Family **ACTINOSTROMATIDAE** Nicholson, 1886*

Family Actinostromidae Nicholson, 1886, Palaeont. Soc., vol. 39, p. 74.
Family Actinostromatidae Stechow, 1922, Archiv. Naturg., Abt. A, vol. 88, Heft 3, p. 151.

Coenosteum laminar or massive, rarely cylindrical, composed of definite laminae and continuous or superposed, strong pillars. The laminae are regular, irregular or irregularly cystose, with much secondary thickening tissue. Skeletal tissue compact or vacuolate, not maculate. Galleries usually superposed. Astrorhizae present or absent.

Silurian common, Devonian abundant.

KEY TO PALEOZOIC GENERA OF ACTINOSTROMATIDAE

1a. Pillars connected by radial processes in the laminae .... ACTINOSTROMA
1b. Pillars not connected by radial processes
  2a. Pillars throughout interlaminar spaces
    3a. Laminae with transverse pores .... GERRONOSTROMA
    3b. Laminae without transverse pores .... TRUPETOSTROMA
  2b. Pillars only in the mamelons .... LOPHIOSTROMA

Genus **ACTINOSTROMA** Nicholson, 1886

Type species, *A. clathratum* Nicholson, 1886, Palaeont. Soc., vol. 39, p. 75, pl. 1, figs. 8-13; pl. 2, fig. 11; p. 131, pl. 12, figs. 1-5 (Mid. Dev. Gerolstein, Germany); Lecompte, 1951, Inst. Roy. Sci. Nat. Belgique, Mém. 116, p. 67.

Rosenia Waagen and Wentzel, 1887, Mem. Geol. Surv. India, Pal. Indica, ser. 13, vol. 1, p. 943, monotypic, *Stromatopora astroites* Rosen (Silurian, Oesel Island); Nicholson, 1889, Palaeont. Soc., vol. 42, p. 143, pl. 17, figs. 1-7.

Actinostromella Boehnke, 1915, Palaeontographica, Beitr. Natur. Vorzeit, vol. 61, p. 162. Type species (first species), *A. tubulata* Boehnke, *ibid.*, text figs. 6, 7 (Silurian boulders, N. Germany). (Differs from *Actinostroma* only in having wall-less, tabulated tubes, of doubtful significance.)

Coenosteum massive, laminar to globular, some latilaminate,

* The plural of *stroma* is *stromata,* the stem is *stromat,* hence, Actinostromatidae.

composed of strong laminae and strong, continuous pillars. Pillars with or without lumina, connected in the laminae with three to six adjoining pillars by straight radiating processes. Tissue compact. Surface tuberculate. Astrorhizae generally present.

Silurian and Devonian; Europe, North America, Asia, Africa, Australia. Over 70 species. *Actinostroma trentonense* Ulrich and Everett (1890, Ill. State Geol. Surv., vol. 8, p. 282, pl. 7, fig. 3) is surely a sponge.

We include the original figures and a description of the type species to show the diagnostic characters of the genus.

Actinostroma clathratum Nicholson Pl. 10, figs. 4a, b

Actinostroma clathratum Nicholson, 1886, Palaeont. Soc., vol. 39, p. 76, pl. 1, figs. 8-13; pl. 2, fig. 11 (Mid. Dev., Gerolstein, Germany); 1886, Ann. Mag. Nat. Hist., ser. 5, vol. 17, p. 226, pl. 6, figs. 1-3 (Mid. Dev., Hebborn, Germany and Dartington, England); 1889. Palaeont. Soc., vol. 42, p. 131, pl. 12, figs. 1-5; pl. 13, figs. 1, 2 (Mid. Dev. Hebborn, Germany and Teignmouth and Dartington, England); 1890, Geol. Mag., decade 3, vol. 7, p. 193, pl. 8, figs. 8a, b (Mid. Dev., Western Australia); Lecompte, 1951, Inst. Roy. Sci. Nat. Belgique, Mém. 116, p. 77, pl. 1, figs. 1-12 (Mid. Dev., Givetian and Frasnian, Belgium).

The following description is based on the original description and figures by Nicholson, and on the redescription and new figures of the type by Lecompte.

Coenosteum massive, up to 18 cm. in diameter. The surface is without mamelons but has numerous round papillae which represent the ends of the pillars. Astrorhizae are present in some specimens and not in others, usually small and inconspicuous, imperfect, irregular in distribution, not superposed. Latilaminae are 1 to 6 mm. thick.

Vertical section.—Laminae straight or slightly undulatory, composed of a single layer of compact tissue, 0.07 to 0.10 mm. thick, six to eight in 2 mm. Pillars long, extending through many laminae, nearly parallel, averaging 0.10 to 0.12 mm. broad, 8 to 10 in 2 mm. The pillars increase in number outward by intercalation. Galleries mostly square, 0.15 to 0.18 mm. high. Dissepiments are absent.

Tangential section.—Pillars round, some have a small central lumen; radial processes, 0.01 to 0.02 mm. thick, make an angular meshwork, leaving successive galleries connected by foramina. The astrorhizae are small, with canals which are 0.2 mm. broad at the base.

Actinostroma clathratum Nicholson is characterized by the lack of mamelons, by the obscure astrorhizae, and by the prominent coarse, radial arms on the pillars.

Occurrence.—The type is from the Middle Devonian of Gerolstein, Germany. The species has been identified from the Middle Devonian of England, Belgium, other areas in Germany, southeast Asia, and Australia. We did not find this species in our midwestern material.

Actinostroma tyrrelli Nicholson Pl. 11, figs. 1, 2

Actinostroma Tyrrellii Nicholson, 1891, Ann. Mag. Nat. Hist., ser. 6, vol. 7, p. 317, pl. 8, figs. 4, 5, text fig. 1 (Mid. Dev., Lake Winnipegosis, Canada); Parks, 1936, Univ. Toronto Studies, Geol. Ser., No. 39, p. 121, pl. 19, figs. 1, 2 (Mid. Dev., Presqu'ile dolo., Great Slave Lake, Canada).

Coenosteum massive, a fragment is 4 cm. high and 7 cm. in diameter. The surface is undulatory but lacks definite mamelons. Papillae are small and round. Astrorhizae are distinguished only on a polished surface, are small but typical, about 3 mm. in diameter and 3 to 5 mm. apart from center to center. The latilaminae average 1 to 2 mm. thick.

Vertical section.—The skeleton is composed of thin, nearly straight, slightly crenulated, closely spaced laminae and long, thicker pillars. The laminae are 0.03 mm. thick, 18 to 20 in 2 mm. and made by the rays from the pillars at concordant levels and flat extensions from the rays, and are therefore discontinuous. The pillars are straight and thin, 10 to 12 in 2 mm., 0.06 mm. broad. The galleries are low, rectangular or arched upward, averaging 0.08 mm. high and 0.20 mm. broad, closer at the junction of latilaminae. The tissue of both the laminae and pillars is very compact, and the pillars have a thin, dark axis, but ordinarily no lumina. Round or oval astrorhizal canals, 0.18 to 0.26 mm. in diameter, are scattered through the section, but are not conspicuous; the astrorhizae are not superposed and do not make mamelons or columns.

Tangential section.—The skeletal tissue represents about 40 percent of the thin section, where cut between laminae. The pillars are round, 0.09 to 0.1 mm. in diameter, 0.15 to 0.2 mm. apart, and connected by four to six thin, radial arms, 0.2 to 0.3 mm. broad. The galleries are connected around the pillars, and polygonal between the radial arms. The astrorhizae are small and obscure, 2 to 3 mm. in diameter, composed of thin, short, branching canals about 0.1 mm. broad at the base, without axial tube.

The thin, close-set laminae, small pillars, and small astrorhizae characterize the species. The texture of the skeleton is unusually fine for the genus.

Occurrence.—One well-preserved specimen, which fits Nicholson's type, was collected from the Middle Devonian Logansport limestone at the France Lime and Stone Company quarry, five miles east of Logansport, Indiana.

Plesiotype.—Indiana University Paleontological Collections, slides 303-67, 68, 100. Cat. No. 5328.

Genus **GERRONOSTROMA** Yavorsky, 1931

Type species (first species, here selected), *G. elegans* Yavorsky, 1931, Bull. United Geol. Prosp. Service, U. S. S. R., vol. 50, fasc. 94, p. 1406, pl. 1, fig. 12; pl. 2, figs. 3-6 (Mid. Dev., Kuznetsk Basin, south of Bachat, Russia); Riabinin, 1941, U. S. S. R. Acad. Sci., Palaeont. Inst., vol. 1, p. 91, 108.

Coenosteum massive or nodular, with definite, thick laminae and wide interlaminar spaces. Pillars strong, superposed through many interlaminar spaces, spool-shaped between laminae, not composed of rods, nor with lumina. In tangential section the pillars are round or coalescing, without radial processes. Laminar tissue transversely porous, vacuolate; galleries superposed, frequently with dissepiments. Astrorhizae present or absent.

Middle and Upper Devonian, Kuznetsk Basin, Urals, and Leningrad regions, Russia; Middle Devonian, Indiana. Six species.

This genus is similar to *Hermatostroma,* but the laminae and pillars are not bordered with clear tissue. *G. concentrica* and *G. batschatense* resemble *Trupetostroma,* even to the presence of vacuoles in the tissue. Yavorsky considered the genus to be like

Actinostroma but without radial processes from the pillars. A topotype of *G. elegans* sent to us by Mr. Yavorsky has laminae extending between short, superposed pillars, the laminar tissue is transversely porous, and the pillar tissue is transversely fibrous; small vacuities are the remnants of galleries.

KEY TO AMERICAN DEVONIAN SPECIES OF GERRONOSTROMA

1a. Mamelons large, irregular, 7 mm. in diameter .... *G. elegans* Yavorsky
1b. Mamelons small, 1 to 3 mm. in diameter
  2a. Mamelon columns plicate .... *G. plectile,* n. sp.
  2b. Mamelon columns nonplicate
    3a. Dissepiments abundant .... *G. excellens,* n. sp
    3b. Dissepiments rare to common ......*G.* cf. *insolitum* (Parks)

Gerronostroma elegans Yavorsky — Pl. 11, figs. 2a, b

Gerronostroma elegans Yavorsky, 1931, Bull. United Geol. Prosp. Service U. S. S. R., vol. 50, fasc. 94, p. 1406 (English summary), pl. 1, fig. 12; pl. 2, figs. 3-6 (Mid. Dev., Kuznetsk Basin, Russia).

Coenosteum massive, up to 10 cm. high and 17 cm. in diameter (Yavorsky's measurements). Surface with prominent papillae, may have irregular mamelons 7 mm. in diameter and 1.5 to 2 mm. high, as indicated by tangential section. No astrorhizae were observed. Latilaminae are 1 to 3 mm. thick. Polished surfaces show that the specimen had been badly broken and the pieces cemented together in an irregular manner.

Vertical section.—Laminae strong, irregular in thickness, 0.03 to 0.20 mm. thick, averaging 0.11 mm., seven or eight in 2 mm., straight to slightly undulatory, composed of a single coarsely porous layer, rarely with a clear, intermittent, median layer. Pillars short, spool-shaped, commonly superposed through 2 to 11 interlaminar areas, 0.07 to 0.24 mm. broad, four to six in 2 mm. The laminar tissue has coarse transverse fibers and is transversely porous in places. The pillars are transversely fibrous and spotted with small vacuoles about 0.02 mm. in diameter. The galleries are round to subrectangular, 0.10 to 0.29 mm. high and one to six times as broad. Superposed galleries, 0.05 to 0.42 mm. broad, one to four in 2 mm., are short to long, irregular in breadth, and many are connected by foramina in the laminae. Dissepiments common, usually oblique, thin, mostly curved upward, a few curved downward.

Tangential section.—The skeletal tissue represents about 50 percent of the area of the thin section. The laminae are coarsely fibrous, the fibers in swirls, and there are scattered, round pores. The pillars are mostly round, 0.09 to 0.16 mm. in diameter, coalescent to 0.27 mm. apart, without radial arms, some are connected by dissepiments, and some are elongate and not so thick as the round pillars. The vacuoles in the pillars are not so prominent as in the vertical section. No astrorhizae were observed.

Gerronostroma elegans Yavorsky is characterized by the irregular mamelons, the grill of thick laminae and stronger, superposed pillars, the small vacuoles and fewness of dissepiments. The species resembles *G. insolitum* (Parks), from which it is distinguished by the lack of tubes produced by sharp upturns of the laminae, by a more irregular thickness of the laminae, and by the lack of rings in tangential section.

Occurrence.—We are grateful to Mr. V. I. Yavorsky, Head Geologist of the Central Scientific Institute of Geological Research at Leningrad, Russia, for sending us a fragment of a paratype of his species *Gerronostroma elegans* which he collected from the Middle Devonian of the Kuznetsk Basin in Russia, south of the village of Bachat. We have selected the species as the type of the genus, and include a figure and description in this work because the genus is little known outside of Russia. We have three species of *Gerronostroma* in our faunas. Although the paratype varies somewhat from Yavorsky's published figures, we are convinced they are the same species.

Paratype.—Indiana University Paleontological Collections slides 306-43, 44. Cat. No. 5379.

Gerronostroma plectile Galloway and St. Jean, n. sp. Pl. 11, figs. 3a, b

Coenosteum massive, up to 12 cm. high and 12 cm. in diameter. The surface has mamelons 1 to 1.5 mm. in diameter, 0.5 to 1 mm. high, and 2 to 3 mm. apart from center to center, 10 to 12 in 1 sq. cm. Astrorhizae absent; latilaminae 1 to 5 mm. thick.

Vertical section.—The laminae are rather thin, 0.04 to 0.09 mm. thick, three or four in 2 mm., continuous, thicken and turn sharply into small mamelon columns; they are composed of a single, coarse, transversely porous layer, resembling the tissue of *Stromatoporella* and *Stictostroma*. The pillars, 0.09 to 0.15 mm. thick, are commonly superposed, two to five in 2 mm., are thin, rodlike, or spool-shaped, in some places with a dark central core. The pillar tissue is transversely fibrous, as in typical *Anostylostroma*. The pillars thicken in the mamelons and are arranged with the sharply upturned laminae in such a manner that the mamelon columns have a braided appearance as seen under low power, especially on polished vertical surfaces. The mamelon columns divide in some places. The mamelon tubes are compound, 0.5 to 1.5 mm. broad, two or three in a field 5 mm. in diameter. The galleries are rectangular, variable in size, normally 0.2 to 0.4 mm. high and one to three times as broad as they are high, with a few foramina through the laminae. Dissepiments abundant, thin, irregular in size and shape, mostly highly arched, horizontal or oblique.

Tangential section.—The pillars are round, rarely coalescent, 0.15 to 0.20 mm. in diameter, 0.1 to 0.3 mm. apart. The tubes in the mamelons are multiple, each mamelon containing from one to eight round to irregular tubes, 0.1 to 0.3 mm. in diameter; the multiple tubes are joined by curved dissepiments. The galleries are large, with an area 10 or more times the area of the pillars. Astrorhizae absent.

Gerronostroma plectile is characterized by small mamelon columns with tubes having a braided appearance, suggesting the specific term. It differs from *G. insolitum* (Parks) in the multiple, plicate tubes in the mamelons, and more abundant dissepiments, and from *G. excellens* in having multiple tubes in the mamelon columns.

Occurrence.—One specimen was collected from the Louisville Cement Company quarry at Speed, Indiana, another from the road metal quarry at Charlestown, Indiana, both from the Middle Devonian, Jeffersonville limestone.

Holotype.—Indiana University Paleontological Collections, slides 295-23, 24, 25. Cat. No. 5377.

Paratype.—Slides 282-15, 16.

Gerronostroma excellens Galloway and St. Jean, n. sp. Pl. 11, figs. 4a, b

Coenosteum massive, up to 9 cm. high and 16 cm. in diameter. The surface has mamelons 1 to 3 mm. in diameter, 0.5 to 1.0 mm. high and 2 to 6 mm. apart from center to center. Astrorhizae absent; latilaminae 3 to 11 mm. thick.

Vertical section.—The laminae are rather thick, 0.05 to 0.2 mm., four to five in 2 mm., are composed of a single layer of moderately coarse, transversely porous tissue, undulate slightly, and turn abruptly into simple, thick-walled tabulate mamelon tubes 0.5 to 0.7 mm. in diameter. The laminae do not turn up into ring-pillars. The pillars are straight, sporadically superposed, 0.1 to 0.2 mm. thick, two to four in 2 mm., and tend to thicken in the mamelons. The pillar tissue is composed of coarse, transverse fibers. The galleries are rectangular to oval, 0.3 to 0.5 mm. high and one to three times as broad as they are high. Dissepiments are abundant, highly arched, broadly curved, and oblique.

Tangential section.—The laminae are thick, flocculent and obscurely porous. The pillars are round, 0.1 to 0.2 mm. in diameter, 0.2 to 0.3 mm. apart, rarely coalescent. The mamelons have usually one thick annulus, 0.5 to 0.7 mm. in diameter, much larger than ring-pillars; there are rarely mamelon rings with two or more tubes, and rarely one or two annuli of laminae around a mamelon column. The annuli are joined by curved dissepiments and by pillars. The galleries are five to ten times the area of the pillars. No astrorhizae were noted.

Gerronostroma excellens is characterized by four to five laminae in 2 mm., small mamelons or tubercles, sporadic superposed pillars, by simple, straight, tabulate mamelon tubes, abundant dissepiments, and abundant, large annuli. Two paratypes differ from the holotype in having thinner laminae and pillars, more superposed pillars, and fewer dissepiments, grading toward *G. insolitum* (Parks), from which the species normally differs in having more abundant dissepiments, and more widely spaced laminae. *G. excellens* differs from *G. plectile* in having fewer and smaller compound tubes, the tubes do not have a braided appearance in vertical section. The thick-walled mamelon rings are two or three times as large as are ring-pillars of *Stromatoporella,* and they are not confined to one interlaminar space in vertical section, as are ring-pillars of *Stromatoporella.*

The three species, *G. insolitum, G. plectile,* and *G. excellens,* have overlapping characters, so that some specimens are difficult to assign to their species. At present there is no difficulty in distinguishing the holotypes of the three species, for they differ markedly in characters usually used to distinguish species in other genera, such as the number of laminae in a given distance, the number of tubes in the mamelons, the size of the tubes, the amount of superposition of the pillars, and the number of dissepiments. A' three species are anomalous in that the numerous, single mamelon tubes might be mistaken for the ring-pillars of *Stromatoporella.* The laminar wall tissue is porous like that of *Stromatoporella* or *Stictostroma,* but the transversely fibrous pillar tissue is like that of *Anostylostroma.* The dark core in many of the pillars in all three species is like that noted in *Anostylostroma meshbergerense.* The superposed pillars are like those of *Trupetostroma,* but the tissue is porous, not compact, as it is in *Trupetostroma.*

Occurrence.—The holotype is from the Middle Devonian, Jeffersonville limestone at the road metal quarry at Charlestown, Indiana. Two paratypes are from the Middle Devonian, Jeffersonville limestone at the Falls of the Ohio at Jeffersonville, Indiana.

Holotype.—Indiana University Paleontological Collections, slides 282-12, 13, 14. Cat. No. 5378.

Paratypes.—Slides 295-32, 33, 66, 67.

Gerronostroma cf. insolitum (Parks) Pl. 12, figs. 1a, b

Stictostroma insolitum Parks, 1936, University of Toronto Studies, Geol. Ser., No. 39, p. 86. pl. 15, figs. 4, 5 (Mid. Dev., Columbus limestone, Marblehead, Ohio).

Coenosteum massive, up to 9 cm. high and 15 cm. in diameter.

The surface is irregularly undulate with irregular, small mamelons, 1 to 3 mm. in diameter. Astrorhizae absent; latilaminae indistinct.

Vertical section.—The laminae gently undulate, turning up sharply into tabulate tubes. The laminae are variable 0.05 to 0.15 mm. thick, variably spaced, five to eight in 2 mm. The laminar tissue is transversely porous, shown only in favorable sections, and flocculent, and normally consists of only one layer. The pillars are strong, 0.1 to 0.2 mm. broad, three or four in 2 mm. spool-shaped, and normally superposed through distances of two to eight interlaminar spaces. They are perpendicular to the laminae and are cut by the laminae and composed of transversely fibrous and flocculent tissue but without tubules. No ring-pillars made of up-turned laminae were observed in nine vertical sections. The galleries are oval to rectangular, 0.2 to 0.4 mm. high and one to four times as broad as high. The sharply upturned laminae are superposed to form tabulate thick-walled tubes, 0.5 to 0.6 mm. in outer diameter with an inner diameter 0.3 to 0.4 mm. and extending through 4 to 10 laminae. Up to three tubes may be seen in a field 5 mm. in diameter. Dissepiments are few to common, highly arched, horizontal or diagonal, scarce where the laminae and pillars are straight.

Tangential section.—The laminae are thick, coarsely fibrous and flocculent, and porous in places. Most pillars are uniformly round, not coalescent, 0.1 to 0.2 mm. in diameter, and abundant, 0.2 to 0.4 mm. apart. The mamelon tubes occur as thick-walled, isolated rings, much larger than ring-pillars, with an outer diameter of 0.5 to 0.7 mm., and a few mamelons have two, three, or four tubes, with a diameter up to 1.2 mm. Mamelon tubes are not usually joined by dissepiments. Astrorhizae are absent.

Gerronostroma insolitum is characterized by the strong laminae, superposed pillars, common dissepiments, and abundant annuli. It differs from *G. plectile* in lacking the plicate columns and in having fewer dissepiments. It differs from *G. excellens,* from the same locality and horizon, in having fewer annuli and more superposed pillars, and in general fewer dissepiments. Our specimens fit most of Parks' descriptions and his figure 4, plate 15, but he does not show any large, mamelon rings, 0.5 to 0.7 mm. in diameter, only small rings, 0.3 mm. in diameter, in figure 5, plate 15, and there are more dissepiments in our specimens. One of our specimens (305-57) has small rings 0.17 to 0.3 mm. in diameter, formed by mere inflections of the laminae, and are not ring-pillars; it also shows mamelon rings 0.56 mm. in diameter and quadruple mamelon rings, 0.9 mm. in diameter, in the same field. The upturns of laminae which form ring-pillars in *Stromatoporella* are not apparent in Parks' vertical section, which we have examined, nor are they present in nine vertical sections we have of this species. Our specimens may not be *G. insolitum,* but only a variant of *G. excellens.*

Occurrence.—One specimen was collected from the Middle Devonian, Jeffersonville limestone at the road metal quarry, Charlestown, Indiana, and one specimen from the same limestone at the Falls of the Ohio, Jeffersonville, Indiana.

Plesiotypes.—Indiana University Paleontological Collections, slides 282-10, 11; 295-20, 49; 305-53, 54, 57, 58, 61, 62. Cat. No. 5361.

Genus **TRUPETOSTROMA** Parks, 1936

Type species, *T. warreni* Parks, 1936, Univ. Toronto Studies, Geol. Ser., No. 39, p. 52, pl. 10, figs. 1, 2 (Mid. Dev., Great Slave Lake, Canada); Lecompte, 1952, Inst. Roy. Sci. Nat., Belgique, Mém. 117, p. 219.

Coenosteum massive. Primary laminae typically thin, secondarily thickened on both sides, leaving a clear or dark middle line. Pillars stronger than the laminae, large, round, regularly superposed, composed of secondary material, spreading on both sides of the microlaminae. Galleries superposed, some with dissepiments. Tissue compact, not maculate nor with tubular pores, but the median line may have small, round vacuities, or vertical pores, and vacuoles. Astrorhizae and mamelons strong to weak.

Middle and Upper Devonian, North America and Belgium. Five American and twelve Belgium species.

Trupetostroma is characterized by (1) the continuous microlaminae, (2) the superposed pillars and galleries, (3) the pillars and secondary thickening on the microlaminae with oval vacuities. The type species almost lacks dissepiments, but they are abundant in most species. *Trupetostroma* seems to differ from *Gerronostroma* in lacking pores in the laminae, and in the presence of vacuoles in the pillars and secondary tissue. The laminae, pillars and superposed galleries resemble *Parallelopora,* but the tissue lacks the large maculae and tubules and rods in the pillars.

Figures and description of the type species are given to demonstrate the characters of the genus.

KEY TO THE AMERICAN DEVONIAN SPECIES OF TRUPETOSTROMA

1a. Microlaminae prominent, continuous
  2a. Pillars thin, microlaminae light ....*T. warreni* Parks
  2b. Pillars thick, microlaminae dark ....*T. raricystosum,* n.sp.
1b. Microlaminae vague, intermittent, or absent
  2c. Pillars thick, coalescent
    3a. Galleries large ....*T. iowense* Parks
    3b. Galleries small ....*T. coalescens,* n.sp.
  2d. Pillars thin; network lacy ....*T. maculosum* Parks

Trupetostroma warreni Parks   Pl. 12, figs. 2a, b

Trupetostroma warreni Parks, 1936, Univ. Toronto Studies, Geol. Ser., No. 39, p. 55, pl. 10, figs. 1, 2 (Mid. Dev., Great Slave Lake, Canada).

Coensteum massive, fragments 25 mm. thick and 70 mm. in diameter. The surface has mamelons 5 to 7 mm. in diameter, 1 mm. high and 8 to 12 mm. apart from center to center. Astrorhizae are small and scattered, and a small fragment may not show any at the surface. Latilaminae are 2 to 6 mm. thick.

Vertical section.—The laminae are strong, 0.1 to 0.3 mm. thick, eight or nine in 2 mm. turning smoothly into the low domal mamelons, composed of a median, clear, compact layer, 0.03 to 0.07 mm. thick, covered above and below in most places by darker, homogeneous tissue which spreads out from the pillars. The median layer varies in width, having a beadlike appearance. The darker covering tissue is 0 to 0.14 mm. thick. The pillars are short, superposed spools, composed of dark, homogeneous tissue with moderately large, ovoid vacuoles 0.05 to 0.08 mm. in diameter. The vacuoles in our specimen are not so abundant as shown in Parks' figure. The pillars are 0.06 to 0.12 mm. broad, two to six in 2 mm., in divergent rows in the mamelons. The tissue of both laminae and pillars is unusually dense, neither fibrous, flocculent, porous nor maculate. Under 150× magnification the tissue appears as dusty particles in a lighter groundmass. Galleries are rounded rectangular, 0.13 to 0.45 mm. high by one to seven times as broad; many superposed galleries are connected by foramina in the laminae. Dissepiments rare, thin, low arched plates which are oblique in most places. Astrorhizal canals are scattered, about twice the height of the galleries, not confined to the mamelons, and not well shown in our figure.

Tangential section.—Between the laminae the pillars are round to elongate, tending to be rectangular, about 0.1 mm. in thickness. In the upper and lower layers of the laminae the pillars join into a honeycomb network, with round galleries 0.15 to 0.2 mm. in diameter. The thin median lamina is compact, flocculent, dusty in appearance and continuous, except where it is pierced by an intergallery foramen. The secondary tissue is dense, dusty and darker than the median lamina, and contains abundant, round, sporadic vacuities. Dissepiments are very rare.

Trupetostroma warreni Parks, the type of the genus, is characterized by the mamelons, the strong laminae with prominent light, median line, and the strong, superposed pillars with vacuolate tissue which spreads out over the median lamina. Our specimen is infested by a wormlike tube, not *Syringopora*.

Occurrence.—Our specimen was collected by Mr. Dan Kralis, Jr., from the Middle Devonian, Key Scarp bioherm facies in the Fort Creek shale, at Hoosier Ridge, 22 miles down the Mackenzie River from Fort Norman, Northwest Territories, Canada. It is identical with the type specimen and slides of the type which we have studied.

Topotype.—Indiana University Paleontological Collections, slide 282-26. Cat. No. 5380.

Trupetostroma ? raricystosum Galloway and St. Jean, n. sp.
Pl. 12, figs. 3, 4

Coenosteum massive, up to 3 cm. high, 15 cm. in diameter; a paratype is attached to a large head of *Anostylostroma mediale,* n.sp. The surface is irregular, lacking definite mamelons but with papillae. Astrorhizae are small, scattered and not typically radiate. Latilaminae are thin, 2 to 4 mm. thick, and obscure.

Vertical section.—The skeleton is composed of thin to thick, curved laminae, seven to eight in 2 mm., and thick, spool-shaped pillars which are superposed in long lines. The vertical lines of pillars are light in color and not obvious. The laminae are composed of prominent, dark, continuous median microlaminae, 0.014 mm. thick, bounded above and below by irregular layers of lighter, compact tissue. Some laminae are thicker with a light median line of variable width. The upper laminar layer is up to 0.09 mm. thick, the lower layer is up to 0.16 mm. thick. The tissue is compact, containing many faint, flocculent spots, 0.023 mm. in diameter, similar to maculae. Vacuoles, 0.035 mm. in diameter, are mostly concentrated along the peripheries of the pillars. The spool-shaped pillars are 0.19 mm. in diameter at the thinnest point between the laminae. There are about four pillars in 2 mm. The galleries are oval, and superposed, averaging 0.17 mm. high and 0.25 mm. broad, with rare foramina between. Astrorhizal canals are scattered, and twice as wide and high as the galleries, rarely with dissepiments. Dissepiments in the galleries irregular in size and shape, rare to absent, suggesting the name.

Tangential section.—The skeletal tissue represents about 80 percent of the thin section. The pillars are large, oval to round, 0.21 mm. in diameter, 0.08 to 0.26 mm. apart, some are joined by cysts, and they coalesce in the laminae forming a mosaic pattern of roundish pillars separated by lines of darker tissue. The laminar and pillar tissue is flocculent, and porous in places but not regularly maculate. The galleries are round to irregular, about as wide as the pillars are thick. Astrorhizae are not well formed, 2 to 3 mm. in diameter, composed of short thick, irregular canals about 0.12 mm. wide.

Trupetostroma ? raricystosum is characterized by the rare dissepiments, the dark microlaminae, and the flocculent tissue. It differs from *T. crassum* Lecompte in the rarity of dissepiments, and from *T. arduennensis* Lecompte in lacking the vertical, pseudozooidal tubes, in the thinner median microlamina, and the astrorhizal canals are smaller. There is doubt that this and similar forms belong in *Trupetostroma;* it may be a *Clathrocoilona*; it lacks the the pseudozooidal tubes of *Stromatopora.* The tissue is much like that of the *Stromatopora pachytexta* group of species, and might be called maculate tissue by some workers.

Occurrence.—Three specimens were collected from the Middle Devonian, Logansport limestone, at the France Lime and Stone Company quarry, five miles east of Logansport, Indiana.

Holotype.—Indiana University Paleontological Collections, slides 294-14, 23, 24; 303-24, 25. Cat. No. 5329.

Paratypes.—Slides 294-25, 26; 304-67, 68. Cat. No. 5330.

Trupetostroma coalescens Galloway and St. Jean, n.sp. Pl. 12, figs. 5a, b

Coenosteum massive, 7 cm. high, 14 cm. in diameter; surface with small, low mamelons, 2 to 2.5 mm. in diameter, 1 mm. high, and 5 mm. apart from center to center. Coalescent pillars form short, vermicular ridges. The astrorhizae are small, in the mamelon centers, with many short, radial canals. The latilaminae are 2 to 4 mm. thick. Polished sections have an unusually dense appearance.

Vertical section.—The skeleton is a dense network of laminae and pillars. The laminae are obscured by the pillars, but are thick, five or six in 2 mm., and composed of dark and light, discontinuous microlaminae, three or four to a lamina; they turn gently into the small mamelons. The pillars are thick, spool-shaped, and superposed, making long straight or curved lines, and so close they touch and coalesce in many places, making dark tissue where they touch. The pillars, 0.13 mm. in diameter, six in 2 mm., are stronger than the laminae, and divergent in the mamelons. The pillar tissue is compact, and flocculent, with small vacuoles, but not definitely maculate. The galleries are small, low, elongate to oval, four to seven in 2 mm., superposed but do not make pseudozooidal tubes. Dissepiments are rare. Small astrorhizal canals occur in the mamelon columns.

Tangential section.—The skeletal tissue, mostly pillars, represents 80 to 90 percent of the thin section. The pillars are round, 0.12 to 0.14 mm. in diameter, commonly coalescent in curved or vermicular lines, but obscure, with darker tissue where the pillars touch, up to 0.12 mm. apart. The galleries are round to oval in the inter-mamelon areas, about the same size as the pillars, but scarce. The astrorhizae are conspicuous, 4 mm. in diameter, with many short, radial canals, 0.1 mm. broad at the base, which may bifurcate once. Many small, round vacuoles occur in the laminae and pillars, some with darker borders, like supermaculae, but the irregularity in size and number of the vacuoles leads us not to consider them as maculae.

Trupetostroma coalescens is characterized by the small mamelons, and dense skeleton of thick, closely spaced laminae and pillars, and the coalescence of the pillars in both sections, which suggested the name of the species. *T. coalescens* differs from *T. iowense* Parks in the thicker and closer pillars; the galleries are smaller and do not form pseudozooidal tubes. The pillars are closer together than in the associated *T. ? raricystosum,* and in *T. crassum* Lecompte. The small size of the galleries gives this species somewhat the appearance of *Stromatopora,* but the long lines of superposed pillars and lack of pseudozooidal tubes and definite maculae makes it a *Trupetostroma.* It lacks the large, continuous pillars and the maculae of *Syringostroma.*

Occurrence.—One specimen was collected from the Middle Devonian, Logansport limestone, at the France Lime and Stone Company quarry, five miles east of Logansport, Indiana.

Holotype.—Indiana University Paleontological Collections, slides 304-71, 72. Cat. No. 5346.

Family **STROMATOPORIDAE** Winchell, 1867

Family Stromatoporidae Winchell, 1867, Proc. Am. Assoc. Adv. Sci., p. 98; Nicholson, 1886, Palaeont. Soc., vol. 39, p. 74; Kühn, 1939, in Schindewolf, Handbuch Paläozoologie, Bd. 2A, p. A44.

Coenosteum massive to laminar, composed of latilaminae, laminae and short and long pillars, the interlaminar spaces more or less filled with secondary tissue. Tissue finely or coarsely maculate and amalgamated. Pseudozooidal tubes are common. Astrorhizae and mamelons common.

Upper Ordovician doubtful, China, Japan; Silurian common, Devonian abundant, not definitely known above the Devonian. Upper Paleozoic and Mesozoic forms probably do not belong to the order Stromatoporoidea but to the order Sphaeractinoidea.

KEY TO GENERA OF STROMATOPORIDAE

1a. Pillars absent (except for secondary filling of interlaminar spaces, leaving very small galleries) .... STROMATOPORA
1b. Pillars long, well marked, continuing through several laminae
  2a. Pillars narrow, of denser tissue than in other genera .... STROMATOPORA
  2b. Pillars large, continuous, dominating vertical sections
    3a. Pillars without lighter borders
      4a. Pillars not composed of parallel tubes and rods .... SYRINGOSTROMA
      4b. Pillars composed of parallel tubes and rods .... PARALLELOPORA
    3b. Pillars with lighter borders .... HERMATOSTROMA
1c. Pillars short, confined to one interlaminar space
  2c. Pillars incidentally or sporadically superposed; laminae of three layers .... CLATHROCOILONA
  2d. Pillars regularly superposed; laminae composed of microlaminae .... SYNTHETOSTROMA
1d. Pillars long and short; skeleton mostly of dissepiments .... ACTINODICTYON

Genus **Stromatopora** Goldfuss, 1826

Type species (monotypic) *Stromatopora concentrica* Goldfuss, 1826, Petrefacta Germaniae, 1st ed., p. 21, pl. 8, fig. 5 (Mid. Devonian, Gerolstein, Germany); Nicholson, 1886, Palaeont. Soc., vol. 39, p. 91, pl. 11, figs.

15-18; 1891, vol. 44, p. 164, pl. 21, figs. 1-3 (topotypes); Ripper, 1937, Proc. Roy. Soc. Victoria, new ser., vol. 49, p. 184; Kühn, 1939, in Schindewolf, Handbuch Paläozoologie, Bd. 2A, p. A44; Lecompte, 1952, Inst. Roy. Sci. Nat. Belgique, Mém. 117, p. 263.

Coenostroma Winchell, 1867, Proc. Am. Assoc. Adv. Sci. for 1866, vol. 15, p. 99. Type species (selected by Miller. 1889). *Stromatopora monticulifera* Winchell. (Mid. Dev., N. Michigan). (Supposedly distinguished from *Stromatopora* by mamelons and astrorhizae.)

Lioplacacyathus Ludwig, 1866, Palaentographica, Beitr. Natur. Vorwelt, vol. 14, p. 139, 142, pl. 72, fig. 1 (*Stromatopora* renamed.)

Prisciturben Kunth, 1870, Zeitschr. Deutsch. Geol. Gessell., vol. 22, p. 82, (A combination of a stromatoporoid and a coral.)

Pachystroma Nicholson and Murie, 1878, Jour. Linn. Soc. London, Zool., vol. 14, p. 214, 223. Monotypic, *P. antiquum* N. & M. (Silurian, Ont.)

?Caunopora Phillips, 1841, Palaeoz. Foss. Cornwall, Devon and W.-Somerset, p. 18, pl. 10, fig. 29. Type species, *Coscinopora placenta* Lonsdale. (Mid. Dev., Devonshire.) (An unknown stromatoporoid with symbionts.)

Stromatopora? Yabe and Sugiyama, 1930, Sci. Rept. Tôhoku Imp. Univ., Sendai, ser. 2, vol. 14, p. 58, pl. 19, fig. 1; pl. 21, figs. 1-4 (Ordovician). (May well be a sponge.)

Coenosteum massive to laminar, composed of latilaminae, which in turn are composed of thin, close-set, discontinuous microlaminae, which are thickened by secondary, maculate tissue, leaving small galleries, tabulate tubes, and filling tissue which serves as pillars. The tissue of laminae and pillars is all fused and greater in amount than the galleries. Tissue finely to coarsely maculate, not compact nor porous, the maculae consisting of small, both light and dark, spheroidal dots. Astrorhizae usually well developed. Dissepiments usually rare.

Ordovician, Japan?; Silurian and Devonian, Europe, North America, Asia, Arctic, and Australia. About 60 species.

Stromatopora has smaller pillars than *Syringostroma*, and the pillars are not composed of parallel tubules, as in *Parallelopora*. Erect and ramose forms, otherwise like *Stromatopora*, may be placed in the genus *Clavidictyon*. Typical species of *Stromatopora* have the interlaminar spaces largely filled with secondary, maculate, amalgamated tissue, as determined by Nicholson (1886, p. 91).

In spite of the fact that Bargatzky, Nicholson, and Lecompte have studied Goldfuss' type material of *Stromatopora concentrica*, and Lecompte gave a figure designated as a section of the type specimen, the internal characters of the type species have never been figured nor described, and the essential characters of the type specimen are almost as little known as they were when Goldfuss named and illustrated the species in 1826.

Goldfuss' figure 5c, an enlarged vertical section, shows strong latilaminae, strong laminae and vertical pillars. Bargatzky (1881, p. 282) considered the species to have the structure we now ascribe to *Actinostroma, i. e.,* strong laminae, continuous pillars and radial processes from the pillars, making the laminae. Nicholson (1886, p. 2, 3, 5; 1891, p. 164) noted that in Goldfuss' specimen, "The general texture of the fossil is so dense that no clear idea can be obtained as to the minute structure of the skeleton by the use of a hand-lens". He also said that a microscopic examination of thin sections of *S. concentrica* showed a network of horizontal and vertical fibers, "so united as to form a continuous reticulation," with "corresponding complex anastomosing canals." He gave no figure of Goldfuss' type specimen, but did figure a fragment and tangential section of a topotype, which he said (pl. 11, figs. 15, 16), "is absolutely identical with the original example of the specimen figured in the 'Petrefacta Germaniae'." On plate 21, figs. 1, 2, 3, he figured another topotype from Gerolstein, and figure 2 shows the "sieve-like and porous structure of the fibre," which dots we call maculae, since they are not tubulose but spherical.

Nicholson's interpretation of the structure of *Stromatopora* Goldfuss as having maculate tissue, with horizontal and vertical structures amalgamated, so that laminae and pillars are obscure in both sections, has been accepted by all subsequent workers on the genus, and is accepted by us. The lack of well-defined laminae and pillars, and the large amount of secondary, maculate tissue, makes the genus *Stromatopora* and its species the most difficult of all stromatoporoids to identify.

The genus *Stromatopora* embraces four groups of species, involving considerable variation, but the groups still are not sufficiently distinct to warrant the erection of new generic, or even subgeneric, names for each group. One group that is typified by *S. antiqua,* was named *Pachystroma* by Nicholson and Murie, in 1878, but was abandoned by Nicholson in 1886 (p. 91) as a synonym of *Stromatopora.* The four groups are defined below, and several typical species of each group enumerated.

GROUPS OF SPECIES OF STROMATOPORA

Group 1. *S. concentrica* group. Interlaminar spaces largely filled with secondary, maculate tissue, obscuring laminae, pillars and galleries.

S. concentrica Goldfuss. Middle Devonian
S. compta Počta. Middle Devonian
S. obscura, n. sp. Middle Devonian
S. marpleae, n. sp. Middle Devonian
S. larocquei, n. sp. Middle Devonian
S. submixta, n. sp. Middle Devonian
S. antiqua (Nicholson and Murie). Middle Silurian

Group 2. *S. hüpschi* group. Pseudozooidal tubes conspicuous to dominant over laminae and galleries.

S. hüpschi (Bargatzky). Middle Devonian
S. florigera Nicholson. Middle Devonian
S. bücheliensis Bargatzky. Middle Devonian
S. inaequalis Nicholson. Middle Devonian
S. lilydalensis Ripper. Middle Devonian
S. divergens, n. sp. Middle Devonian
S. typica Rosen. Silurian
S. discoidea Lonsdale. Silurian

Group 3. *S. laminosa* group. Laminae dominant over pillars and pseudozooidal tubes.

S. laminosa Lecompte. Middle Devonian
S. dubia Lecompte. Middle Devonian
S. colliculata Nicholson. Middle Devonian
S. goldfussi Bargatzky. Middle Devonian
S. goldfussi mixta Lecompte. Middle Devonian
S. stricta Lecompte. Middle Devonian
S. eumaculosa, n. sp. Middle Devonian
S. mononensis, n. sp. Middle Devonian

Group 4. *S. pachytexta* group. Laminae strong, coarsely maculate; pillars long, light-colored and dense, round in tangential section.

S. pachytexta Lecompte. Middle Devonian
S. cooperi Lecompte. Middle Devonian

S. cumingsi, n. sp. Middle Devonian
S. conicomamillata, n. sp. Middle Devonian
S. magnimamillata, n. sp. Middle Devonian

KEY TO AMERICAN DEVONIAN SPECIES OF STROMATOPORA

1a. Laminae, pillars, and galleries obscure ......*S. concentrica* GROUP
  2a. Astrorhizae small, 2 to 10 mm. diameter
    3a. Without mamelons ....*S. concentrica* Goldfuss
    3b. With strong mamelons, 3 to 5 mm. diameter
      4a. Pseudozooidal tubes rare ....*S. obscura*, n. sp.
      4b. Pseudozooidal tubes common ...*S. submixta*, n. sp.
  2b. Astrorhizae large, 10 to 20 mm. diameter
    3c. Laminae 6 to 8 in 2 mm., crinkled *S. marpleae* n. sp.
    3d. Laminae 14 to 16 in 2 mm., not crinkled ....*S. larocquei*, n. sp.
1b. Pseudozooidal tubes long and abundant ....*S. hüpschi* GROUP
  2c. Without mamelons ....*S. hüpschi* (Bargatzky)
  2d. With mamelons ....*S. divergens*, n. sp.
1c. Laminae dominant over galleries, pseudozooidal tubes and pillars ....*S. laminosa* GROUP
  2e. Microlaminae prominent; 7 to 18 laminae in 2 mm.
    3e. Laminae 7 to 9 in 2 mm.
      4a. Pseudozooidal tubes abundant ....*S. laminosa* Lecompte
      4d. Pseudozooidal tubes scarce ....*S. dubia* Lecompte
    3f. Laminae 10 to 12 in 2 mm. ....*S. eumaculosa*, n. sp.
    3g. Laminae 16 to 18 in 2 mm. ....*S. mononensis*, n. sp.
  2f. Microlaminae obscure; 4 to 5 laminae in 2 mm. *S. submixta*, n. sp.
1d. Laminae strong, coarsely maculate; pillars long, light-colored and dense, round in tangential section ....*S. pachytexta* GROUP
  2g. Surface without mamelons
    3h. Pillars large and long ....*S. pachytexta* Lecompte
    3i. Pillars thin, long ....*S. cumingsi*, n. sp.
    3j. Pillars thin, intermittent ....*S. cooperi* Lecompte

2h. Surface with mamelons
  3k. Mamelons conical, 2 to 3 mm. in diameter .... *S. conicomamillata,* n. sp.
  3l. Mamelons low domes, 5 mm. in diameter *S. magnimamillata,* n. sp.

Stromatopora marpleae Galloway and St. Jean, n. sp. Pl. 13, figs. 1a, b

Coenosteum an undulating plate, 3 cm. thick and 18 cm. in diameter. Surface undulating but smooth, without mamelons or papillae. Astrorhizae large, 10 to 15 mm. in diameter and 15 to 20 mm. apart. Latilaminae 2 to 4 mm. thick. It is difficult to tell which side of the specimen is up, since there are no mamelons or dissepiments.

Vertical section.—The laminae are crinkled and thin, 0.015 mm., six to eight in 2 mm. The skeleton has been crushed in places, but as in the lower right corner of the figure, the crinkling of the laminae seems to be original structure. The interlaminar spaces are largely filled with secondary tissue. Under the 10× hand lens, the polished vertical edge shows the thin, crinkled laminae, the interlaminar spaces largely filled with tissue and crossed by thin pillars scarcely thicker than the laminae, and a few are superposed. The galleries are roundish remnants of the interlaminar spaces and are mostly located at the base of the interlaminar filling. Round, astrorhizal tubes, 0.3 to 0.4 mm. in diameter, are scattered through the section. Under the microscope, the vertical structures are less well marked and the galleries are nearly filled with secondary tissue. There are abundant, short, vertical pseudozooidal tubes, but no dissepiments. Some of the astrorhizae are superposed, but there seems to be no axial tube, and tabulae are lacking. The tissue is amalgamated, and is finely, but obscurely maculate.

Tangential section.—The tissue occupies an estimated 60 to 70 percent of the field. The galleries are round and anastomosing but indefinite. Round, pseudozooidal tubes are common. Pillars are scarcely discernible, but are irregular, lacy, and confluent. The pattern of galleries, pillars and pseudozooidal tubes varies with the level cut. Astrorhizae are large, 10 mm. in diameter, with branching arms 0.4 mm. in diameter, without diaphragms. The tissue is finely maculate.

This species is characterized by the lack of mamelons, the large astrorhizae, crinkled thin laminae, and obscure pillars. It belongs to the *S. concentrica* group of *Stromatopora,* which includes *S. obscura* and *S. larocquei* in our faunas. *Parallelopora goldfussi* of Johnson and Pfender (1939, p. 515) is not *Parallelopora* nor *P. goldfussi* Bargatzky, but is a *Stromatopora* similar to *S. marpleae* and *S. larocquei. Anostylostroma insulare* also has wrinkled laminae, but the pillars are stronger, the galleries not filled with maculate, secondary tissue.

Occurrence.—The type specimen was collected by Dr. M. F. Marple from the Columbus limestone, from the southside quarry on Kelleys Island, Ohio.

Holotype.—Part in the Paleontological Collections of Indiana University, slides 306-34, 35. Cat. No. 5403; part, with slides, in the Paleontological Collections of Ohio State University.

Stromatopora obscura Galloway and St. Jean, n. sp. Pl. 13, figs. 2a, b

Coenosteum a massive head, 10 cm. in height and 18 cm. in diameter. The surface is strongly mamillate; the mamelons are from 3 to 5 mm. in diameter, about 2 mm. high and from 5 to 8 mm. apart. Astrorhizae are seen with difficulty in the centers of the mamelons, about 2 mm. in diameter, with short, sparingly branching canals. Small pillars, eight in 2 mm., tending to be superposed, small, round galleries and small pseudozooidal tubes up to 1 mm. in length, can be seen with a 10$\times$ lens on a polished, vertical surface. Laminae, pillars and other structures are so nearly the color and composition of the infiltrated and crystallized calcite that the structures can scarcely be distinguished in very thin sections. Latilaminae are 2 to 3 mm. thick.

Vertical section.—The laminae are wrinkled and thick, 0.1 to 0.15 mm., conspicuous on weathered vertical surfaces, six or seven in 2 mm., regularly flexed upward in the mamelons and downward in the interlaminar areas. Pillars are obscure, merely the interlaminar fillings, so that they can scarcely be measured or counted in thin sections. The galleries are small and roundish, occupying less than one-third of the interlaminar space, some making pseudozooidal tubes 0.06 to 0.08 mm. in diameter and up to 1 mm. or more long; there are no tabulae or dissepiments discernible. The mamelon columns are in part occupied by a vertical tube, 0.2 to 0.3 mm. in diameter, and round astrorhizal canals of the same diameter occur mostly on the flanks of the mamelon columns. The tissue is finely maculate, best seen where the section is very thin.

Tangential section.—The tissue occupies about 80 percent of the section, in which darker, broad bands indicate the laminae. The chambers are small, round or irregularly anastomosing, and small, round spots which seem to be the pseudozooidal tubes. The pillars are roundish, about 0.15 mm. in diameter between laminae, and mostly amalgamate with the laminae so that neither can be distinguished. The tissue is finely but vaguely maculate. The astrorhizae are small, 2 to 3 mm. in diameter, in the mamelons and surrounded by annuli of laminae. The centers of the mamelons are mostly denser than the rims, rarely with an open tube 0.3 mm. in diameter, and the astrorhizal canals are short and sparingly branched.

This species is characterized by the strong mamelons, small astrorhizae, strong laminae, the large amount of interlaminar tissue, and the obscurity of the finer structures. It is a typical *Stromatopora*, and belongs to the group of *Stromatopora* species typified by *S. concentrica,* in which laminae and pillars are obscured by secondary tissue.

Occurrence.—A single, large specimen from the Middle Devonian, Jeffersonville l'mestone, two miles south of Hartsville, Ind., was collected by Dr. E. R. Cumings.

Holotype.—Indiana University Paleontological Collections, slides 285-8, 9, 10, 11; 306-36. Cat. No. 5381.

Stromatopora larocquei Galloway and St. Jean, n. sp. Pl. 13, figs. 3a, b

Coenosteum a massive, flat head; a fragment is 6 cm. high and 17 cm. long. The surface is nearly smooth, with large, low mamelons, 10 to 12 mm. in diameter, 1 to 2 mm. high and 15 to

20 mm. from center to center. Each mamelon is occupied by a large astrorhiza up to 20 mm. in diameter, but without axial tubes; the branches radiate and divide dendritically; the canals are large, open in our specimen, joining canals from adjacent astrorhizae. The latilaminae average 2 mm. thick, and the coenosteum tends to split between latilaminae. The specimen is not completly infiltrated; the astrorhizal canals are open, and the tissue is in part recrystallized.

Vertical section.—The laminae are thin but not so thin as microlaminae, 0.06 to 0.09 mm. thick, nearly straight, and close together, 14 to 16 in 2 mm. The pillars are vague, small, 0.1 to 0.17 mm. in diameter, about eight in 2 mm., spool-shaped; some are superposed for a distance of 1 to 2 mm. The galleries are small, round, 0.1 to 0.15 mm. in diameter, mostly closed by secondary tissue. Pseudozooidal tubes are numerous but narrow and indistinct. The laminae, pillars, and filling tissue are all alike and amalgamated, finely and vaguely, the maculae being from 0.02 to 0.03 mm. in diameter. Astrorhizal canals are round or oval holes, 0.2 to 0.3 mm. in diameter, and scattered through the section and the vertical polished face, but are larger and more abundant near the mamelon axis; there is apparently no tube in the mamelon axis, though none of our sections cut exactly in an axis. There are no dissepiments.

Tangential section.—The tissue occupies about 90 percent of the section. Round and confluent, dusky pillars, about 0.15 mm. in diameter, are separated in places by narrow, anastomosing galleries, half the width of the pillars; the cut laminae show as a nearly solid, dusty and maculate mass. Round, pseudozooidal tubes are common. Large, open astrorhizal canals, 0.23 to 0.3 mm. in diameter occur, not shown in the figure; some canals have tabulae. The tissue is finely but obscurely maculate; most of the finer structure has been destroyed by recrystallization.

This species is characterized by the close laminae, the small remnants of galleries, the obscure pillars, and large astrorhizae in low mamelons. It is a typical example of the *S. concentrica* section of *Stromatopora*. It differs from *S. obscura* in the larger lower mamelons, large astrorhizae, and closer laminae. From

S. marpleae it differs in the noncrinkled, and closer laminae, larger pillars, and more secondary tissue. *S. larocquei* differs from *S. compta* Počta (1894, p. 158) in having astrorhizae; Počta does not give the magnification.

Occurrence.—The type specimen was collected by Prof. A. LaRocque, of Ohio State University, from the Columbus limestone at the Marble Cliff quarry, just outside of Columbus, east of Highway 33 and north of Trabue Road.

Holotype.—Indiana University Paleontological Collections, Cat. No. 5404, part of the specimen and slides 306-30, 31. Part of the specimen and slides in the Geology Department of Ohio State University.

Stromatopora divergens Galloway and St. Jean, n. sp. Pl. 13, figs. 4a, b

Coenosteum massive, a fragment is 5 cm. high and 21 cm. in diameter. Surface with low, conical mamelons 2 to 3 mm. in diameter, up to 1 mm. high, and 3 to 5 mm. from center to center; astrorhizae small, indistinct, at the center of each mamelon; latilaminae indistinct, 1 to 3 mm. thick.

Vertical section.—The skeleton is composed of laminae, 0.16 mm. thick, six to seven in 2 mm., arched into the low mamelons, consisting of an upper, single, thin, dark microlamina, and a lower, thick, maculate layer, which is also microlaminate in places; the microlaminae are about 8 microns thick. Pillars short, straight, thick, superposed, six in 2 mm., mostly composed of secondary filling of the interlaminar spaces, and become thicker and divergent in the mamelons, filling all of the galleries in parts of the mamelons. Astrorhizal tubes long, thin, in the axes of the mamelons. Galleries round to horizontally elongate, 0.12 mm. high, from 0.14 to 1.11 mm. long, occurring at the bases of the thick laminae, usually superposed, forming narrow but conspicuous vertical, pseudozooidal tubes, 0.09 mm. wide, four in 2 mm. Dissepiments rare. Tissue, microlaminae, laminae, and pillars are finely maculate; maculae 14 microns or less in diameter and not arranged in vertical tubules in the pillars. Dissepiments rare to absent.

Tangential section.—The groundmass is uniform in texture, finally maculate, amalgamated so that microlaminae are not distinguishable and composing 70 to 80 percent of the area of the section. Astrorhizae 5 mm. in diameter; astrorhizal canals long, without tabulae, 0.1 mm. wide at the base, with short branches. Astrorhizae may appear compound because the laminae curve upward in the mamelons so that up to three sets of astrorhizae may be cut in one mamelon. There is usually a round, vertical tube in the center of each mamelon, 0.18 mm. in diameter. Pillars mostly coalescent, merely the filling of the interlaminar spaces, some round and contiguous, 0.19 mm. in diameter. Galleries round to vermicular and anastomosing; pseudozooidal tubes round, giving a speckled appearance to the section. The specimen is perfectly preserved by infiltration of calcium carbonate.

Stromatopora divergens is characterized by the divergent arrangement of the pillars in the mamelons, by the prominent astrorhizal columns in the mamelons, by small galleries, and by the prominent pseudozooidal tubes. It is much like *S. hüpschi* but has mamelons. *S. divergens* resembles *S. mononensis*, but the microlaminae are always located superior to the thick maculate layer, and it has diverging pillars in the mamelons. The pillars, though large, are not round in tangential section, as they are in *Syringostroma*. Excepting for the lack of large, long pillars this specimen is much like *Syringostroma micromamillata*, n. sp. There is some resemblance between *S. divergens* and *Syringostroma foveolatum* Girty (1895, p. 295), of the Lower Devonian, which we take to be a *Stromatopora;* it has small round pillars, but we have not been able to make comparisons of sections.

Occurrence.—Middle Devonian, Logansport limestone at the France Lime and Stone Company quarry, five miles east of Logansport, Indiana.

Holotype.— Indiana University Paleontological Collections, slides 294-29, 30. Cat. No. 5331.

Stromatopora laminosa Lecompte Pl. 14, figs. 1a, b, 2

Stromatopora laminosa Lecompte, 1952, Inst. Roy. Sci., Nat. Belgique, Mém. 117, p. 276, pl. 55, fig. 3; pl. 56, figs. 1, 2 (M. Dev., Givetian, Belgium).

Coenosteum massive to tuberose, up to 10 cm. in diameter.

Surface with low, conical mamelons, 0.5 mm. high, 3 to 5 mm. in diameter and 6 to 8 mm. apart from center to center, each mamelon occupied by a small astrorhiza. Latilaminae unusually thin, about 1 mm. thick, and marked by darker and closer microlaminae. The specimens are dense and well preserved by infiltration of calcium carbonate.

Vertical section.—The skeleton is composed of microlaminae, 10 to 12 in 1 mm., which in turn are composed of conspicuous, dark maculae, about 0.027 mm. in diameter. The maculae are separated in the microlaminae and the microlaminae are separated by an equal or larger amount of light-colored, denser tissue. There are no ordinary laminae nor pillars, the laminate tissue between adjacent galleries serving as pillars, the rows of galleries indicating the laminae, seven to nine in 2 mm. There are no long pillars. The galleries are mostly round, some irregular and some superposed, making a few irregular, thin vertical tubes. The galleries appear as if they had been dissolved from the groundmass, and only tend to be at the same levels. The galleries are small, 0.07 to 0.18 mm. in diameter, and are bordered by large maculae.

Astrorhizae are superposed through several millimeters, and consist of round canals and microlaminae which rise over the mamelons; columnar tubes are rare and thin and rarely cut in vertical section. Many sections show no astrorhizae in vertical sections when there are conspicuous astrorhizae in tangential sections from the same specimen. The tissue is amalgamated, so that neither laminae nor pillars are definite.

Tangential section.—About 80 percent of the area is maculate groundmass. The galleries are oval and vermicular. Astrorhizae are conspicuous, but small, with sparingly branching and irregular canals, but ordinarily without central tubes. Caunopore tubes (*Syringopora*) occur rarely (slide 295-75).

S. laminosa is characterized by the microlaminae (which compose the skeleton and suggest the name), the small galleries, the small low conical mamelons, the small astrorhizae, and lack of long pillars. It is much like *S. cumingsi,* with which it occurs, which also has microlaminae of large maculae, but it lacks the long, narrow pillars of *S. cumingsi.* It has smaller and more irregular galleries than *S. dubia*. The Indiana form may be a different species from the Belgian type, for it has fewer pseudozooidal tubes, but it is similar.

Occurrence.—Abundant in the Middle Devonian, at the type locality of the Logansport limestone, at Pipe Creek Falls, 10 miles southeast of Logansport, Ind. It is also abundant in the France Lime and Stone Company quarry, five miles east of Logansport, in the lower 10 feet of the Devonian limestone.

Plesiotypes.—Indiana University Paleontological Collections, slides 295-92, 93; 279-6. Cat. Nos. 5356, 5332. Other typical specimens, slides 279-4; 294-31, 32, 33, 36, 37; 295-74, 75, 76, 86, 94; 303-15, 16, 17; 304-36, 37, 49, 50, 55, 56.

Stromatopora dubia Lecompte Pl. 14, figs. 3a-c

Stromatopora dubia Lecompte, 1952, Inst., Roy. Sci. Nat. Belgique, Mém. 117, p. 279, pl. 57, figs. 1, 1a, b, 2 (Mid. Dev., Frasnian, Dinant Basin, Belgium).

Coenosteum massive, a fragment is 7 cm. high and 6 cm. in diameter. The surface does not show distinct mamelons, but based on thin sections, they are about 1 mm. high, 4 mm. in diameter and 9 mm. apart from center to center. The astrorhizae are intricate, with many radial canals, up to 9 mm. in diameter and 10 mm. apart from center to center. Latilaminae are 1 to 3 mm. thick.

Vertical section.—The laminae turn gently into the low mamelons, are 0.14 mm. thick, seven to eight in 2 mm., and composed of a thin, dark, median microlamina, 0.015 mm. thick, covered on both sides with an irregular thickness of maculate tissue, which is confluent with the pillar tissue. The pillars are spool-shaped, 0.11 mm. thick, five to seven in 2 mm., thicker and more coalescent in the mamelons, and are merely secondary tissue between galleries. The laminar and pillar tissues are coarsely maculate, with maculae averaging 0.02 mm. in diameter. The galleries are round to elongate, 0.1 to 0.15 mm. in diameter, and up to 1 mm. broad, and in conspicuous horizontal rows. There are no typical pseudozooidal tubes. Dissepiments are sporadic, mostly in the mamelons.

Tangential section.—The skeletal tissue represents about 85 percent of the area of the thin section. The pillars are coalescent, vermicular and anastomosing. Tubes in the mamelons may be single or compound, averaging 0.27 mm. in diameter, and the astrohizal canals are small and branched. The galleries are vermicular and anastomosing. The astrorhizae are composed of many short, irregular, disconnected, branching canals, 0.08 mm. thick at their base. The tissue is unusually coarsely maculate in the mamelons.

Stromatopora dubia Lecompte is characterized by irregular pillars (which coalesce in vertical section), by a single dark median microlamina (the only feature by which the laminae can be distinguished), and by small round non-superposed galleries. *Stromatopora dubia* differs from *S. laminosa* Lecompte, in the one prominent dark microlamina in each lamina, and round galleries. *S. mononensis* differs in the finer structure, including maculae.

Occurrence.—One fragmental specimen was collected from the lower 10 feet of the Middle Devonian, Logansport limestone, at the France Lime and Stone Company quarry, five miles east of Logansport, Indiana.

Plesiotype.—Indiana University Paleontological Collections, slides 285-94, 95, 99; 303-14. Cat. No. 5333.

Stromatopora eumaculosa Galloway and St. Jean, n. sp. Pl. 14, figs. 4a, b

Coenosteum massive, 4.5 cm. high and 10 cm. in diameter. The surface, which is partly silicified and poorly preserved, is smooth, with indistinct astrorhizal canals. Latilaminae are 1 to 3 mm. thick.

Vertical section.—The laminae are slightly undulatory, 0.05 to 0.14 mm. thick, 10 to 12 in 2 mm., composed of vertical rows of maculae and one or more thin microlaminae between or above the rows of maculae. The pillars, 0.07 to 0.21 mm. broad, 6 to 10 in 2 mm., are spool-shaped between laminae and in part superposed, and composed of horizontal and vertical rows of maculae. The pillar and laminar tissue is confluent. The maculae are moderately large, 0.02 to 0.03 mm. in diameter, are clear, and are close together in horizontal and vertical alignment. The galleries are small, round to elliptical, 0.06 to 0.11 mm. high by one to four times as broad, and are in part superposed, producing some pseudozooidal tubes, commonly crossed by the microlaminae. Most of the chambers are capped by a dark, thin, semicircular arc, an upbending of the microlamina. Dissepiments are small, arched and oblique, rare to common.

Tangential section.—The laminae are indicated by broad, dark bands of maculate tissue. The pillars coalesce, losing their identity. Galleries are round in the laminae and anastomose between laminae. The maculae in the tissue are small, dark, close together and conspicuous. Pseudozooidal tubes are round, 0.06 to 0.12 mm. in diameter, scarcely distinguishable from galleries. The astrorhizae are about 10 mm. in diameter, composed of many narrow, elongate sinuous, branching canals, 0.08 to 0.10 mm. broad at the base. One astrorhizal center has a tube 0.47 mm. in diameter. Dissepiments are rare to absent.

Stromatopora eumaculosa is characterized by the lack of mamelons, close laminae, thin pillars, small, round galleries, and the close packing of the maculae. *S. eumaculosa* is much like a *Parallelopora* but has stronger laminae but without the continuous pillars characteristic of *Parallelopora.*

Occurrence.—One specimen was collected from the Middle Devonian, Jeffersonville limestone, at the Falls of the Ohio, Jeffersonville, Indiana, by Dr. J. W. Huddle.

Holotype.—Indiana University Paleontological Collections, slides 274-21, 304-3,4. Cat. No. 5362.

Stromatopora mononensis Galloway and St. Jean, n.sp. Pl. 15, figs. 1a, b

Coenosteum massive, a fragment is 10 mm. high, and 65 mm. in diameter. Surface with low conical mamelons 4 or 5 mm. in diameter, 1 to 2 mm. high, and 5 to 8 mm. from center to center; papillae inconspicuous. Small astrorhizae occur in the center of most of the mamelons; latilaminae thin, about 1 mm. thick, not well marked but the coenosteum splits between the latilaminae.

Vertical section.—The skeleton is composed of undulose, touching laminae, 16 to 18 in 2 mm., separated by light-colored microlaminae 0.018 mm. thick. Both laminae and microlaminae finely and uniformly maculate, the maculae being about 0.01 mm.

in diameter, and light in color where the section is thin. Small galleries occupy the bases of the laminae, are round or oval, variable in size, averaging about 0.07 mm. in diameter; some occupy the whole width of a lamina, and commonly several smaller galleries are superposed, making the ordinary vertical, pseudozooidal tubes common for the genus. Pseudozooidal tubes narrow, 0.7 mm. wide, two to four in 2 mm., and have no tabulae except for the microlaminae. Pillars not definite structures but only filling of the interlaminar spaces, short, thick, irregular in size, about four in 1 mm. tending to be superposed, but not forming long pillars. Tissue in the mamelons larger in amount, filling most of the interlaminar space excepting the galleries, pseudozooidal tubes and astrorhizal canals, which are larger than the galleries, averaging 0.1 mm. in diameter. Dissepiments are absent.

Tangential section.—About 80 to 90 percent of the area consists of fine, uniformly maculate tissue, enclosing round, vermicular and anastomosing galleries, and round pseudozooidal tubes. The pillars are in part round, mostly vermicular and coalescing. The astrorhizae are conspicuous, having larger canals than the galleries, without tabulae, and radiate from centers, which have no round vertical, axial tubes.

Stromatopora mononensis is characterized by the thin laminae separated by the microlaminae, the low mamelons, the fine maculae, the small, round galleries, and thin vertical tubes. It differs from *S. laminosa* in the finer structures and finer maculae, and the laminae are not made of microlaminae. It differs from *S. divergens* in having larger mamelons, in lacking distinct diverging pillars in the mamelons, and in lacking mamelon tubes. *S. mononensis* does not have large, long pillars as does *Syringostroma subfuscum.*

Occurrence.—Middle Devonian, Logansport limestone, or Little Rock Creek limestone, two miles west of Monon, Ind. A similar form occurs in the upper part of the Traverse group at Petoskey, Mich., but the laminae are composed of microlaminae.

Holotype.—Indiana University Paleontological Collections, slides 278-21, 22, 23. Cat. No. 5347.

Stromatopora submixta Galloway and St. Jean, n. sp. Pl. 15, figs. 2a,b

Coenosteum massive, a fragment is 60 mm. high and 50 mm. in diameter. The surface is not preserved but based on thin sections and cut surfaces; the mamelons are about 3 mm. in diameter, 1 mm. high, and 7 mm. from center to center; astrorhizae small, with short radial canals; latilaminae obscure, about 1 mm. thick.

Vertical section.—The skeleton is composed of thick laminae, not well distinguishable, four or five in 2 mm., which turn smoothly into the mamelons. The laminae are composed of maculate tissue which is fused with the maculate pillar tissue, and the tissue, including pillars, is vaguely microlaminate. The maculae are 18 microns in diameter, are in vertical lines in the pillars, but not making vertical tubules separated by rods, as in *Parallelopora.* Galleries are small, round or oval, 0.09 mm. in diameter. The superposed galleries form many narrow, pseudozooidal tubes, which are long, straight, or curved, crossed by closely spaced, arched tabulae. Pillars short, many superposed, not recognizable in the mamelons, which are filled with maculate tissue, excepting for the astrorhizal canals.

Tangential section.—The galleries are round to vermicular spaces in the groundmass which embraces about 90 percent of the section. Pillars are not distinguishable. Astrorhizae are of medium size with short, thick, radial canals which are mostly unbranched, and without tabulae.

S. submixta is characterized by the thick laminae and small galleries, the pseudozooidal tubes with many closely spaced tabulae, and large, complex astrorhizae. It differs from *S. mixta* Lecompte (1952, p. 283) in the presence of mamelons, in having slightly thicker laminae and pillars, and fewer dissepiments. The specimen is solid and nearly perfectly preserved by infiltration of calcium carbonate, yet the lack of distinctness of laminae and pillars makes it difficult to illustrate the species. It has larger pseudozooidal tubes and larger astrorhizae than *S. obscura.*

Occurrence.—Uncommon in the Middle Devonian, Logansport limestone, from Pipe Creek Falls, 10 miles southeast of Logansport, Indiana.

Holotype.—Indiana University Paleontological Collections, slides 295-80, 81. Cat. No. 5357.

Stromatopora pachytexta Lecompte Pl. 15, figs. 3a, b

Stromatopora pachytexta Lecompte, 1952, Inst. Roy. Sci. Nat. Belgique, Mém. 117, p. 265, pl. 54, fig. 6; pl. 55, figs. 1, 2 (M. Dev., U. Couvinian, Dinant Basin, Belgium).

Coenosteum massive, hemispherical, fragments up to 65 mm. high and 100 mm. in diameter. Mamelons absent; astrorhizae small, about 5 mm. in diameter, 8 to 10 mm. apart from center to center; astrorhizal canals bifurcate once or twice; latilaminae 2 to 3 mm. thick, three to eight in 10 mm.

Vertical section.—The latilaminae are composed of 6 to 11 laminae. Laminae are 0.16 mm. thick, six to eight in 2 mm., composed of an intermittent, thin, dense, layer which grades into outer, thicker, coarsely maculate layers. The pillars are broad, 0.13 to 0.2 mm., continuous, conspicuous, six to eight in 2 mm., composed of a central, thick, compact, light-colored core of tissue, which grades sharply into an outer, thin, coarsely maculate layer. The maculae are large, 0.025 mm. in average diameter. Short pillars composed of maculate tissue occur in a few places between the long pillars. Galleries round, oval, or vermicular, tending to be horizontally elongate, especially at a latilaminar boundary, averaging 0.18 mm. high, width variable from 0.16 to 1.7 mm. Galleries are commonly superposed, with foramina between but do not make tubes. The laminae and pillars, which are of about the same strength, make a rectangular network. Dissepiments are rare or lacking. Astrorhizal canals, which are only slightly larger than the galleries, are difficult to distinguish.

Tangential section.—Pillars appear as round spots, 0.18 to 0.25 mm. in diameter, coalesce or up to 0.25 mm. apart; the central, thick compact tissue is sharply contrasted with the outer thin, coarsely maculate tissue. Galleries round, oval, or vermicular, about the same size as the pillars. Astrorhizal canals nonseptate, about 0.15 mm. wide.

Stromatopora pachytexta is characterized by the thick pillars and laminae, making a conspicuous, rectangular pattern. *S. pachy-*

texta differs from *S. cumingsi* in the more definite laminae and thicker long pillars, showing as conspicuous round pillars in the tangential section. The Indiana specimens seem to be identical with the type from Belgium; the Indiana horizon may be a little higher, middle Givetian, than the Belgian horizon.

Occurrence.—Common in the lower 10 feet of the Middle Devonian, Logansport limestone at the France Lime and Stone Company quarry, 5 miles east of Logansport, Ind. and from the Logansport limestone at the top of Pipe Creek Falls, 10 miles southeast of Logansport.

Plesiotypes.—Indiana University Paleontological Collections, slides 294-12; 296-1, 2, 3, 10, 11. Cat. No. 5358.

Stromatopora cumingsi Galloway and St. Jean, n.sp. Pl. 15, figs. 4a, b

Coenosteum massive, headlike, up to 10 cm. in height and 20 cm. in diameter. The surface is smooth and finely papillate; there are no mamelons. Astrorhizae are observable only in thin sections or polished surfaces. They are small, 3 to 5 mm. in diameter and 5 to 8 mm. apart, the longer canals of adjacent astrorhizae joining. Latilaminae are conspicuous on weathered surfaces, varying from 1 to 3 mm. thick.

Vertical section.—The skeleton is composed of thick laminae and short, spool-shaped pillars and thin, long pillars. The laminae and short pillars are composed of microlaminae, not always observable, which are made of lines of large, dark maculae and light-colored, compact tissue. The long pillars have a light-colored core of compact tissue and a coarsely maculate sheath, and are thin, 0.06 to 0.13 mm. in diameter. The microlaminae average 12 to 15 in 1 mm. There are from 8 to 10 laminae in 2 mm., and about 8 pillars in 2 mm. The maculae are most numerous on the outsides of both short and long pillars, hence more numerous around the galleries and astrorhizal canals. They vary from 0.02 to 0.03 mm. in diameter. The galleries are largely round chambers in the section, 0.16 mm. in diameter. Superposed galleries are common, many with foramina between but scarcely make vertical tubes. The horizontal and vertical structures are made of the same kind of tissue and are completely amalgamated. The astrorhizal canals appear sporadically in the section; they are somewhat larger than the galleries, occur in groups without vertical tubes, and the microlaminae rise slightly over the groups of astrorhizal canals. There are few diaphragms in the canals. Dissepiments few, small, arched or oblique.

Tangential section.—Both the tissue and the chambers make similar, vermicular, branching and anastomosing patterns. The tissue occupies about 60 percent of the area of the field, and is coarsely maculate, especially on the edges of the irregular pillars. In the irregular pillars there are scattered round pillars, 0.1 to 0.16 mm. in diameter, composed of compact tissue of a yellowish hue, with large, dark maculae surrounding the compact tissue. Astrorhizae are conspicuous in most tangential sections when viewed with a 10× lens. The canals are about 0.15 mm. wide branch and anastomose moderately, and radiate from centers with fewer than ordinary maculae. The astrorhizal centers do not have tubes.

Caunopore tubes (*Syringopora*) occur sparingly in some specimens (slides 299-13; 295-95, 96). The specimens appear to be perfectly preserved by infiltration of calcium carbonate.

The species is characterized by the smooth surface, predominance of round galleries, the few vertical tubes, the microlaminae, the coarse maculae on the borders of the structures, and especially by the long, thin, vertical pillars. It differs from *S. laminosa* Lecompte (1952, p. 276, pl. 55, fig. 3) in the fewer vertical tubes and the presence of the long pillars. It differs from *S. pachytexta* Lecompte (1952, pl. 55, figs. 1-3) in having fewer and smaller long pillars and more microlaminae. It differs from *S. conicomamillata* and *S. magnimamillata* mainly in lacking mamelons. It is much like *S. cooperi* Lecompte, having larger galleries and more regular pillars.

The species is named for Prof. E. R. Cumings, formerly head of the Department of Geology of Indiana University, who collected some of the specimens.

Occurrence.—Abundant in the Middle Devonian, lower Logansport limestone at the Upper Dam on Eel River, six miles northeast of Logansport, Ind., abundant in the France Lime and Stone Company quarry five miles east of Logansport, the holotype, and at Pipe Creek Falls, 10 miles southeast of Logansport.

Holotype.—Indiana University Paleontological Collections, slides 304-47, 48. Cat. No. 5334.

Paratypes.—Slides 282-95, 96, 97, 98; 294-13, 18-22, 27, 28; 295-87, 88, 95, 96; 296-4, 5, 8, 9; 302-99, 100; 303-55, 56; 304-43, 44, 45, 46, 57, 58, 59, 60, 73, 74, 94, 95; 305-1, 2, 13, 14.

Stromatopora conicomamillata Galloway and St. Jean, n. sp.
Pl. 16, figs. 1a, b

Coenosteum a massive head 6 cm. high, 12 cm. in diameter. The surface is mamillate and papillate; mamelons 2 to 3 mm. in diameter, 1 to 1.5 mm. high, and 4 to 6 mm. apart from center to center, averaging 14 in 4 sq. cm.; papillae are small anastomosing ridges with pits and grooves between. Astrorhizae are small and indistinct, occurring sporadically in the mamelon centers. Latilaminae conspicuous on a weathered surface, 1 to 4 mm. thick.

Vertical section.—The skeleton is composed of discontinuous laminae of variable thickness, interlaminar tissue making short, irregular pillars, and long, thin pillars. The laminae and short pillars are composed of microlaminae, which in turn are composed of lines of large, dark maculae 0.016 mm. in diameter. The laminae are 0.07 to 0.17 mm. thick, 7 in 2 mm. The long pillars are abundant and thin, 0.06 to 0.11 mm. in diameter, have a light-colored, compact core of primary tissue, and large, dark maculae on the outside. Galleries are round to oval or irregular, 0.12 mm. in diameter. Pseudozooidal tubes, 3 to 10 in 4 mm., 0.05 to 0.14 mm. wide, are long, with straight or curved tabulae. Pillars are narrower than the pseudozooidal tubes, and look much the same in photographs, but are more strongly marked by dark maculae on the edges. Astrorhizal canals sporadic, larger than the galleries.

Tangential section.—The tissue occupies about 80 percent of the section. The tissue is coarsely maculate, with the maculae concentrated around the edges of the long, round pillars, which are 0.09 mm. in diameter, but difficult to distinguish. The short irregular pillars anastomose and cannot be distinguished from the laminae. The galleries are round to irregular, and the pseudozooidal tubes are round and numerous. Astrorhizae, 2 to 4 mm. in diameter, are simple and indistinct, without axial tubes. The astrorhizal canals are 0.15 mm. wide. The primary, round pillars are smaller and less conspicuous than they are in *S. cumingsi.*

Stromatopora conicomamillata is named for the characteristically small, closely spaced, conical mamelons. Neither the long thin, primary pillars, vertical tubes nor the laminae are conspicuous. *S. magnimamillata* is similar, but has larger, low mamelons, and the vertical tubes are not so conspicuous. This species differs from *S. cumingsi* in having mamelons and smaller, long, narrow pillars. *S. cooperi* Lecompte lacks mamelons, or indications of mamelons in thin section, and also lacks primary pillars, but does have long, small, vertical tubes and indefinite laminae.

Occurrence.—Five specimens were found in the Middle Devonian, lower Logansport limestone at the France Lime and Stone Company quarry, five miles east of Logansport, Indiana.

Holotype.—Indiana University Paleontological Collections, slides 303-73, 74. Cat. No. 5335.

Paratypes.—303-79, 80, 88, 89; 304-1, 2, 23, 24.

Stromatopora magnimamillata Galloway and St. Jean, n. sp.
Pl. 16, figs. 2a, b

Coenosteum massive, one fragment is 5 cm. high and 11 cm. in diameter. The surface has low, broad mamelons, 5 mm. in diameter, 1 to 1.5 mm. high, 7 to 10 mm. from center to center, nine in 4 sq. cm., and low, round papillae. Astrorhizae in the center of each mamelon are composed of delicate, branching, radial canals, indistinct except on a wetted surface. Latilaminae 2 mm. thick.

Vertical section.—The skeleton is composed of discontinuous laminae of variable thickness, six in 2 mm. and long narrow pillars and interlaminar tissue. The laminae are composed of microlaminae, which are rows of large, coarse maculae, 0.028 mm. in diameter, including the flocculent edge. The long pillars are abundant, straight or inclined, and narrow 0.13 to 0.17 mm. in diameter, with a narrow core of compact, primary tissue and an outer sheath of coarse maculate tissue. The interlaminar tissue serves as short pillars. The galleries are small, round to irregular, averaging 0.12 to 0.15 mm. in diameter, frequently superposed, making short, tabulate vertical or irregular pseudozooidal tubes. The pillars are slightly divergent in the mamelons. Dissepiments are rare to absent. The mamelons are not shown in the figure.

Tangential section.—The skeletal tissue covers about 70 percent of the section. Laminae are not distinguishable. The long pillars are round, 0.17 mm. in diameter, with light, yellowish centers, accentuated by the outer sheath of maculae, mostly confluent, but up to 0.14 mm. apart, and forming about half of the tissue of the section. The galleries are irregular and vermicular, about the size of the large pillars. The short pillars are not distinguishable from the laminar and interlaminar tissue. Astrorhizae composed of long, thin, vermicular, branching canals, 0.10 mm. wide near their base. Maculae are large, 0.013 to 0.028 mm. in diameter, with clear centers. The galleries and round pillars are outlined by strong, dark maculae. Pseudozooidal tubes are common, round and appear white.

Stromatopora magnimamillata is named for its characteristic broad, low mamelons, which distinguish it from the smooth-surfaced *S. pachytexta* Lecompte and *S. cumingsi*. The large, low mamelons distinguish it from *S. conicomamillata,* which has smaller, higher, more closely spaced mamelons, and the pillars are thinner than is *S. pachytexta*. It should be emphasized that all of the species of the *S. pachytexta* group are much alike.

Occurrence.—Common in the Middle Devonian, lower Logansport limestone, at the France Lime and Stone Company quarry, five miles east of Logansport, Indiana.

Holotype.—Indiana University Paleontological Collections, slides 303-78, 79. Cat. No. 5336.

Paratype.—Slides 304-53, 54, 63, 64, 85, 86.

Genus **SYRINGOSTROMA** Nicholson, 1875

Type species (selected by Nicholson, 1886, p. 98), *S. densum* Nicholson, 1875, Geol. Surv. Ohio, vol. 2, pt. 2, p. 251, pl. 24, fig. 2 (Mid. Dev., Kelleys Island, Ohio); Nicholson, 1886, Palaeont. Soc., vol. 39, p. 97, pl. 11, figs. 13, 14; 1891, Ann. Mag. Nat. Hist., ser. 6, vol. 7, p. 326, pl. 10, figs. 8, 9; Girty, 1895, 48th Ann. Rept. State Geol. New York for 1894, vol. 2, p. 289; Parks, 1909, Univ. Toronto Studies, Geol. Ser., No. 6, p. 8; Ripper, 1937, Roy. Soc. Victoria Proc., new ser., vol. 49, p. 179; Kühn, 1939, in Schindewolf, Handbuch Paläozoologie, Bd. 2A, p. A46; Lecompte, 1951, Inst. Roy. Sci. Nat. Belgique, Mém. 116, p. 195.

Stylodictyon Nicholson and Murie, 1878, Jour. Linn. Soc. London, Zool., vol. 14, p. 221.

Coenosteum massive or tuberose, composed of latilaminae and thin, porous laminae. Interlaminar spaces largely filled with maculate tissue, leaving small oval, and narrow, superposed galleries. Pillars large and long, and short and spool-shaped; in the type species the large pillars are made by sharp upturns of the laminae, making small columns which are filled with more compact maculate tissue. In many other species there are no mamelon columns. Tangential section with large, roundish pillars or concentric circles, round or irregular small pillars and round and anastomosing galleries. Tissue fused and conspicuously maculate. Astrorhizae largely developed.

Silurian and Devonian, North America, Europe and Australia. About 20 species.

Syringostroma differs from *Stromatopora* only in the large, continuous, round pillars, which are in the goundmass as seen in tangential section. It resembles *Parallelopora* in the maculate tissue and strong, long pillars, but lacks the vertical tubules and rods in the pillars. *Syringostroma* of Lecompte (1951, p. 195) is not typical, and most of his species belong in other genera.

KEY TO AMERICAN MIDDLE DEVONIAN SPECIES OF SYRINGOSTROMA

1a. Surface without mamelons
  2a. Long pillars not surrounded by galleries
    3a. Long pillars less than 0.5 mm. broad
      4a. Short pillars more abundant than long pillars .... *S. densum* Nicholson
      4b. Long pillars more abundant than short pillars .... *S. sanduskyense*, n. sp.
    3b. Long pillars about 1 mm. broad ...... *S. perdensum*, n. sp.
  2b. Long pillars surrounded by galleries

3c. Long pillars stellate; laminae turn 45°or less into the pillars
4c. Laminae turn up 45° into long pillars .... *S. superdensum*, n. sp.
4d. Laminae turn up 10° to 30° into long pillars .... *S. papillatum*, n. sp.
3d. Long pillars wheel-shaped in tangential section; laminae turn 60° into the pillars
4e. Coenosteum erect, tuberose .... *S. tuberosum*, n. sp.
4f. Coenosteum massive .... *S.* sp. undescribed
1b. Surface mamillate
2c. Astrorhizae large, 10 mm. or more in diameter .... *S. radicosum*, n. sp.
2d. Astrorhizae small, 3 to 5 mm. in diameter
3e. Mamelons 7 to 10 mm. in diameter .... *S. perfuscum*, n. sp.
3f. Mamelons 3 to 6 mm. in diameter
4g. Pseudozooidal tubes abundant
5a. Pillars strong, mamelons strong .... *S. fuscum*, n. sp.
5b. Pillars weak; mamelons weak .... *S. subfuscum*, n. sp.
4h. Pseudozooidal tubes rare; laminae rise into pillars .... *S. bicrenulatum*, n. sp.

Syringostroma densum Nicholson Pl. 16, figs. 3a, b

Syringostroma densa Nicholson, 1875, Geol. Surv. Ohio, vol. 2, pt. 2, p. 251, pl. 24, figs. 2a, b.; *S. densum* Nicholson, 1886, Palaeont. Soc., vol. 39, p. 97, pl. 11, figs. 13, 14; 1891, Ann. Mag. Nat. Hist., ser. 6, vol. 7, p. 326, pl. 10, figs. 8, 9 (Mid. Dev., Columbus ls., Kelleys Island, Ohio).

Coenosteum small, hemispherical, 2 to 3 cm. high and up to 9 cm. in diameter. Surface nearly smooth, without mamelons. Astrorhizae are large, up to 10 mm. in diameter, scattered and inconspicuous, with long, narrow canals, 0.2 to 0.5 mm. in diameter. Latilaminae 2 to 3 mm. thick.

Vertical section.—The laminae are moderately thick, about eight in 2 mm., each composed of two to four microlaminae with much coarsely maculate thickening tissue. The pillars are of two kinds, abundant short and common long. The short pillars are indefinitely spool-shaped, and tend to be superposed; the long pillars extend through many laminae, are from 0.18 to 0.3 mm. in diameter and the laminae rise slightly into the long pillars. Short pillars and laminae are composed of coarsely maculate tissue; the maculae tend to be arranged in vertical lines, and are from 0.02 to 0.03 mm. in diameter. The long pillars are composed of more compact tissue than the laminae and short pillars, and the maculae have smaller, light-colored centers and appear smaller because they are closer together. The maculae in the long pillars tend to be arranged in diverging, vertical lines, but no tubules are made by maculae as is true for *Parallelopora.* The microlaminae, laminae, short pillars and long pillars are amalgamated and composed of the same kind of maculate tissue. The galleries are round and irregular in shape; many are superposed, making pseudozooidal tubes 0.06 mm. in diameter, but they are not a conspicuous feature of the section. Astrorhizal canals are round to oval and 0.25 to 0.3 mm. in diameter some with curved tabulae. Dissepiments are scarce.

Tangential section.—The tissue is a lacy network of maculate tissue of three shades, the loose interlaminar tissue, the darker laminae, and the darker, large, round pillars. There are round pseudozooidal tubes, irregular and vermicular galleries, small vacuities, and large astrorhizal canals, up to 0.4 mm. in diameter, not shown in the figure. The maculae are irregular in shape, many are confluent, from 0.02 to 0.03 mm. in diameter. In the maculate groundmass are dusky, roundish, more compact spots, 0.2 to 0.35 mm. in diameter, which are the large pillars. The dusty tissue of the pillars surrounding the maculae is more dense than in the groundmass, and few of the pillars are outlined by a ring of galleries, and none by microlaminae. The tissue is completely amalgamated, and microlaminae are not seen.

This species is characterized by the smooth laminae, only slightly rising into the long pillars, by the small size of the long pillars, as compared with *S. superdensum,* and the lacy appearance in the tangential section. Our description and figures are taken from topotypes, and they fit the original and later descriptions and figures of Nicholson. The generic term "*syringo*" seems to have had reference to the astrorhizal canals, which are by no means characteristic of *Syringostroma,* but occur in many genera of stromatoporoids. The specific term "*densum*" is correct in indicating the finer texture of the species as compared with *Anostylostroma* and *Parallelopora,* with which it occurs, but it is no more dense than *Stromatopora marpleae* from Kelleys Island, and the dense structure is much less marked than in *Syringostroma superdensum* and other forms from southern Indiana. The genus *Syringostroma* must stand on the presence of continuous, large pillars which lack the vertical tubules of *Parallelopora,* but the two genera are closely related. This species differs from *S. superdensum,* with which it might be confused, in the smaller long pillars and small rise of the laminae into the long pillars.

Occurrence.—We have several fragmentary specimens from the north shore of Kelleys Island, Ohio, collected through the kindness of Dr. M. F. Marple, of Ohio State University, and two large, well-preserved specimens from the Meshberger Stone Company quarry, two miles northeast of Elizabethtown, Ind. (Slides 302-60, 61, 62, 63).

Plesiotype.—Indiana University Paleontological Collections, slides 306-8, 9. Cat. No. 5405.

Syringostroma sanduskyense Galloway and St. Jean, n. sp.
Pl. 16, figs. 4a, b

Coenosteum massive, a fragment is 6 cm. high and 13 cm. in diameter. The surface is not preserved, but based on thin sections, it has large conical papillae 0.2 to 0.3 mm. in diameter; mamelons absent; astrorhizae are large, up to 10 or 15 mm. in diameter, with centers about 15 mm. apart, composed of thin, branching radial canals. Latilaminae are 2 to 5 mm. thick.

Vertical section.—Laminae are straight, thick, 0.1 to 0.3 mm. thick, five to eight in 2 mm., composed of two to six thin microlaminae which are interlaminated with light-colored maculate tissue. The laminae turn sharply up into the long pillars through which they extend, though in many places, the pillars pierce the laminae. Long pillars abundant, 0.2 to 0.3 mm. broad, one to five in 2 mm., flaring into each lamina, with long parallel light and dark streaks, but scarcely making tubules and rods, as in *Parallelopora.* Short pillars common, spool-shaped, 0.1 to 0.3 mm. broad. All of the pillars are composed of tissue containing large maculae, 0.02 to 0.03 mm. in diameter, similar to the tissue embracing the microlaminae. The maculae are dusky spheres and clear spots, obvious in some places, obscure in others, the variation depending on preservation, where the maculae are cut, and the thickness of the section. The galleries are small round, or low broad, rectangles, 0.1 to 0.2 mm. high, one to four times as broad. The galleries are mostly superposed, but few are connected by foramina in the laminae. Dissepiments rare, broadly curved and oblique. Pseudozooidal tubes are short, rare, and not typical.

Tangential section.—The pillars are conspicuous, mostly 0.3 mm. in diameter, round with irregular edges and tenuous processes joining adjacent pillars, but not making radial rods, as in *Actinostroma.* Many pillars coalesce and fuse with the laminae. Most of the thin section is composed of dark, mottled laminar tissue, with one or two rows of pillars between two laminae and with vacuities in the laminar tissue. The galleries are narrow, 0.12 mm. wide, anastomosing about the pillars. The large astrorhizae are composed of long, sinuous, branching canals with some intercalated short branching canals; both long and short canals are sparsely tabulate, 0.19 to 0.22 mm. broad at the base.

S. sanduskyense is characterized by the lack of mamelons, by the large pillars, and by the multiple microlaminae within the thick laminae. It differs from *S. radicosum,* n. sp., in lacking mamelons, and in having smaller pillars and smaller astrorhizal canals. This species is much like the type of *Synthetostroma* (Lecompte, 1951, p. 194, pl. 20, figs. 3, 4) including the maculate tissue and microlaminae, but has fewer dissepiments; the relative number of dissepiments is a specific character but not a generic one. It is much like *Clathrocoilona,* which has flocculent tissue, but not typically maculate tissue. Laminae are composed of microlaminae in many genera. *S. sanduskyense* emphasizes the close relationship between *Syringostroma, Parallelopora,* and *Synthetostroma.*

Occurrence.—The specimen, loaned from the Ohio State University Museum by Dr. Mildred F. Marple, is from the Middle Devonian, Columbus limestone of northern Ohio. The name *Stroma-*

topora sanduskiensis was on the label, so that the specimen is presumably from somewhere near Sandusky, Ohio. To our knowledge the species has never been published, and we have adopted the name that was on the label, with a correction in spelling, changing the *i* to *y*.

Holotype.—Indiana University Paleontological Collections, slides 306-19, 20; Cat. No. 5406. Ohio State University Museum, Paleontological Collections, specimen number 2211, and 2 slides.

Syringostroma perdensum Galloway and St. Jean, n. sp. Pl. 17, figs. 1a, b

Coenosteum massive, tuberose, an incomplete specimen is 9 cm. high and 15 cm. in diameter. Surface with papillae, 1 to 1.5 mm. in diameter and 2 to 3 mm. from center to center; very small astrorhizae are located between the papillae. Latilaminae are 3 to 4 mm. thick, seen well on a polished surface, as are the diverging columns. The specimen is well preserved, highly infiltrated with calcium carbonate, and very dense.

Vertical section.—The skeleton is composed of thin laminae, 12 to 16 in 2 mm., which rise sharply into the large pillars, and are in turn composed of thin microlaminae, 0.008 to 0.012 mm. thick, with a darker microlamina at the top of each lamina. The large pillars are about 1 mm. in diameter, some of which have tubes 0.1 mm. in diameter, and are marked by gray, dense tissue, making long diverging pillars. The laminae are largely superposed, leaving small, oval galleries, about 0.08 mm. in diameter, and narrow pseudozooidal tubes, five to six in 2 mm., crossed by thin microlaminae. The short pillars, 0.2 to 0.3 mm. wide, are superposed, and in many cases are confluent laterally. The tissue is finely maculate, the maculae being small, about 0.012 mm. in diameter, and visible only in favorable parts of the section.

Tangential section.—The groundmass is uniformly maculate, covering more than 90 percent of the area of the section. The confluent, amalgamated mass of maculate tissue is pierced by short, thin astrorhizal canals, about 0.1 mm. in diameter, by vertical tubes, from 0.06 to 0.09 mm. in diameter, and by branching, vermicular galleries 0.1 mm. wide. The truncated large pillars appear as slightly darker, round areas within the groundmass, set off by several concentric rows of microlaminae, not outlined by a circle of galleries, and are difficult to distinguish. The small pillars are round, 0.2 to 0.27 mm. in diameter, and separated by narrow, anastomosing galleries, many confluent and merging with the laminae.

Stromatopora perdensum is characterized by the long, large pillars, into which the laminae turn, and by the small size and small number of the galleries and large amount of tissue. It is a typical *Syringostroma*, being like *Stromatopora* but having large, long pillars. It differs from *S. densum* in the even more dense structure, finer maculae, and smaller galleries.

Occurrence.—Middle Devonian, Logansport, 0 to 10 feet above the base, at the France Lime and Stone Company quarry, 5 miles east of Logansport, Indiana.

Holotype.—Indiana University Paleontological Collections, slides 294-74; 303-19, 20, 21, 37, 38, 39, 46, 47, 48. Cat. No. 5337.

Paratype.—Slides 304-77, 78.

Syringostroma superdensum Galloway and St. Jean, n. sp.
Pl. 17, figs. 2a, b

Coenosteum making hemispherical heads 15 cm. in diameter. Surface without mamelons, but with small papillae, 1 mm. in diameter, ½ mm. high and 2 mm. apart from center to center. Scattered astrorhizae, 3 mm. in diameter are difficult to detect. Latilaminae, 2 mm. thick may be seen on the polished, vertical surface.

Vertical section.—The skeleton is composed of thick laminae, about eight in 2 mm., which in turn are composed of 4 to 6 microlaminae. Round and oval galleries, 0.1 to 0.15 mm. in diameter occur in the lower half of the laminae. Superposed galleries are common, some making vertical, tabulate tubes, 0.1 mm. in diameter. Pillars are of two kinds, short and long. The short pillars are thick, spool-shaped, 10 to 12 in 2 mm., and usually superposed; microlaminae cut across the short pillars, but are conspicuous. The long pillars, characteristic of the genus, occupy the axes of small columns, and traverse several latilaminae; they are mostly straight, 0.5 to 0.6 mm. in diameter, two to four in 4 mm. and are composed of more compact and finer maculate tissue than the small pillars, and the maculae tend to be in diverging lines, but not in parallel lines, as in *Parallelopora*. The laminae rise sharply, about 45° into the long pillars, and in places cut the pillars and curve back down. All pillars, the laminae and microlaminae are amalgamated and coarsely maculate, with maculae 0.023 to 0.038 mm. in diameter; the clear lumina in the maculae are only 0.018 mm. in diameter in dense specimens from the Falls of the Ohio, but in less dense specimens from northeast of Louisville, Ky., the lumina of the maculae are larger, 0.03 to 0.034 mm.

Tangential section.—The maculate tissue occupies about 80 percent of the area of the section. The maculae are more conspicuous than they are in the vertical section. The short pillars may be round, but mostly coalesce, forming a groundmass in which occur the small, round, pseudozooidal tubes, round and anastomosing galleries, and an occasional astrorhizal canal. The long pillars are also small columns, about 0.6 mm. in diameter, 0.8 to 1.2 mm. apart, and appear stellate, each with a single ring of large, round or curved galleries surrounding the pillar. The maculae of the large pillars are more conspicuous than those in the small pillars and laminae, but are not measurably larger.

The species *S. superdensum* is characterized by the small papillae, the small astrorhizae, the large, stellate pillars in which the microlaminae rise at about 45°. The specimens appear as dense limestone to the eye and hand lens, but no more dense than specimens of *Stromatopora* and *Parallelopora* occurring with them. It differs from *S. tuberosum*, n. sp., in the shape of the coenosteum, the more distant laminae and lower angle of microlaminae in the large pillars, and a less lacy and more dense appearance. It has much larger long pillars than *S. densum*, hence the specific name.

Occurrence.—This species occurs abundantly in the Jeffersonville limestone at the Falls of the Ohio at Jeffersonville, Ind., (slides 272-6; 285-27, 28, 29; 295-3, 4, 9, 10, 13, 14, 17, 18), and is common in the Jeffersonville limestone in the Independent quarry, four miles south of Dupont, Ind., (slides 285-53, 54, 58), the Meshberger quarry, eight miles south of Columbus, Ind. (302-60, 61), one mile north of Kent, Ind. (295-61, 62), and 3.3 miles southwest of Prospect, Ky., (306-1, 2). A similar species, with higher angle of microlaminae in the prominent, small columns, appearing wheel-like in tangential section, and larger astrorhizae, occurs in the Middle Devonian at Coral Rapids, northern Ontario (slides 301-98, 99, 100; 302-1, 2).

Holotype.—Indiana University Paleontological Collections, slides 285-27, 28, 29. Cat. No. 5363.

Syringostroma papillatum Galloway and St. Jean, n. sp. Pl. 17, figs. 3a, b

Coenosteum massive, a fragment is 25 mm. high and 55 mm. in diameter. The surface has low, domal papillae, 0.3 mm. high, 0.5 to 1 mm. in diameter, and 1 to 2 mm. from center to center, and small astrorhizae, 4 mm. in diameter, 5 mm. from center to center. The astrorhizal canals meander between the papillae, and their centers are in some cases in the centers of the papillae. The latilaminae are slightly undulatory, four to five in 10 mm.

Vertical section.—The skeleton is composed of thick laminae, 0.25 mm. thick, 10 in 2 mm., which turn smoothly into large pillars. The laminae are made of several microlaminae 0.02 mm. thick. The top edge of each lamina is sharply demarked by a dark microlamina. The galleries are small, round to oval, or elongate, 0.08 mm. in diameter and occupy about half of the interlaminar space at the lower sides of the laminae. There are 10 galleries in 2 mm. horizontally. Short, spool-shaped pillars occur between the galleries and are in general superposed. The long, large pillars are 0.3 to 0.5 mm. wide, about two in 2 mm. and make the papillae at the surface. Astrorhizal canals are abundant, round, 0.16 mm. in diameter and are located between the large pillars. Vertical astrorhizal tubes occur in places, 0.16 mm. in diameter and are crossed by upward curved tabulae. Pseudozooidal tubes are abundant, seven or eight in 2 mm., 0.06 to 0.08 mm. in diameter, mostly straight but some are diagonal and some curve. The tissue is yellowish and dusty in appearance and filled with both light and dark maculae, 0.02 mm. in diameter. Dissepiments are rare or absent.

Tangential section.—Maculate tissue occupies about 80 percent of the section. The short pillars are in part round but mostly confluent. The large pillars are round, 0.3 to 1 mm. in diameter and 1 to 2 mm. apart from center to center and surrounded by galleries, and there are several round pseudozooidal tubes in each large pillar. The large pillars are thus difficult to distinguish under the microscope, although the tissue is more dense than that between the pillars which are readily seen with a 10× lens. The galleries are round to irregular and anastomosing. The section is dotted with round, pseudozooidal tubes, 0.06 to 0.08 mm. in diameter. Astrorhizae are conspicuous, 4 mm. in diameter, some with a central, round tube 0.23 mm. in diameter; the canals are larger than the galleries.

Syringostroma papillatum is characterized by the strong papillae, the small, round galleries and a large amount of tissue as compared with galleries. It is much like *Stromatopora divergens,* n. sp., but it has long pillars, lacks mamelons, and has closer laminae. The species differs from *S. superdensum,* of the Jeffersonville limestone, in the smaller galleries and maculae, and the laminae do not turn as abruptly into the columns; the microlaminae rise at about 30°. The skeleton is fully as dense as it is in *S. superdensum* and more dense than it is in *S. densum.*

Occurrence.—Middle Devonian, Hamilton group, Logansport limestone, from the France Lime and Stone Company quarry, five miles east of Logansport, Indiana.

Holotype.—Indiana University Paleontological Collections, slides 278-5, 6; 303-49, 50. Cat. No. 5338.

Syringostroma tuberosum Galloway and St. Jean, n. sp. Pl. 17, figs. 4a, b

Coenosteum erect, tuberose, up to 12 cm. high and 8 cm. in diameter, commonly elliptical in cross section. Surface with low conical papillae, 1 to 1.5 mm. in diameter, about half as high and 1.5 to 2 mm. apart from center to center. Astrorhizae are difficult to detect, with small, short, simple canals. Latilaminae are 2 to 3 mm. thick. The axis of the coenosteum is a nearly vertical column 20 mm. in diameter, and the long pillars abruptly turn outward at an angle of 80° from the vertical and proceed to the surface in straight lines, thus producing an axial and a cortical region in mature specimens. Some of the pillars increase by bifurcation.

Vertical section.—Laminae, 0.04 to 0.12 mm. thick, 10 to 12 in 2 mm., composed of one or more microlaminae, bounded on the lower sides by maculate tissue. The laminae curve continuously between closely spaced long pillars, into which they turn at about 60° and become nearly vertical, the microlaminae appearing as sheaths around the pillars. The long pillars, 0.26 to 0.66 mm. broad, one or two in 2 mm., are in the axes of small, radial columns. Short pillars, 0.04 to 0.12 mm. broad, six to eight in 2 mm., between the long pillars, have a tendency to be superposed. Both pillar and laminar tissue contain large maculae, 0.02 to 0.04 mm. in diameter. Galleries are subrectangular, 0.09 to 0.16 mm. high and one to three times as broad. Superposed galleries are short, usually divided by microlaminae, 0.42 mm. broad, one to two in 2 mm., but typical, long zooidal tubes are not formed. One vertical section (296-20) has a large, straight, tabulate astrorhizal tube, 0.18 mm. broad, with several horizontal branches, but not in a papillar column. Dissepiments are thin, low to highly arched, mostly oblique, rare.

Tangential section.—The tissue composes about 50 percent of the area of the section. The section is a complex, lacy pattern of large pillars, small, confluent pillars, round and irregular galleries, round and elongate astrorhizal canals, small vacuities and maculae. The maculae are large, round, conspicuous, light-colored dots, about 0.03 mm. in diameter, separated by darker, dusty appearing tissue, which is larger in amount in the large pillars, so that the maculae appear smaller because of the restriction of the white centers. The tissue of laminae, short pillars, and microlaminae are amalgamated. The small pillars are irregular, coalescent, and not well defined, 0.1 to 0.2 mm. in diameter. The large pillars are 0.9 to 1.1 mm. in diameter and 0.2 to 0.4 mm. apart, with solid but maculate centers, and marked by one or two rings of galleries, microlaminae, and astrorhizal canals. Astrorhizae are small, simple, rarely branching canals, 0.08 to 0.09 mm. broad at the base and extended between the large pillars.

S. tuberosum is characterized by the erect, tuberose shape of the coenosteum, by the close spacing of the long pillars, and by the high angle at which the laminae turn into the pillars. It is similar to *S. superdensum*, n. sp., but differs in the tuberose shape, in the more closely spaced laminae, the smaller amount of tissue, and in the high angle at which the laminae turn into the columns. It is more similar to an undescribed species from the Columbus limestone from Coral Rapids, northern Ontario, differing in the tuberose shape of the coenosteum rather than massive and in having larger papillae and pillars.

Occurrence.—Three specimens, including the holotype, were collected from the Middle Devonian, Jeffersonville limestone, one mile north of Kent, Indiana, by Mr. Guy Campbell; one specimen is from Commiskey Cave, Jennings County, Ind.; common in the Meshberger Stone Company quarry, two miles northeast of Elizabethtown, Ind.

Holotype.—Indiana University Paleontological Collections, slides 296-20, 21, 22; 305-100. Cat. No. 5382.

Paratypes.—Slides 295-63; 296-23, 24; 305-95, 96.

Syringostroma radicosum Galloway and St. Jean, n. sp. Pl. 18, figs. 1a, b

Coenosteum massive, a fragment is 4 cm. high, 8 cm. in diameter. The surface has prominent conical mamelons, 6 to 8 mm. in diameter, 2 to 5 mm. high, 10 to 15 mm. apart from center to center. Astrohizae large, 10 mm. or more in diameter, composed of numerous large, branching canals, some of which connect with canals of adjacent astrorhizae. Latilaminae thin, 1 or 2 mm. thick. The tissue appears dense, with mamelons, long pillars, and large astrorhizal canals.

Vertical section.—Laminae, 0.07 to 0.14 mm. thick, five to eight in 2 mm., are composed of several microlaminae, which are bounded by secondary tissue containing maculae 20 to 25 microns in the diameter. The laminae turn sharply into large mamelons and long pillars. The short pillars are spool-shaped and broad, filling most of the interlaminar space, and maculate; long pillars, about 0.5 mm. broad, composed of more compact, maculate tissue, extend through the laminae, in and between the mamelons. Both the laminae and pillars thicken in the mamelon columns, which are compact and finely maculate. The galleries are round or oval, 0.05 to 0.15 mm. in diameter, one to three times as broad, and are smaller than the astrorhizal canals. Pseudozooidal tubes are short and not common. Dissepiments are rare.

Tangential section.—The short pillars are mostly confluent and difficult to distinguish; in well-preserved specimens the pillar tissue is slightly darker than the surrounding tissue. The tissue occupies 80 to 90 percent of the section. The large pillars are 0.35 to 0.5 mm. in diameter, maculate and compact, with obscure annuli. The galleries are small and irregular. The astrorhizae are composed of large branching canals up to 0.28 mm. broad at the base, with curved tabulae; the astrorhizae have no particular relation to the large pillars, tend to be located in columns, but without axial tubes.

Syringostroma radicosum is characterized by large mamelons, large astrorhizae and a large amount of tissue. The specific term refers to the conspicuous, astrorhizal canals. It is similar to *S. superdensum* but differs in having mamelons and large astrorhizae.

Occurrence.—Four specimens were collected from the Middle Devonian, Jeffersonville limestone at the Jefferson County quarry, 1.2 miles northeast of the Louisville, Kentucky, city limits on Highway 42, by Mr. P. McGrain and Mr. F. H. Walker of the Kentucky Geological Survey. The specimens are somewhat weathered.

Holotype.—Indiana University Paleontological Collections, slides 305-88, 89. Cat. No. 5392.

Paratypes.—Slides 305-86, 87, 90, 91, 92.

Syringostroma fuscum Galloway and St. Jean, n. sp. Pl. 18, figs. 2a, b

Coenosteum thick, laminar, 2 to 5 cm. thick and 15 to 20 cm. in diameter. The base is marked by prominent, concentric wrinkles, 10 to 12 mm. from crest to crest and 1.5 mm. high. Surface with domal mamelons from 4 to 6 mm. in diameter, 1.5 to 2 mm. high, and 8 to 10 mm. from center to center and with low, conical papillae, about 0.5 mm. in diameter, which are the upper ends of the long pillars. Astrorhizae are small and indistinct, located in the centers of the mamelons. Latilaminae are from 1 to 2 mm. thick, between which the coenostea readily split.

Vertical section.—The skeleton is composed of a network of thin laminae, 10 in 2 mm., and vertical pillars, the long ones being more conspicuous than the laminae. The laminae are separated by thin, white microlaminae, about 0.03 mm. thick. The pillars are both short and long, with a few short pillars between two long pillars. The long pillars are 0.3 to 0.37 mm. wide, three in 2 mm., are recognized by their dusky appearance, suggest the name *fuscum,* and are composed of maculate tissue more compact than that of the laminae and short pillars. Both kinds of pillars are divergent in the mamelons and are traversed by the microlaminae. The laminae rise gently in the mamelon axes and sharply in the long pillars. The mamelon axes are occupied by several vertical astrorhizal tubes, by round, horizontal, astrorhizal canals, and by long, compact pillars like the ordinary dusky pillars. The mamelons are not shown by the figure. The galleries are mostly round, some horizontally confluent, about 0.13 mm. in diameter. Pseudozooidal tubes are abundant, round, traversing several laminae, thin, about 0.10 mm. wide, three to eight in 2 mm., with microlaminae extending across them. The round astrorhizal canals in the columns are 0.17 mm. in diameter. The tissue is entirely maculate; the maculae are small, averaging 0.016 mm. in diameter. Dissepiments appear to be absent.

Tangential section.—About 70 percent of the area is composed of a maculate ground mass. The larger pillars are round, 0.25 to 0.3 mm. in diameter, 0.25 mm. or more apart, composed of tissue darker and more compact than the surrounding groundmass, and recognized by their dusky appearance, rather than outlined by galleries, best seen under 10× magnification. The small pillars are coalescent. The skeletal elements are amalgamated, so that neither laminae nor microlaminae are distinguishable in tangential sections. The galleries are round, as well as vermicular and coalescent. Vertical tubes, 0.10 mm. in diameter, are round and abundant. The astrorhizae are composed of straight, short, thick radial canals, 0.12 to 0.24 mm. wide, without tabulae.

Syringostroma fuscum is characterized by the thick, laminar coenosteum, the mamelons 4 to 6 mm. in diameter, the basal corrugations, and the small size of the long pillars which are not outlined by a ring of galleries. This species is like *S. subfuscum* and *S. perfuscum,* with which it occurs, but has larger mamelons than the former and smaller mamelons than the latter. It differs from *S. densum* in having mamelons, narrower long pillars, the laminae do not turn into the pillars as strongly, and the pillars are not outlined by a ring or rings of galleries. *S. fuscum* approaches the *Stromatopora hüpschi* group of the genus *Stromatopora* but is placed in the genus *Syringostroma* on the basis of the large, round pillars which are distinguishable in tangential section. The specimens are well preserved but have been oxidized to a buff color.

Occurrence.—Abundant in the upper Middle Devonian, Little Rock Creek limestone, 10 to 30 feet above the Silurian-Devonian contact, France Lime and Stone Company quarry, five miles east of Logansport, Indiana, and on Pipe Creek, one mile north of Bunker Hill, Indiana.

Holotype.—Indiana University Paleontological Collections, slides 294-66, 67. Cat. No. 5348.

Paratypes.—Slides 294-54, 56, 57, 58, 59, 62, 68, 69, 70, 78, 79, 80, 81, 82, 91, 92, 93; 303-18, 35, 36, 43; 305-9, 10, 11, 12.

Syringostroma subfuscum Galloway and St. Jean, n. sp. Pl. 18, figs. 3a, b

Coenosteum laminar, one fragment is 3.5 cm. thick and 14 cm. in diameter. The surface has smoothly rounded, low mamelons, 3 to 4.5 mm. in diameter, 1 to 1.5 mm. high, and 8 to 10 mm. from center to center. Papillae, the ends of the round pillars, are abundant. Astrorhizae are small, 2 mm. in diameter. Latilaminae 1 to 5 mm. thick.

Vertical section.—The skeleton is composed of undulose laminae, 0.1 to 0.2 mm. thick, 10 to 15 in 2 mm., which rise into the mamelons and in places into the long pillars. Laminae are separated by light-colored microlaminae, with maculate tissue largely filling the interlaminar spaces and fusing with the pillar tissue. The long pillars are 0.2 to 0.3 mm. wide and composed of dusky, superposed, short segments, six pillars in 2 mm., which become larger, divergent, curved, and branched in the mamelons. The galleries are small, round to oval, 0.11 mm. in diameter. Pseudozooidal tubes are 0.15 mm. wide, four or five in 2 mm., and abundant. The tissue is finely but conspicuously maculate, the maculae being 0.01 to 0.015 mm. in diameter. Dissepiments are absent.

Tangential section.—The groundmass makes up about 70 percent of the section. The long pillars are round, averaging 0.2 mm. in diameter, slightly darker than the groundmass but difficult to distinguish, best seen with a 10× hand lens. The short pillars are confluent, about 0.2 mm. wide. There are tubes in some of the mamelons, but they are small, about 0.2 mm. in diameter. The pseudozooidal tubes are round, 0.12 mm. in diameter, and many are surrounded by a thick ring of tissue but not making ring-pillars. The galleries are small, 0.13 mm. wide, vermicular and anastomosing, making a regular meshwork with the groundmass. The astrorhizae are small and simple, with radial canals about 0.1 mm. wide, mostly straight and sparsely branching.

Syringostroma subfuscum is characterized by the small mamelons, and indistinct, long, round pillars; otherwise this species can scarcely be distinguished from *S. fuscum* or *S. perfuscum,* both of which have larger mamelons and stronger pillars. The specific name refers to the general similarity of the species to *S. fuscum.* This species resembles *Stromatopora mononensis* but has long, round pillars and longer and larger pseudozooidal tubes. It has a great resemblance to the *Stromatopora hüpschi* group; some workers may consider it to be a species of *Stromatopora.*

Occurrence.—Common in the Middle Devonian, Little Rock Creek limestone, 10 to 30 feet above the Silurian-Devonian contact at the France Lime and Stone Company quarry, five miles east of Logansport, Indiana.

Holotype.—Indiana University Paleontological Collections, slides 294-71, 303-44. Cat. No. 5349.

Paratypes.—Slides 294-49, 52, 77, 87, 88, 94, 95, 96; 303-11, 12, 13.

Syringostroma perfuscum Galloway and St. Jean, n.sp. Pl. 18, figs. 4a, b

Coenosteum thick, laminar, fragments are up to 5 cm. high and 14 cm. in diameter. The surface is strongly mamillate and papillate; mamelons are high domes, 7 to 10 mm. in diameter, 2 to 3 mm. high and 9 to 15 mm. from center to center; papillae are large, round, low domes about 0.8 mm. in diameter, with a height one-third to one-half the diameter; astrorhizae are small, 3 to 4 mm. in diameter, indistinct, in the center of each mamelon; latilaminae about 1.5 mm. thick.

Vertical section.—The skeleton is composed of thick laminae four or five in 2 mm., and small and large pillars, best appreciated with a 10× lens. The laminae are undulose, turning smoothly upward into the large mamelons, and are composed of many microlaminae, some light, some dark, and maculate tissue between the microlaminae. The microlaminae turn sharply into the large pillars but cut straight across the small pillars. The small pillars are composed of maculate tissue, tend to be superposed, and branch, average 0.15 mm. wide, four or five in 2 mm. The large pillars are straight, 0.34 mm. wide, one to two in 2 mm., and are also composed of maculate tissue, but the maculae are darker than in the short pillars and tend to be arranged in vertical rows. Both long and short pillars are slightly divergent in the mamelons. The laminae and pillars are amalgamated. The pseudozooidal tubes are long and tabulate, 0.11 mm. wide, five in 2 mm. The galleries are round to oval, 0.16 mm. in diameter, less abundant than the vertical tubes. A thin epitheca, 0.44 mm. thick, is composed of maculate, thick-walled, highly-arched imbricating cyst plates 0.20 mm. broad, 0.09 mm. high. The maculae are about 0.012 mm. in diameter, and conspicuous in well-preserved specimens. Dissepiments are rare to absent. The mamelon axes are not shown in the figure.

Tangential section.—The groundmass covers about 80 percent of the section. The short pillars coalesce and are indistinguishable as separate units. The large pillars are subround and distinguished by their dusky, darker appearance, 0.3 to 0.5 mm. in diameter, 0.8 to 1.0 mm. apart, and merge with the groundmass. The galleries are round or vermicular. The pseudozooidal tubes are round, abundant, averaging 0.11 mm. in diameter. Vertical tubes in the mamelons are subround, about 0.14 mm. in diameter. The astrorhizae are composed of long thin radial canals up to 0.14 mm. wide which may branch once or twice; several astrorhizae are cut in a single mamelon column, so the canals appear as oval openings.

Syringostroma perfuscum is characterized by large mamelons and papillae, and by the large, roundish pillars which are not surrounded by rows of chambers or concentric laminae in tangential section. The name *perfuscum* refers to the characteristic large mamelons, larger than in *S. fuscum*. The long pillars are larger and much more obvious than those of *S. subfuscum*. The vertical rows of maculae in some of the large pillars suggest the genus *Parallelopora*, but the maculae are small and do not form rods or tubules, so that the species is placed in *Syringostroma*.

Occurrence.—Rare in the Middle Devonian, Little Rock Creek limestone, 10 to 30 feet above the Silurian-Devonian contact, at the France Lime and Stone Company quarry, five miles east of Logansport, Indiana.

Holotype.—Indiana University Paleontological Collections, slides 278-24, 25; 279-1; 303-32; 33, 34, 45. Cat. No. 5350.

Syringostroma bicrenulatum Galloway and St. Jean, n. sp.
Pl. 19, figs. 1a, b

Coenosteum saucer-shaped, up to 4 cm. thick and 13 cm. in diameter. The upper surface is concave and usually covered with foreign material, therefore, the surface characteristics are based on thin sections and polished surfaces. The mamelons average 3 to 5 mm. in diameter, 1 to 1.5 mm. high, and 6 mm. apart. Astrorhizae are small and simple, 2 mm. in diameter. Latilaminae scarcely distinguishable, about 1 mm. thick. The under surface of the coenosteum is marked by concentric wrinkles, 4 to 7 mm. apart, corresponding to the latilaminae.

Vertical section.—The laminae are closely spaced, 15 to 18 in 2 mm., and turn smoothly into the mamelons and sharply into the large pillars in a bicrenulate manner. The laminae are separated by thin, light-colored microlaminae, and the laminae are made of finely maculate tissue which fills most of the space between the microlaminae. Small, round astrorhizal canals, 0.1 to 0.15 mm. in diameter are scattered through the section, and are more numerous on the flank of the mamelons, they are larger than the galleries, and cut the white microlaminae. Small pillars are absent; the large pillars are well marked, long and straight, diverging strongly on the flanks of mamelons, 0.25 mm. wide, three in 2 mm., marked by maculate tissue, darker than the surrounding tissue into which it merges, and by sharp, upward bent laminae. The galleries are few, small, round or oval, 0.06 mm. in diameter. Pseudozooidal tubes are not conspicuous, but a few extend through several laminae. The tissue is filled with minute maculae, 0.012 mm. in diameter, and is amalgamated.

Tangential section.—The groundmass covers more than 90 percent of the section. The pillars are obscure, but abundant and marked by the darker color, round, 0.35 mm. in diameter, 0.08 to 0.36 mm. apart. The galleries are small, round or elliptical, about one-fourth the size of the pillars. The astrorhizae are small, about 2.2 mm. in diameter, not superposed but more numerous in the columns, composed of short, radial canals, 0.10 mm. wide.

Syringostroma bicrenulatum is characterized by the saucer-shaped coenosteum, the bicrenulate microlaminae rising into the pillars as well as the mamelons, the dense texture of the skeleton, the scarcity of galleries and pseudozooidal tubes, the lack of short pillars, and by the small astrorhizae. It is similar to *S. subfuscum,* differing in the greater bicrenulation of the microlaminae, smaller and fewer pseudozooidal tubes and galleries, and more prominent pillars. It resembles *Stromatopora mononensis,* but it has definite, long pillars, best seen on polished vertical surfaces with a 10× lens; it is, therefore, a typical *Syringostroma.* The surface is weathered, but in places the dotted appearance made by the long, round pillars is very different from the reticulate pattern of *S. subfuscum.* On account of the poor preservation of the tangential section, there is considerable difficulty in seeing the structure. It differs from *S. fuscum* in vertical section, in the closer laminae, but particularly in the smaller long pillars and scarcity of galleries and pseudozooidal tubes.

Occurrence.—We have four specimens from the upper Middle Devonian, Little Rock Creek limestone, 10 to 30 feet above the Silurian-Devonian contact, at the France Lime and Stone Company quarry, five miles east of Logansport, Indiana.

Holotype.—Indiana University Paleontological Collections, slides 294-63, 64; 303-26. Cat. No. 5351.

Paratype.—Slides 294-75, 76; 303-27.

Genus **PARALLELOPORA** Bargatzky, 1881

Type species (first species, selected by Nicholson, 1891, p. 193), *P. ostiolata* Bargatzky, 1881, Verhandl. naturhist. Vereins preuss. Rheinlande West-

falens, vol. 38, p. 291 (Mid. Devonian, Germany); Nicholson, 1886, Palaeont. Soc., vol. 39, p. 95, pl. 2, figs. 6, 7; 1891, vol. 44, p. 191; Parks, 1936, Univ. Toronto Studies, Geol. Ser., No. 39, p. 53; Kühn, 1939, in Schindewolf, Handbuch Paläozoologie, Bd. 2A, p. A45; Lecompte, 1952, Inst. Roy. Sci. Nat. Belgique, Mém. 117, p. 292, pl. 51, figs. 3, 3a-c.
Not *Parallelopora* Newell, 1935, Jour. Paleont., vol. 9, p. 241; a sponge.
Not *Parallelopora* Johnson and Pfender, 1939, Jour. Paleont., vol. 13, p. 515; might be a *Stromatopora*.

Coenosteum laminar to massive, composed of thin laminae or multiple microlaminae with maculate tissue between, above, and below the microlaminae. Pillars large, continuous, composed of small, parallel, vertical tubules and vertical rods or columns of dark dots; in tangential section the pillars are roundish between the laminae, and irregular and connected in the laminae. Galleries superposed, some making pseudozooidal tubes, (the parallel pores of Bargatzky) not characteristic but occurring in other genera with continuous pillars. Dissepiments uncommon. Tissue coarsely maculate and amalgamated. In tangential section the galleries are round, vermiculate, and anastomosing. Astrorhizae numerous.

Middle Devonian, Europe, North America, and Australia; Permian?, Japan. About 19 species. Many species in Kühn (1928, Foss. Cat., p. 51) belong in *Syringostroma* or *Stromatopora*.

This genus differs from other genera of the Stromatoporidae in having pillars composed of tubules and rods, and in the coarse maculae. It differs from *Syringostroma* in the coarser and superposed maculae and more obvious tubules in the pillars. It is characterized by the superposed chambers or parallel pseudozooidal tubes, and by the coarsely maculate, amalgamated laminae and pillars in which the maculae are superposed.

KEY TO AMERICAN DEVONIAN SPECIES OF PARALLELOPORA

1a. Coenosteum without mamelons
  2a. Pillars confluent in tangential section, smaller than 0.5 mm. in diameter
    3a. Pillars 10 in 2 mm.
      4a. Galleries mostly round .... *P. ostiolata* Bargatzky
      4b. Galleries mostly vermicular and anastomosing .... *P. campbelli*, n. sp.

3b. Pillars 6 or 7 in 2 mm. .... *P. typicalis*, n. sp.
2b. Pillars separate, amoeboid, 0.5 to 1 mm. in diameter .... *P. pulchra*, n. sp.
1b. Coenosteum with definite mamelons
2c. Mamelons 8 to 10 mm. in diameter
3c. Laminae weak; pillars 0.15 mm. in diameter .... *P. nodulata* (Nicholson)
3d. Laminae strong; pillars 0.2 to 0.3 mm. in diameter .... *P. snoufferensis*, n. sp.
2d. Mamelons 3 to 5 mm. in diameter .... *P. eumamillata*, n. sp.
2e. Mamelons 1.5 to 2 mm. in diameter .... *P.* sp. undes.

Parallelopora ostiolata Bargatzky Pl. 19, figs. 2a, b

Parallelopora ostiolata Bargatzky, 1881, Verhandl. naturhist. Vereins Rheinlande Westfalens, vol. 38, p. 292 (Mid. Dev., Büchel, Germany); Nicholson, 1886, Palaeont. Soc., vol. 39, p. 95, pl. 2, figs. 6, 7 (Mid. Dev., Büchel, Germany); 1891, Palaeont. Soc., vol. 44, p. 193, text fig. 23 (Mid. Dev., Büchel, Germany); Gürich, 1896, Verhandl, russ. K. mineralog. Ges. St. Petersburg, ser. 2, vol. 32, p. 124 (Mid. Dev., Poland); Lecompte, 1952, Inst. Roy. Sci. Nat. Belgique, Mém. 117, p. 292, pl. 51, figs. 3, 3a-c (Mid. Dev., Büchel, Germany).

Coenosteum massive, the holotype is a fragment 1.3 cm. high and 3.5 cm. in diameter. The surface is without mamelons. Astrorhizae typical, 4 to 8 mm. in diameter, with centers 7 to 9 mm. apart; latilaminae 5 to 10 mm. thick.

Vertical section.—Laminae are indistinct, irregular, and intermittent, being continuous only at the latilaminar boundaries, 0.02 to 0.10 mm. thick, difficult to count, up to 20 in 2 mm. The laminae appear cystlike in many places where they are mere tabulae in the pseudozooidal tubes, not extending across the pillars, composed of one to two microlaminae with or without a covering of maculate tissue. The pillars are long and straight, with straight sides, 0.07 to 0.15 mm. broad, 9 to 11 in 2 mm., composed of maculate tissue with the maculae arranged in vertical rows so as to form tubules, two to four rows of tubules in each pillar. The maculae are coarse, 0.025 mm. in diameter in both the laminae and pillars, and have clear centers. The galleries are mostly round or subround, 0.10 to 0.13 mm. in diameter, but they are much elongate at the latilaminar boundaries. Pseudozooidal tubes are short to long, 0.08 to 0.12 mm. broad, seven or eight in 2 mm., divided only by microlaminae or tabulae. Dissepiments rare, small, thin, oblique, mostly in the astrorhizal canals. Astrorhizal canals are superposed, forming cylinders.

Tangential section.—The pillars coalesce to form a network of anastomosing bands, 0.09 to 0.12 mm. broad, surrounding the round pseudozooidal tubes which are confluent in a few places, 0.10 to 0.17 mm. in diameter. The astrorhizae are composed of five or six simple, unequal branching, radial canals; some have a central tube 0.3 to 0.4 mm. in diameter. The tissue is coarsely maculate.

Parallelopora ostiolata Bargatzky is characterized by the lack of mamelons, by the moderately large pillars with two to four rows of tubules, by the indistinct laminae between the latilaminae, and by the astrorhizal cylinders. *P. ostiolata* most closely resembles *P. campbelli* from our faunas, from which it is distinguished by the equal size of the pillars and galleries and greater regularity of the network of laminae and pillars in both vertical and tangential sections, and in having large, typical astrorhizae 10 mm. in diameter.

The above description is based on Bargatzky's description, Nicholson's figures and description, and on the description and excellent figures of the type published by Lecompte in his monograph on the Belgium stromatoporoids.

Occurrence.—Bargatzky's type refigured and described by Lecompte, is from the upper Middle Devonian at Büchel, Germany, and is in the Museum of Paleontology of the University of Bonn. We have a specimen from the Columbus limestone of Kelleys Island, Ohio, which seems to be this species. (Slides 305-77, 78).

A description and figures of the holotype of the type species are given to authenticate our understanding of the structure of *Parallelopora*.

Parallelopora campbelli Galloway and St. Jean, n. sp. Pl. 19, figs. 3a, b

Coenosteum hemispherical, 10 cm. or more in diameter. Surface smooth, without mamelons, tubercles or papillae. Astrorhizae small, atypical, up to 5 mm. in diameter and 4 to 8 mm. apart, with central tube surrounded by about five oval canals of similar size. Latilaminae are 2 to 4 mm. thick.

Vertical section.—Laminae thick, variable and discontinuous, averaging about 0.2 mm. thick, five or six in 2 mm., consisting of superposed maculae separated by dark rods, and with discontinuous microlaminae and curved plates 0.02 to 0.03 mm. thick. The pillars are continuous, 0.08 to 0.12 mm. in diameter, wider than the galleries, about 10 in 2 mm., joining others, especially in sections which are not exactly vertical; pillars composed of coarse, superposed maculae making tubules 0.02 to 0.03 mm. in diameter, two to four in each pillar, separated by vertical rods 0.02 mm. in diameter. Tissue coarsely maculate, the maculae 0.03 mm. in diameter, with large clear centers. The microlaminae and curved plates are not maculate, but composed of dusty particles in a clear groundmass. The galleries join to form long, vertical, pseudozooidal tubes, 0.06 to 0.09 mm. in diameter. There are some larger pillars, 0.5 mm. in diameter, best seen with 10× lens, which have maculae the same size as those in the general tissue. There are many round astrorhizal canals and some vertical, astrorhizal tubes, 0.25 mm. in diameter. Some of the astrorhizae are superposed in astrorhizal cylinders, but do not make mamelons.

Tangential section.—The pillars and galleries each occupy about half the area of the section, and have much the same size and shape. The pillars, about 0.1 mm. thick, join each other, making an irregular network; a few are isolated and amoeboid in shape, up to 0.2 mm. in diameter. Galleries are 0.08 to 0.1 mm. wide, and mostly vermicular and anastomosing, many round, 0.1 to 0.12 mm. in diameter. There are scattered astrorhizal canals 0.15 to 0.3 mm. in diameter, scarcely branching, and rarely making typical astrorhizae. The laminae and pillars are amalgamated, coarsely maculate, the maculae being light in color, 0.02 to 0.03 mm. in diameter, separated by dark, dusty looking material.

This species is characterized by the lack of mamelons, the long, narrow pillars, the anastomosing network of both pillars and galleries in tangential section, the small, atypical astrorhizae, and few microlaminae. It differs from *P. ostiolata* Bargatzky in the anastomosing network of both pillars and galleries, rather than having anastomosing pillars and round galleries and pseudozooidal tubes, and the astrorhizae are much smaller and without branching radial canals. This species is much like *Syringostroma densum,* also from Kelleys Island, but lacks the long, large pillars of more compact tissue of that species. It resembles *Parallelopora goldfussi* Bargatzky of Nicholson (1886, pl. 11, figs. 7-9; 1891, p. 191, pl. 25, figs. 4-9; woodcuts text figs. 22, 24, 25), which are not from Bargatzky's type, but it lacks the dissepiments of Bargatzky's type as figured by Lecompte (1952, pl. 57, fig. 3).

Occurrence.—Holotype from the Jeffersonville limestone, one mi. north of Kent, Ind., was collected by Mr. Guy Campbell, of Corydon, Ind. A specimen from the Columbus limestone, west of the North Side quarry, Kelleys Island, Ohio, collected by Dr. M. F. Marple, of Ohio State University, has large astrorhizae and seems to be *P. ostiolata* Bargatzky (305-77, 78).

Holotype.—Indiana University Paleontological Collections, slides 295-64; 303-64. Cat. No. 5383.

Parallelopora typicalis Galloway and St. Jean, n. sp. Pl. 19, figs. 4a, b

Coenosteum is represented by a fragment 5 cm. high and 9 cm. in diameter. Surface without mamelons. Astrorhizae absent or obscure. Latilaminae 2 to 3 mm. thick.

Vertical section.—Laminae regularly curved, not undulating, composed of from one to six, usually two, microlaminae surrounded by thickening tissue, with light-colored, coarse maculae and dark specks in vertical lines. Pillars continuous, 0.1 to 0.25 mm. in diameter, about seven in 2 mm., spool-shaped between microlaminae, continuous but cut by the microlaminae, composed of coarse maculae in vertical, parallel lines, making parallel tubules and dark specks in vertical lines, appearing as rods. Maculae light in color, large, 0.03 to 0.045 mm. in diameter, the dark specks and rods half as thick as the maculae. Laminae and pillars are amalgamated,, composed of the same kind of maculate tissue, not counting the microlaminae which are composed of a single line of light and dark specks similar in appearance to the dark rods in the pillars. Galleries round, oval or elongate horizontally, with ragged borders, many superposed and forming pseudozooidal tubes, 0.12 to 0.18 mm. in diameter, crossed usually by the microlaminae but not by sporadic tabulae. Dissepiments scarce, convex, in the galleries and pseudozooidal tubes. Astrorhizal canals, scarcely distinguishable from galleries, but larger, and without vertical astrorhizal tubes.

Tangential section.—The pillars are confluent, 0.13 to 0.2 mm. wide, forming a network surrounding the oval, roundish and partly confluent galleries and pseudozooidal tubes, which are 0.15 to 0.2 mm. in diameter. Galleries forming long, confluent patterns between laminae. The tissue of the pillars is a conspicuous network of large maculae, 0.03 to 0.038 mm. in diameter, separated by black dots, 0.01 to 0.015 mm. in diameter, which are connected by processes making a hexagonal network surrounding the maculae. Laminae and pillars amalgamated; microlaminae are rarely seen in the tangential section. Astrorhizae obscure, not forming stellate systems. Dissepiments are nearly absent.

This species is characterized by the large, continuous pillars which are spool-shaped between microlaminae in vertical section, and are confluent in tangential section, and the large superposed maculae, making parallel pores like those illustrated by Bargatzky for *P. goldfussi* (1881, p. 279, figs. 9, 10). It differs from *P. ostiolata* Bargatzky, in the coarser network of pillars and pseudozooidal tubes.

Occurrence.—One specimen was obtained from the Jeffersonville limestone, at the Falls of the Ohio, Jeffersonville, Indiana.

Holotype.—Indiana University Paleontological Collections, slides 295-7, 8. Cat. No. 5364.

Parallelopora pulchra Galloway and St. Jean, n. sp. Pl. 20, figs. 1a, b

Coenosteum headlike, 10 cm. or more in diameter. Surface without mamelons but with papillae 0.6 mm. in diameter. Astrorhizae doubtful. Latilaminae about 3 mm. thick.

Vertical section.—The skeleton is composed of thick laminae, five or six in 2 mm., and large, continuous pillars, three or four in 2 mm. The laminae are in turn composed of two to four thin microlaminae, with coarsely maculate tissue between and above and below; the maculae are superposed. The galleries are round, oval, or horizontally elongate, from 0.2 to 0.37 mm. high, and mostly superposed, making large, vertical tubes cut by single microlaminae, in places 1 or 2 mm. long without tabulae. The long pillars are spool-shaped between laminae, and cut by the microlaminae, which rise in many of the pillars, and are composed of coarse maculae in vertical files, making 6 to 12 parallel tubules separated by vertical, black rods. Some of the galleries have curved plates. The maculae are large for stromatoporoids, 0.06 mm. in diameter, and surrounded by dustlike tissue. The microlaminae are 0.02 to 0.03 mm. thick, and composed of dustlike particles.

Tangential section.—The pillars are amoeboid in shape, separate between laminae, 0.5 to 1 mm. in diameter, but joining and coalescing in the laminae, and forming 60 to 80 percent of the field. The clear maculae of the pillars makes a conspicuous network of round tubules, 0.05 to 0.07 mm. in diameter, separated by dark, dustlike tissue. The galleries are in part round and confluent between laminae. Dissepiments rare.

This species is characterized by the large, amoeboid pillars, coarse network of laminae and pillars, and large maculae which give the tissue a coarse appearance. The type specimen is completely silicified, yet all the structures are beautifully preserved.

Occurrence.—Rare in the Jeffersonville limestone, three miles south of Westport, Decatur Co., Ind. Collected by E. R. Cumings and J. P. Kerr.

Holotype.—Indiana University Paleontological Collections, slides 282-46, 47. Cat. No. 5384.

Parallelopora nodulata (Nicholson) Pl. 20, figs. 2a, b

Stromatopora nodulatum Nicholson, 1875, Paleont. Ohio, vol. 2, pt. 2, p. 249, pl. 24, figs. 3, 3a, 3b (Mid. Dev., Columbus Is., Kelleys Island, Ohio).
Syringostroma nodulatum Nicholson, 1891, Ann. Mag. Nat. Hist., ser. 6, vol. 7, p. 325, pl. 10, figs. 5-7.

Coenosteum massive, over 15 cm. in diameter and 10 cm. high. Surface with strong, regular mamelons, 8 to 10 mm. in diameter and 12 mm. apart from center to center; the summits are sharply rounded and each summit is occupied by an astrorhiza with small, radiating canals. Latilaminae are 2 to 3 mm. thick and well marked, so that the specimen breaks readily into layers.

Vertical section.—The skeleton is composed of thick, or thin and discontinuous laminae, six to eight in 2 mm., and more prominent and regular, continuous pillars, six or seven in 2 mm. and 0.14 to 0.2 mm. in diameter. The laminae and pillars are amalgamated and composed of the same kind of coarse, maculate tissue. The maculae are large, round, clear-colored, averaging 0.038 mm. in diameter, and separated by superposed, dark, dustlike specks, and arranged in vertical files in both pillars and thick laminae, making vertical tubules, and vertical rods. The galleries are round, 0.15 mm. in diameter, and in part horizontally confluent, and largely arranged in vertical files of varying sizes, making pseudozooidal tubes. The tabulae in the pseudozooidal tubes are in part convex upward. The microlaminae are composed of dark, dustlike particles. The laminae and microlaminae rise into the mamelons but not into the pillars.

Tangential section.—The pillars between laminae are roundish to amoeboid in shape, about 0.2 mm. in diameter, some with pointed projections joining other pillars, but largely coalescing, forming 50 to 60 percent of the field. Galleries round in the laminae and vermicular and anastomosing between laminae. The tissue of ordinary pillars and laminae is composed of coarse maculae, from 0.02 to 0.05 mm. in diameter, averaging 0.04 mm., separated by minute dark specks of varying size. The tissue in the mamelons is finer grained and more compact than that in the laminae and pillars. The mamelons have small astrorhizae, 2 mm. in diameter, with sparsely branching canals, 0.17 mm. in diameter. The canals do not have tabulae. The mamelons may have several small axial canals, but there is no large, axial tube.

The above description is drawn from an infiltrated and well-preserved topotype from the Columbus limestone of Kelleys Island, Ohio, and it fits perfectly Nicholson's 1891 description and figures. The species is characterized by the large, regular mamelons, strong pillars, and lacy tissue. It differs from *P. eumamillata* in the larger, more regular mamelons and in the more compact tissue in the mamelons. It is a typical *Parallelopora,* with the coarse maculae making vertical tubules and rods in the pillars, from which it differs from *Syringostroma*. It has no particular resemblance to *Actinostroma*. The pseudozooidal tubes, made of superposed galleries, are not characteristic of *Parallelopora*, for they occur as well formed in *Syringostroma, Stromatopora, Hermatostroma,* and *Trupetostroma*.

Occurrence.—Middle Devonian, Columbus limestone, Kelleys Island, Ohio.

Plesiotype.—Indiana University Paleontological Collections, slides 282-22, 23. Cat. No. 5407.

Parallelopora snoufferensis Galloway and St. Jean, n. sp. Pl. 20, figs. 3a, b

Coenosteum massive, discoid, more than 9 cm. thick and 15 cm. in diameter. Surface with regular mamelons, 6 to 8 mm. in diameter, 2 to 3 mm. high, and 8 to 15 mm. apart from center to center, and domal papillae about 0.4 mm. in diameter. Astrorhizae indistinct, 8 to 10 mm. in diameter, in the mamelon centers, with narrow, branching canals. Latilaminae 3 to 5 mm. thick. The holotype is well preserved but was embedded in the rock and the upper surface is not shown; the paratype exhibits the mamelons.

Vertical section.—Laminae prominent, 0.1 to 0.4 mm. thick, four to six in 2 mm., composed of two to six strong microlaminae which are covered and separated by tissue with large maculae, 0.03 to 0.04 mm. in diameter, and containing vacuoles 0.06 to 0.15 mm. in diameter, in part remnants of galleries, in part fused maculae. The laminae turn abruptly into long pillars and smoothly into the mamelons. Pillars long, 0.2 to 0.3 mm. broad, three to five in 2 mm., spool-shaped between laminae, composed of tissue with large maculae, about 0.038 mm. in diameter, arranged in three or four vertical tubules across the breadth of the pillar, and separated by dark, dusty appearing rods. The laminae and pillars thicken in the mamelons, become darker, merge and lose their identity (right end of fig. 3a). Galleries oval and elongate horizontally, 0.1 to 0.3 mm. high and up to 1 mm. broad at the base of a latilamina. The galleries are normally superposed but make few pseudozooidal tubes. Dissepiments rare to absent. Each mamelon column has several astrorhizal canals, but there is no single, large axial tube.

Tangential section.—The laminae and pillars are amalgamated, including the microlaminae, which can rarely be detected. The laminae and the maculae have been filled with secondary tissue, so that the maculae, while very coarse, about 0.04 mm. in diameter, do not have clear centers and are not conspicuous as those of *P. nodulata* and other species. They are round to polygonal and surrounded by a polygonal network of dark, dusty material. The pillars are roundish with irregular edges and coalescent in the laminae, 0.4 mm. in diameter, round and discrete between laminae, 0.2 to 0.3 mm. in diameter. Some of the maculae in the pillars are unusually large, obviously double, about 0.07 mm. in diameter. Tubes in the mamelons are small and multiple, 0.1 to 0.3 mm. in diameter. The galleries are small and round, indistinguishable from pseudozooidal tubes, to large and anastomosing. There are small, round vacuities in the laminae, 0.06 to 0.1 mm. in diameter, which are remnants of galleries nearly filled with secondary material. Astrorhizae with broad, branching canals, 0.2 to 0.3 mm. wide at the base, cut obliquely in the mamelons, and with the two or three annuli of thickened laminae, making a roseate rather than a stellate pattern (not shown in the figure).

Parallelopora snoufferensis is characterized by the large, domal mamelons, thick laminae, prominent microlaminae which turn up into the pillars, strong pillars, and few pseudozooidal tubes. It differs from *P. nodulata*, which has mamelons of much the same size, in the thicker laminae, thicker and fewer pillars, stronger microlaminae and the rarity of pseudozooidal tubes.

Occurrence.—The holotype is from the Middle Devonian, Columbus limestone at the Snouffer quarry on the east bank of the Scioto River, five miles northwest of Columbus, Ohio. The paratype, from the Columbus limestone at Delaware, Ohio, was borrowed from the Ohio State University Museum collection.

Holotype.—Indiana University Paleontological Collections, slides 282-29, 30, 31, 32, 34. Cat. No. 5408.

Paratype.—Slides 305-93, 94; Ohio State University Paleontological Collections, specimen 17146 and 2 slides.

Parallelopora eumamillata Galloway and St. Jean, n. sp.
Pl. 20, figs. 4a, b

Coenosteum massive, up to 6 cm. high and 17 cm. in diameter. The surface has regular mamelons 3 to 5 mm. in diameter, 1.5 to 2 mm. high, and 4 to 7 mm. apart from center to center. Astrorhizae are small, 2 mm. in diameter, in the mamelon centers, imperfectly developed, with branching canals. Latilaminae are 1 to 5 mm. thick.

Vertical section.—The laminae undulate regularly into the mamelon columns but not into the pillars, are variable in thickness, 0.02 to 0.19 mm. thick, five to seven in 2 mm., composed of one or more microlaminae which are composed of dusty tissue, and are mostly covered with coarsely maculate and vacuolate tissue. The laminae have large maculae in vertical lines and are pierced by a moderate number of pseudozooidal tubes, 0.10 to 0.15 mm. broad, with thin tabulae. The pillars are rather thick, 0.17 to 0.28 mm. broad, six to eight in 2 mm., straight, and about equal in size to the laminae. Both the pillars and laminae are thicker and more dense in the mamelons, and the maculae appear smaller. The laminar and pillar tissue has large, clear maculae, 0.03 to 0.04 mm. in diameter, making a lacy network. The maculae are superposed in the pillars and may coalesce to form two or three small tubules in each pillar. Some of the maculae, with their thick, dark walls, are over 0.1 mm. in diameter. The galleries are small to large, irregular, subrectangular, 0.14 to 0.30 mm. high, ½ to 3 times as broad. Several small mamelon tubes, 0.15 to 0.23 mm. broad, and commonly tabulate, are located in the centers of small astrorhizal cylinders. Dissepiments oblique, rare.

Tangential section.—The mamelons are well formed with several laminar annuli, radial pillars, and small astrorhizae. The pillars are in part round or stellate (not well shown in the figure), mostly coalescent, 0.2 to 0.3 mm. in diameter, separated by galleries half as wide. The section has a lacy appearance, due to the large, clear maculae and the vacuoles in the tissue. The dark material makes a hexagonal network around the maculae. Tubes in the mamelons are small, round to irregular in shape, 0.2 to 0.25 mm. in diameter. The galleries are curved and anastomosing around the pillars, 0.06 to 0.15 mm. wide. Pseudozooidal tubes are round but inconspicuous. Astrorhizae are composed of short, small canals which bifurcate no more than once; tabulae rare. Dissepiments nearly absent.

Parallelopora eumamillata is characterized by the closely spaced, small mamelons, thin laminae, strong pillars, and coarse maculae. It has much smaller and closer mamelons than *P. nodulata* and less compact tissue in the mamelons.

Occurrence.—Three specimens were collected for us by Mr. P. McGrain and Mr. F. H. Walker, from the Middle Devonian, Jeffersonville limestone, from the Jefferson County quarry, 1.2 miles northeast of the present boundary of Louisville, Kentucky, on Highway 42, and two specimens were collected by Mr. A. C. Brookley, Jr. from the Jeffersonville limestone from a quarry at Charlestown, Indiana.

Holotype.—Indiana University Paleontological Collections, slides 305-75, 76, from 1.2 miles northeast of Louisville, Ky. Cat. No. 5393.

Paratypes.—Slides 302-58, 59; 305-73, 74, 84, 85; 306-27.

Genus **HERMATOSTROMA** Nicholson, 1886

Type species (monotypic), *H. schlüteri* Nicholson, 1886, Palaeont. Soc., vol. 39, p. 105, pl. 3, figs. 1, 2 (Mid. Dev., Hebborn, Germany); Nicholson, 1892, Palaeont. Soc., vol. 46, p. 215, pl. 28, figs. 12, 13; Parks, 1907, Univ. Toronto Studies, Geol. Ser., No. 4, p. 34, pl. 4, figs. 1, 2; pl. 6, figs. 3, 4 (Mid. Silurian, Guelph dol., Elora, Ont.); Ripper, 1937, Roy. Soc. Victoria Proc., new series, vol. 50, p. 29; Lecompte, 1952, Inst. Roy. Sci. Nat. Belgique, Mém. 117, p. 247.

Coenosteum massive, tuberose or discoidal, composed of strong laminae and large, continuous pillars with darker or lighter and denser centers; the dark tissue may extend into the laminae. Pillars and laminae not originally hollow. Pillars in tangential section round and frequently coalescing and chainlike. Galleries superposed, but not usually making pseudozooidal tubes, some species with dissepiments. The margins of pillars and laminae are lighter in color and are coarsely vesiculate. Tissue coarsely maculate. Astrorhizae generally well developed.

Silurian, Canada; Middle Devonian, Europe, North America. Nine or more species.

This genus differs from *Syringostroma* in the light borders of the pillars. It is much like *Parallelopora*, but the light borders of the pillars and lack of tubules and rods in the pillars distinguish it. The laminae are stronger than in *Trupetostroma,* which lacks the light-colored layers on pillars and laminae, but does have vacuoles in the tissue. *Gerronostroma* lacks the light-colored layers on pillars. Coarse maculae are obvious in *H. logansportense* and obscure in *H. schlüteri.*

We give figures and a description of the type specimen of the type species to show the definite generic characters, and for convenience for comparison.

Hermatostroma schlüteri Nicholson Pl. 21, figs. 1a, b

Hermatostroma schlüteri Nicholson, 1886, Palaeont. Soc., vol. 39, p. 105, text figs. 1, 16; pl. 3, figs. 1, 2 (Mid. Dev., Hebborn, Germany); 1892, Palaeont. Soc., vol. 46, p. 215, text figs. 29-31; pl. 28, figs. 12, 13 (Mid. Dev., Hebborn, Germany); Lecompte, 1952, Inst. Roy. Sci. Nat. Belgique, Mém. 117, p. 247-251, pl. 45, figs. 1, 1a, b (Mid. Dev., Hebborn, Germany).

The following description is based on the original description and figures and on the description and figures of the holotype republished by Lecompte.

Coenosteum a small, massive fragment 2 cm. high and 7 cm. in diameter. The surface has mamelons 3 or 4 mm. in diameter, 1 mm. high and 5 to 7 mm. apart from center to center. Astrorhizae are lacking. Latilaminae are 3 to 11 mm. thick.

Vertical section.—The laminae are straight, smoothly curved into the mamelons, composed of a dark median lamina and an outer, light-colored, porous sheath. The dark, median layer is 0.02 to 0.10 mm. thick, the outer sheaths are 0.04 to 0.09 mm. thick, five or six laminae in 2 mm. Pillars are long and straight, continuous through many laminae into which they flare, 0.1 to 0.3 mm. broad, four to five in 2 mm., composed of a dark central core, 0.05 to 0.22 mm. broad, and an outer sheath, 0.04 to 0.09 mm.

thick. The galleries are square to rectangular, 0.15 to 0.30 mm. high by 2/3 to 3 times as broad. Commonly there are 3 to 12 galleries superposed vertically, of which there are three to six rows in 2 mm. The laminar and pillar tissues are obscurely but coarsely maculate. Dissepiments rare.

Tangential section.—The pillars are round, 0.15 to 0.36 mm. in diameter, about 0.3 mm. apart, many confluent, forming chains, composed of a dark core, 0.10 to 0.24 mm. in diameter, and an outer sheath 0.03 to 0.06 mm. thick, which is divided radially by partitions. We do not agree with Nicholson (1892, p. 216) that the pillars and laminae are traversed by canals, nor does Lecompte agree (1952, p. 250). Astrorhizae are apparently absent.

Hermatostroma schlüteri Nicholson is characterized by the low mamelons, the lack of astrorhizae, the equally spaced laminae and pillars in a rectangular, trellis pattern, and by the thick prominent light-colored sheaths on the pillars and laminae. *H. schlüteri* differs from *H. logansportense,* from our fauna, in having more prominent laminae.

Occurrence.—The species has been described only from the Middle Devonian, in the Paffrath District at Hebborn, Germany, where, according to Nicholson, it is rare. The species has never been reported from North America.

Hermatostroma logansportense Galloway and St. Jean, n. sp.
Pl. 21, figs. 2a, b

Coenosteum massive, flat; a fragment is 16 cm. long, 10 cm. wide and 8 cm. thick. It is made up of thick, regular latilaminae, about 4 mm. thick, slightly undulating but not bending up into mamelons, grown smoothly together, the junctions indicated by finer texture and lighter color. The surface is in general smooth, but covered with round papillae, the upper ends of pillars. There are small astrorhizae, not superposed, about 6 to 8 mm. in diameter and 6 to 10 mm. apart, without vertical tubes, with delicate, branching canals.

Vertical section.—The laminae are thick, coarsely maculate or vesicular, and under low power of the hand lens appear to be at the same levels and continuous; under the microscope, the laminae extend only part way from pillar to pillar, and rise, depress and undulate and are not conspicuously at the same level on the two sides of a pillar. The laminae have no denser, inner part, as do the pillars. The laminae merge into the coarsely maculate sheaths of the pillars, and average about six in 2 mm. The galleries are roundish, oval and lobed, rather than rectangular, and in many places are superposed, but do not form typical pseudozooidal tubes. Dissepiments are absent. The pillars are more prominent than the laminae. They are long, nearly straight, extending continuously through several latilaminae; about 4 occur in a horizontal distance of 2 mm. They are about 0.3 mm. in diameter and separated from each other by about 0.2 mm. They consist of light-colored, coarsely maculate tissue outside, surrounded by a thin dark sheath, with more dense tissue toward the center. The pillars are built up of sheaths, which converge sharply in an upward direction, much as illustrated by Nicholson (1886, pl. 5, fig. 13) for *"Stromatopora" beuthii.* The pillars have no lumina, although there is light-colored tissue in the centers of many pillars. There are no rods in the pillars, but the large, light maculae are superposed in the outer sheath.

Tangential section.—The pillars are round, 0.3 to 0.4 mm. in diameter, consist of an outer thin, dark sheath, a ring of coarsely maculate, light-colored tissue and a central denser part, 0.16 to 0.24 mm. in diameter. There is no lumen. The pillars are connected by thick, coarsely maculate and vesicular processes of the laminae, making chainlike groups, leaving vermicular and anastomosing galleries. The long, branching, astrorhizal canals are slightly larger than the galleries, and without tabulae. The tissue is coarsely maculate, excepting for the inside column of the pillars in which the tissue is compact and dusty.

This species has pillars similar to those of *"Stromatopora" beuthii* Bargatzky, as figured by Nicholson (1886, pl. 5), which species is better placed in the genus *Hermatostroma,* as has been done by Lecompte (1952, p. 253). Our form differs markedly in the less continuous laminae.

Occurrence.—Common in the ledge of blue limestone just above the Upper Silurian, Kokomo tan dolomite, in the lower part of the Middle Devonian, Logansport limestone, in the quarry of the France Lime and Stone Company, five miles east of Logansport, Indiana. The preservation is by infiltration of calcite, without altering in any observable way the original coarse or fine structure, and is so nearly perfect as to leave little to be desired in clarity of structures.

Holotype.—Indiana University Paleontological Collections, slides 278-18, 19; 279-2, 3. Cat. No. 5339.

Paratype.—Slides 285-30.

Genus **CLATHROCOILONA** Yavorsky, 1931

Type species (monotypic), *Clathrocoilona abeona* Yavorsky, 1931, Bull. United Geol. Prosp. Service, U. S. S. R., vol. 50, pt. 94, p. 1407, pl. 1, figs. 9-11; pl. 2, figs. 1,2, 2a (Mid. Dev., S. W. border Kuznetsk Basin, Russia).

Stromatoporella (part) Lecompte, 1951, Inst. Roy. Sci. Nat. Belgique, Mém. 116, p. 152.

Coenosteum lamellar to massive. Laminae thick, tripartite, with clear median line. Pillars mostly confined to one interlaminar space, spool-shaped in vertical section and incidentally or sporadically superposed, oval in cross section but not hollow rings. Galleries round or oval, scarcely higher than the laminae are thick, with thin dissepiments, and additional larger, round or elongate oval cavities with tabulae, the astrorhizal tubes. Yavorsky says, "tissue fibers compact," but Yavorsky's tangential section shows maculae or pores. Surface with mamelons and astrorhizae.

Middle Devonian, Kuznetsk Basin, Russia, Belgium and Indiana. Thirteen species.

If the tissue were solid, this genus would belong in the Actinostromatidae near *Trupetostroma*. The large cavities (astrorhizal tubes), which Yavorsky and distinguished *Clathrocoilona* from *Clathrodictyon* occur in many genera, especially in *Trupetostroma* (Lecompte, 1951, pls. 26-44), and even in forms assigned to *Clathrodictyon* (Lecompte, 1951, pl. 18), also in forms assigned to *Stromatoporella* and *Syringostroma* (Lecompte, 1951, pls. 21-34). The triple laminae with median light zone is an important feature; it occurs in the type species of *Trupetostroma*, and in *Stromatoporella, Syringostroma,* and *Stictostroma.* A recently figured form most close to *Clathrocoilona* is *Stromatoporella saginata* Lecompte (1951, pl. 22, fig. 6a) which has, "Une vague structure alvéolaire" (p. 173).

KEY TO SOME DEVONIAN SPECIES OF CLATHROCOILONA

1a. Laminae not transversely fibrous
  2a. Galleries as thick as the laminae
    3a. Dissepiments rare ....*C. abeona* Yavorsky
    3b. Dissepiments abundant ....*C. subclathrata,* n. sp.
  2b. Galleries narrower than the laminae ....*C. restricta,* n. sp.
1b. Laminae coarsely, transversely fibrous ....*C. fibrosa,* n. sp.

Clathrocoilona abeona Yavorsky   Pl. 21, figs. 3a, b; Pl. 23, figs. 1a, b

Clathrocoilona abeona Yavorsky, 1931, Bull. United Geol. Prosp. Serv., U. S. S. R., vol. 50, pt. 94, p. 1407, pl. 1, figs. 9-11; pl. 2, figs. 1, 2, 2a (Mid. Dev., Kuznetsk Basin, Russia).

Coenosteum a large head, up to 9 cm. in height and 14 cm. in diameter. The surface has small mamelons, 4 mm. in diameter, 2 mm. high and 3 to 5 mm. apart from center to center; the mamelons make continuous columns, but are sporadically developed, and may not show in vertical sections. Astrorhizae are not apparent at the surface, although the small, branching, root-like canals are obvious in tangential sections. Latilaminae are obscure, 3 to 4 mm. thick.

Vertical section.—The laminae are tripartite, thick, averaging about 0.2 mm., and five or six in 2 mm. They consist of a median, thin, clear layer, and on both sides a layer about three times as thick, with coarse, granular and coarsely maculate texture. The maculae are large but flocculent, about 0.03 mm. in diameter. In places there are short, clear vertical fibers in the laminae, but fewer and shorter than in *C. fibrosa.* The galleries are ovoid, elongate where the section does not cut pillars, and average about 0.15 mm. high. The transected astrorhizal canals are larger than the galleries, and are not definitely superposed, and are in part tabulate. Superposed galleries in places have foramina between. Dissepiments are rare. Pillars are short, thick, spool-shaped, and merge without change into the upper and lower layers of the laminae. There are about six pillars in 2 mm. The pillars are of the same composition as are the upper and lower thick layers of the laminae, and are coarsely but sporadically maculate. Some pillars have a central clear nonmaculate, irregular center, but the pillars are not continuous and are only incidentally superposed. Mamelons are sporadic and rarely appear in small vertical sections.

Tangential section.—The tissue of the thick laminae occupies most of the field; it is coarsely and irregularly maculate, and the thin, median line can scarcely be detected, nor can pillars be distinguished, for the laminae and pillars are amalgamated. Where the section cuts the galleries the pillars are oval to elongate, and the galleries are vermicular and anastomosing. Astrorhizae are conspicuous, but have no central tube, are not superposed, so that a section shows a maze of small, branching canals. Dissepiments are practically absent, although the type figure (Pl. 23, fig. 1) shows some dissepiments.

The Indiana form is close to the type species of the genus, *C. abeona* Yavorsky, from the Middle Devonian of Russia, but differs from Yavorsky's first figure (1931, pl. 1, fig. 10) in lacking the lines of superposed pillars; it is nearly identical with his figure 11, plate 1, from a nearby locality, which shows no superposed pillars. It has fewer superposed pillars and especially fewer dissepiments than *C. subclathrata.* It differs from the abundant *C. fibrosa* in lacking the long and abundant transverse fibers in the laminae, but is otherwise quite similar. The tissue is neither compact nor uniform, as it is in *Anostylostroma,* nor is it uniformly maculate, as in *Stromatopora.* The tripartite structure of the laminae is much like that of *Stictostroma,* differing mainly in having much thicker upper and lower layers of the laminae, and in being maculate.

Occurrence.—The figured specimen (Pl. 21, figs. 3a, b) is from the lower part of the Logansport limestone, at the old Upper Dam on Eel River, six miles northeast of Logansport, Indiana. It should also occur at the same horizon in the quarry five miles east of Logansport, and at Pipe Creek Falls, 10 miles southeast of Logansport.

Plesiotype.—Indiana University Paleontological Collections, slides 285-14, 15, 16, 17, 31. Cat. No. 5385.

Clathrocoilona subclathrata Galloway and St. Jean, n. sp.
Pl. 21, figs. 4a, b

Coenosteum massive, 12 cm. high and 15 cm. in diameter. Surface with low mamelons, 4 mm. in diameter, 1 mm. high, and 5 or 6 mm. apart from center to center. Small astrorhizae are indicated by thin irregular, branching grooves. Latilaminae are 3 to 5 mm. thick.

Vertical section.—The laminae turn gently or abruptly into the mamelon columns; the laminae are thick, 0.15 to 0.2 mm., five or six in 2 mm., tripartite, with thin, clear, variable median layer, 0.06 mm. thick, and an inner and an outer layer twice as thick, dark gray in color and granular and flocculent, and in places is coarsely but obscurely maculate. Some of the maculae are minute, round, with white centers. The pillars are short, spool-shaped, composed of gray, granular, flocculent and maculate tissue, continuous with the outer and inner layers of the laminae, 0.1 to 0.15 mm. broad, two to six in 2 mm. Many of the pillars are superposed, but do not pass through the median layer of the laminae, making an imperfect network. The galleries are oval to broad, some with foramina through the laminae, and dissepiments are sporadic. Tabulae are broad or oblique, thin, abundant in the astrorhizal tubes and canals. The mamelon columns contain single or several astrorhizal tubes, and astrorhizal canals 0.2 to 0.4 mm. in diameter, and occur in many places in the section.

Tangential section.—The skeletal tissue represents about 80 percent of the thin section. Laminae and pillars are fused. Between laminae the pillars are round to oval, but not hollow, 0.12 mm. in diameter, coalescent or up to 0.13 mm. apart. The texture of the pillars is finer than that of the laminae. Astrorhizal canals are abundant, 0.14 to 0.3 mm. in diameter, but astrorhizae are not well formed and the vertical astrorhizal tubes are rare. Tabulae are rare in a section from the same specimen as the vertical section. The galleries anastomose around the pillars.

Clathrocoilona subclathrata is characterized by the thick laminae, irregularly spaced, superposed pillars, astrorhizal columns and tubes and common tabulae and dissepiments. The maculae are smaller and more scattered than those in *Parallelopora,* and do not make a lacy network. The tissue and maculae are much like those of the *Stromatopora pachytexta* group of species. It differs from *C. abeona* Yavorsky in the abundant tabulae in the astrorhizal canals, and more numerous dissepiments in the galleries and smaller pillars; from *C. fibrosa* in rarely having transverse fibers in the laminae, but having superposed pillars and abundant dissepiments; from *C. restricta* in the thinner laminae, larger galleries, tabulae and dissepiments and lines of superposed pillars. This species resembles *Gerronostroma* in the superposed pillars, but the laminar structure and maculate tissue allies the form with *Clathrocoilona.*

Occurrence.—Two specimens were collected from the lower 10 feet of the Middle Devonian, Logansport limestone at the France Lime and Stone Company quarry, five miles east of Logansport, Indiana.

Holotype.—Indiana University Paleontological Collections, slides 304-7, 8. Cat. No. 5340.

Paratype.—Slides 304-9, 10.

Clathrocoilona restricta Galloway and St. Jean, n. sp. Pl. 22, figs. 1, 2

Coenosteum laminar to massive, up to 4 cm. high and 24 cm. in diameter. The surface has small, irregular mamelons 3 or 4 mm. in diameter, about 1 mm. high, 8 to 10 mm. apart from center to center, which are often difficult to distinguish. Astrorhizae with small, simple radial canals, distinguishable in the mamelon centers on a wetted surface. Latilaminae 3 to 5 mm. thick.

Vertical section.—The laminae are straight or undulating, turning smoothly into low, conical mamelons; they are thick, 0.2 to 0.3 mm., four to five in 2 mm., and tripartite, composed of thin, light-colored median but discontinuous laminae averaging

0.03 mm. thick, and upper and lower laminae, 0.06 and 0.09 mm. thick. The pillars are 0.15 mm. broad, three to five in 2 mm., thick and spool-shaped, tending to be superposed and coalescent. In some places, the pillars and laminae are abnormally thin. The tissue of upper and lower layers of the laminae and the pillars are continuous, and composed of dark, gray flocculent, maculate and speckled tissue with minute flecks of dark material, not well shown in the section which is too thick, and better shown in the tangential section. The maculae are large, spherical, 0.023 mm. in diameter. Galleries 0.17 mm. high, vary greatly in size, are restricted by the thick laminae and pillars, and are slightly oval to considerably elongate in a horizontal direction, many surrounded by a thin, dark rim. Vertical, astrorhizal tubes, 0.16 mm. wide, are rare, sporadic, short, and irregular, with tabulae. Dissepiments are sporadic, thin, short.

Tangential section.—The tissue occupies about 90 percent of the section. The pillars are round, 0.15 mm. in diameter between laminae, and coalesce with each other and with the thick laminar tissue. The galleries are irregular, anastomosing and branching, one-half as wide to as wide as the pillars; dissepiments rare. The astrorhizae, 4 mm. in diameter, are composed of thin, branching radial canals, 0.16 mm. wide at the base, with rare tabulae. The tissue is flocculent and maculate, not lacy in appearance, with most of the maculae filled by secondary tissue.

Clathrocoilona restricta is characterized by the sporadic occurrence of small, conical mamelons, by the thick laminae, restricted galleries, suggesting its name, and by the minutely flecked tissue with obscure maculae. It differs from *C. abeona* in the thicker laminae and smaller galleries; it might be considered only a variety or an extreme phase of that species. It lacks the transverse fibers so conspicuous in *C. fibrosa.* The laminae are thicker than in *C. subclathrata,* the pillars less definitely superposed. The restriction of the galleries by additions of tissue to the laminae suggests *Stromatopora,* such as *S. dubia,* but the tripartite laminae and lack of pseudozooidal tubes removes it to *Clathrocoilona.*

Occurrence.—Four specimens were collected from the Middle Devonian, lower Logansport limestone at the France Lime and

Stone Company quarry, five miles east of Logansport, Indiana, and one specimen was collected by Dr. T. G. Perry and Mr. Paul Raymond at the May Sand and Gravel Corporation quarry, two miles southwest of Fort Wayne, Indiana. The holotype is encrusted on *Syringostroma perdensum,* n. sp.

Holotype.—Indiana University Paleontological Collections, slides 285-96; 303-39, 40, 41, 42. Cat. No. 5341.

Paratypes.—Slides 294-15; 296-6, 7; 299-24; 304-18, 19, 40, 42. Cat. No. 5342.

Clathrocoilona fibrosa Galloway and St. Jean, n. sp. Pl. 22, figs. 3a, b

Coenosteum massive, in heads of low to high domes, up to 10 cm. high and 14 cm. in diameter. Surface with mamelons, 4 to 6 mm. in diameter, 1 to 2 mm. high, and 8 to 10 mm. from center to center. Astrorhizae are in the mamelon centers, 8 to 10 mm. in diameter, with many small, long, radial canals, which join canals of adjacent astrorhizae. Latilaminae are 2 to 6 mm. thick.

Vertical section.—The laminae, four in 2 mm., average 0.22 mm. in thickness, are tripartite, composed of a thin, variable, clear, median layer, 0.04 to 0.06 mm. thick, and thick, upper and lower layers, 0.06 to 0.09 mm. thick. The tissue of the upper and lower layers of the laminae has large, spheroidal to flocculent maculae, 0.032 mm. in average diameter. The maculae tend to be arranged in nearly vertical rows, with light-colored, homogeneous, vertical fibers between. The fibers are abundant, 0.03 to 0.05 mm. thick, have no walls, pass through all three layers of the laminae, some even pass through the galleries; they are irregular in width, length, and direction. The fibers are considered to be original structures, for the specimens are perfectly preserved by infiltration of calcite, not weathered, and they occur in many specimens, in over 30 thin sections. A few fibers occur in other species of *Clathrocoilona,* but the fibers are the most conspicuous feature of the tissue in *C. fibrosa.* The pillars are short, thick, 0.1 to 0.2 mm., and spool-shaped, from two to five in 2 mm., more irregular and thicker in the mamelons, only incidentally superposed. The tissue of the pillars is confluent with that of the upper and lower layers of the laminae and of the same structure, some with vertical fibers. The galleries are round to oval, and elongate horizontally, are variable in size, 0.3 to 1 mm. broad, 0.24 mm. high; dissepiments are rare. Some astrorhizal canals have a few tabulae. In vertical section it is difficult to distinguish galleries and astrorhizal canals. The mamelons do not make continuous columns but ordinarily extend through only one latilamina (not shown in the figure). Pseudozooidal tubes are not developed.

Tangential section.—The maculate tissue occupies from 60 to 90 percent of the section, and the laminae and pillars are amalgamated, and pillars are difficult to distinguish. The maculae are round with white centers and dark borders (upper right quadrant of the figure); the fibers are light, irregular in shape, 0.02 to 0.03 mm. thick, in places joining and making a mosaic with the maculate tissue, or the fibers make a scrawly pattern as seen in the upper left quadrant of Plate 22, figure 3b. The galleries are irregular, anastomosing in some places, smaller than the astrorhizal canals. The astrorhizae are 8 to 10 mm. in diameter, composed of many thin branching, radial canals. Tabulae in the canals are rare.

Clathrocoilona fibrosa is characterized by the low mamelons, thick laminae and pillars, the transverse fibers, and coarsely maculate tissue. It differs from *C. abeona* and *C. restricta* in having transverse fibers. *C. fibrosa* is frequently attached to other stromatoporoids. Some workers may consider the fibers to be pores.

Occurrence.—Nine specimens are from the Middle Devonian, Lower Logansport limestone, at the France Lime and Stone Company quarry, five miles east of Logansport, Indiana. Three specimens, the holotype and two paratypes are from the same horizon at Pipe Creek Falls, 10 miles southeast of Logansport, Indiana.

Holotype.—Indiana University Paleontological Collections, slides 295-89, 90, 91. Cat. No. 5359.

Paratypes.—Slides 279-5, 6; 285-92, 93; 294-10, 11, 16, 17; 295-77, 78, 99, 100; 303-28, 29, 86, 87; 304-11, 22, 25, 26, 34, 35, 38, 39, 51, 52, 81, 82, 83, 84, 98, 99; 305-7, 8.

Genus **ACTINODICTYON** Parks, 1909

Type species (first species, selected by Bassler, 1915), *A. canadense* Parks, 1909, Univ. Toronto Studies, Geol. Ser., No. 6, p. 30, pl. 20, figs. 1, 2 (Sil., Southampton Island, Canada); Kühn, 1928, Fossilium Catalogus, vol. 1 *pars* 36, p. 25; 1939, in Schindewolf, Handbuch Paläozoologie, Bd. 2A, p. A43, fig. 59; Parks, 1936, Univ. Toronto Studies, Geol. Ser., No. 39, p. 113, pl. 8, figs. 1-7; Lecompte, 1951, Inst. Roy. Sci. Nat. Belgique, Mém. 116, p. 149.

Coenosteum cylindrical to massive, latilaminate. Laminae sporadically developed, dissepiments dominant, pillars short and long and sporadically developed. In tangential section the pillars are round to irregular, both solid and maculate, in part open rings, joined by dissepiments but not by radiating processes. Tissue obscurely maculate. Astrorhizae generally absent.

Silurian, Canada, four species; Devonian, Ohio, Canada and Indiana, one species, one undescribed.

The great predominance of dissepiments and short and long pillars are characteristic. We have studied the type specimens and sections of all of Parks' species; the tissue is plainly maculate, and the laminae are subordinate to dissepiments in the Silurian species and in some Devonian species.

We include the original figures and a description of the type species to show the diagnostic characters of the genus.

Actinodictyon canadense Parks Pl. 22, figs. 4a, b

Actinodictyon canadense Parks, 1909, Univ. Toronto Studies, Geol. Ser., No. 6, p. 32, pl. 20, figs. 1, 2 (Sil., Hudson Bay).

The following description is based on Parks' original description and figures and on the type specimen and slides in the paleontological collections of the Royal Ontario Museum.

Coenosteum cylindrical, encrusting about a coral or with an axial tube; the fragment was 6 or 7 cm. in diameter.

Vertical section.—The skeleton is composed of irregular cyst plates, inflected upward and downward into short pillars, rather than of definite laminae, and of large, long, straight pillars which extend through three to six plates. The tissue of the long pillars is obscurely maculate. The galleries are irregular, 0.2 to 0.8 mm. high and ½ to 2 times as broad.

Tangential section.—Some of the long and short pillars are round, but most are irregular and confluent and are obscured by the irregular, connecting cyst plates. There are also rings 0.2 to 0.3 mm. in diameter. The galleries are irregular and confluent. Astrorhizae are absent.

Occurrence.—Parks' specimen was collected from the Silurian on Southampton Island in Hudson Bay, Ontario.

Actinodictyon vagans Parks Pl. 22, figs. 5a, b

Actinodictyon vagans Parks, 1936, Univ. Toronto Studies, Geol. Ser., No. 39, p. 113, pl. 18, figs. 1, 2 (not figs. 3-7) (Mid. Dev., Columbus ls., Kelleys Island, Ohio).

Coenosteum massive, a fragment is 3 cm. high and 6 cm. in diameter. Based on vertical, polished sections, it has mamelons 10 mm. in diameter, 4 mm. high and 10 to 15 mm. apart from center to center. No astrorhizae were observed. Latilaminae are about 2 mm. thick.

Vertical section.—The laminae are thin, 0.04 mm. thick, five or six in 2 mm., turning gently into mamelon columns. The laminae are continuous, with occasional foramina between superposed chambers. The laminar tissue is flocculent and obscurely maculate, and some laminae are tripartite, with a thin, median layer. The laminar tissue is transversely fibrous and porous in places. The pillars are thin, straight, irregularly spaced, some flaring upward, sporadically superposed. In the mamelons the pillars are not much thickened and are slightly divergent. The tissue of the pillars has fine maculae in obscure, vertical lines, but the pillars are small and the lines of maculae are not so definitely developed as in *Parallelopora* and do not show well in the figure because of imperfect preservation. The mamelons do not make definite columns. The galleries are rectangular, about 0.3 mm. high, varying greatly in breadth. Dissepiments are abundant, highly arched and variable in size, and some are small, hollow spheres, much larger than maculae.

Tangential section.—The skeletal tissue represents about 40 percent of the area of the field. The pillars are round, 0.1 mm. in diameter, and many are joined by dissepiments. The tissue of the pillars is finely but definitely maculate, and, as shown, in favorable places, the laminae are also definitely but sporadically maculate. In some places, especially near the laminae, there are common, small, spherical dissepiments.

Actinodictyon vagans Parks is characterized by the large mamelons, thin laminae, superposed pillars, and by the great abundance of dissepiments.

We were fortunate in being able to study Parks' syntypes of *Actinodictyon vagans,* as well as the Silurian type species of *Actinodictyon, A. canadense* Parks, in the collections of the Royal Ontario Museum in Toronto, Ontario. The type of *Actinodictyon* has a cylindrical coenosteum, maculate tissue, short and long pillars, irregularly shaped cysts, and lacks definite laminae. *A. vagans* has more definite laminae and the coenosteum is massive, but on the whole it fits the genus well. We here select as lectotype of *A. vagans* Parks, the specimen mentioned by Parks as being the most typical, specimen No. 1572 Cn (Parks, 1936, p. 114, pl. 18, figs. 1, 2). The maculae in the Devonian species are scattered, not evenly maculate as in *Stromatopora* and *Syringostroma.* This species has much resemblance to the genus *Anostylostroma.*

Occurrence.—Parks' lectotype is from the Middle Devonian, Columbus limestone of Kelleys Island, Ohio. Our figured specimen is from the Middle Devonian, Jeffersonville limestone, at Pendleton, Indiana, and is somewhat leached. A well-preserved specimen, with thicker laminae and stronger pillars and more obvious maculae, is from the Middle Devonian, Jeffersonville limestone at the Meshberger Stone Company quarry, Bartholomew County, Indiana; it may be a different species. (306-13, 14.)

Plesiotype.—Indiana University Paleontological Collections, slides 305-17, 18, 46, 47. Cat. No. 5386.

Family **IDIOSTROMATIDAE** Nicholson, 1886

Family Idiostromidae Nicholson, 1886, Palaeont. Soc., vol. 39, p. 74, 98.
Family Idiostromatidae Kühn, 1939, in Schindewolf, Handbuch Paläozoologie, Bd. 2A, p. A52.

Coenosteum cylindrical, dendroid or fasciculate, the erect branches usually with axial tube, which may give off branches, the superposed galleries or pseudozooidal tubes. Skeleton composed of thick laminae and irregular pillars, mostly short. Skeletal tissue transversely fibrous or porous, not maculate. Astrorhizae absent.

Silurian, Devonian, common; Carboniferous doubtful.

KEY TO GENERA OF IDIOSTROMATIDAE

1a. Coenosteum without axial tube .... CLAVIDICTYON
1b. Coenosteum with axial tube, irregularly developed
  2a. Without large marginal vesicles
    3a. Tissue not tubulate
      4a. Pillars continuous or regularly superposed ...IDIOSTROMA
      4b. Pillars confined to one interlaminar space .... DENDROSTROMA
    3b. Tissue finely tubulate; galleries largely filled ...STACHYODES
  2b. With large, marginal vesicles .... AMPHIPORA

Genus **AMPHIPORA** Schulz, 1883

Type species (monotypic), *Caunopora ramosa* Phillips, 1841, Paleozoic Foss. Cornwall, p. 19, pl. 8, fig. 22 (Mid. Dev., South Devon, England).
Amphipora Schulz, 1883, Jahrg. Königl. Preuss. geol. Landesanstalt Berg-akad, for 1882, p. 245, pl. 22, figs. 5, 6; pl. 23, fig. 1; Nicholson, 1886, Palaeont. Soc., vol. 39, p. 109, pl. 9, figs. 1-4; 1892, vol. 46, p. 223, pl. 29, figs. 3-7; Felix, 1905, Sitzungsber. Naturforsch. Gesell. Leipzig, for 1903-1904, vols. 30, 31, p. 73-75, 2 figs.; Yabe and Sugiyama, 1933, Japanese Jour. Geol. Geog., vol. 11, p. 19; Ripper, 1937, Jour. Roy. Soc. Western Australia, vol. 23, p. 37; Kühn, 1939, in Schindewolf, Handbuch, Paläozoologie, Bd. 2A, p. A54; Sugiyama, 1942, Jour. Geol. Soc. Japan, vol. 49, p. 112; Lecompte, 1951, Inst. Roy. Sci. Nat. Belgique, Mém. 117, p. 321.

Coenosteum consisting of slender, cylindrical, vermicular stems, which may branch at long intervals, with a variable axial tube, and large vesicles near the surface. Both tube and vesicles may have irregular, curved tabulae. Skeleton composed of obscure, thick, laminae and pillars, and anastomosing galleries. Tissue compact, transversely fibrous, with darker median line in the triple walls. Surface tuberculate around the apertures. Astrorhizae absent.

Silurian, Russia; Middle Devonian, England, Belgium, France, Germany, Moravia, Poland, Estonia, Russia, Italy, Yunnan, Turkestan, China, Australia, Indiana, Montana, California, Alberta, and elsewhere in western North America. ?Carboniferous, Urals; Permian, China, Japan. About 10 species, several of which may be synonymous.

Amphipora resembles a tabulate coral, such as *Cladopora* (*Coenites*). Öpik (1935, Ann. Natur. Soc. Tartu University, No. 41, p. 3) considered *Amphipora* to be a calcareous sponge, but the lack of spicules, and lack of corallites and septa, ally the genus with the stromatoporoids. It is one of the most widespread forms of stromatoporoid, and one of the best index stromatoporoids of the Middle Devonian. It also occurs in the Frasnian, lower Upper Devonian, of Belgium, and the Montana horizon may be Upper Devonian.

Amphipora ramosa (Phillips) Pl. 23, figs. 2-6

Caunopora ramosa Phillips, 1841, Figures and descriptions of the Palaeozoic fossils of Cornwall, Devon and West Somerset, p. 19, pl. 8, figs. 22a-c Mid. Dev., England).

Stromatopora (*Caunopora*) *ramosa* McCoy, 1851, A Systematic Description of the British Palaeozoic Fossils in the Geological Museum of the University of Cambridge, vol. 1, p. 67.

Amphipora ramosa Schulz, 1883, Jahrg. Königl. Preuss. geol. Landesanstalt Bergakad., Abhandl., for 1882, p. 245, pl. 22, figs. 5-7; pl. 23, fig. 1 (Mid. Dev., Germany); Nicholson, 1886, Palaeont. Soc., vol. 39, p. 109, pl. 9, figs. 1-4 (Mid. Dev., Germany); 1892, Palaeont. Soc., vol. 46, p. 223, pl. 29, figs. 3-7 (Mid. Dev., England); Gürich, 1896, Verh. Russ. Kais. Mineralog. Gesell., vol. 32, p. 129, pl. 1, fig. 5; Felix, 1905, Sitzungsber. Naturf. Gesell., vols. 30, 31, p. 74, text figs. 1-3; Vinassa de Regny, 1910, Boll. R. Com. Geol. Italia, vol. 41, p. 48, pl. 1, figs. 9, 10; Heinrich, 1914, Inaugural Dissertation, Friedrich-Wilhelms Universistät, Bonn. p. 46; Vinassa de Regny, 1918, Palaeont. Italica, vol. 24, p. 109, pl. 9 (4), figs. 14, 15. (Mid. Dev., Italy); Riabinin, 1931, Bull. Geol. Prosp. Serv. U. S. S. R., vol. 31, p. 508, pl. 1, figs. 11-13 (Mid. Dev., Russia); Le Maître, 1934, Soc. Géol. Nord, Mém. vol. 12, p. 202, pl. 17, figs. 2-4 (Mid. Dev., France); Öpik, 1935, Ann. Nat. Soc. Tartu Univ., Pub. Geol. Inst. No. 41, p. 3, text fig. 1, pls. 1, 2 (Mid. Dev., Estonia); Le Maître, 1937, Bull. Soc. Géol. France, ser. 5, vol. 7, p. 121, pl. 8, figs. 4, 5; pl. 9, fig. 6 (Mid. Dev., France); Ripper, 1937, Roy. Soc. Western Australia Jour., vol. 23, p. 38, text figs. 1-3, pl. 1 (Mid. Dev., Western Australia); Schäfer, 1938, Austria Geol. Bundesanst. Verh. Nos. 3, 4, p. 114, text figs.; Kühn, 1939, in Schindewolf, Handbuch Paläozoologie, Bd. 2A, p. A54, text fig. 85; Sugiyama, 1942, Geol. Soc. Japan Jour., vol. 49, No. 587, p. 112, pls. 4(3), 5(4); Lecompte, 1952, Inst. Roy. Sci. Nat. Belgique, Mém. 117, p. 325, pl. 67, fig. 3; pl. 68, figs. 1-7 (Mid. Dev., Belgium); Yavorsky, 1955, Stromatoporoidea Sovetskogo Soyuza, p. 152, pl. 82, figs. 1-6.

Coenosteum small, mostly about 2 mm. in diameter, varying from 1 to 4 mm., vermicular, rarely branching, usually with an axial tube, commonly making thick calcareous beds, and lying nearly horizontally. The surface has small, anastomosing grooves; there are no astrorhizae. Many specimens have a smooth surface due to weathering or a covering film of calcium carbonate.

Cross section.—The center usually has a round, axial canal, 0.2 to 0.6 mm. in diameter, followed by a few thick, concentric laminae in which there are small irregular galleries. Near the surface there is a ring of oval galleries. A peripheral lamina is composed of a single transversely fibrous layer, 0.05 to 0.10 mm. thick, without a dark median line. The laminar and pillar tissue is transversely fibrous. Where the laminae and pillars are thin, the fibers extend across the structure; where the laminae and pillars are thick, except for the outer sheath, there is a dark, median line, from which coarse fibers extend perpendicularly on either side. Where the skeleton is a solid mass of tissue around the axial canal, the fibers are in radial clusters. The galleries are 0.1 to 0.6 mm. in diameter and are connected to each other, to the axial canal, and to the outside by irregular, radial tubes. Tabulae are short, straight to variable, rare to common in the peripheral tubes and galleries.

In cross sections with no axial canal, the peripheral lamina is thicker, up to 0.20 mm. thick, and the inner laminae form an irregular network pattern with the pillars and are thinner, 0.05 mm. thick. The pillars are short and irregular in size.

Variation in the cross sections may be due to differences in the maturity of the specimen or due to different positions of the sections along the length of the coenosteum, or to some other reason of variability as varietal or even specific differences. Lecompte (1952, p. 321) erected four new species and one new variety: two of his species with smaller coenostea and larger axial canals than the Givetian *A. ramosa,* occur higher in the Devonian, the Frasnian.

Axial section.—The laminae are mostly obscure, but are highly arched (Pl. 23, figs. 4, 5), thick, pierced by foramina, transversely fibrous, and represented in the axial tube by arched tabulae. The pillars are thick, 0.1 to 0.15 mm. broad, commonly anastomose, branch, and diverge to the outer edge of the coenosteum. The axial tube is single, 0.3 to 0.4 mm. broad, variable, with thin, widely spaced, upward curved tabulae. The radial tubes and marginal vesicles have curved tabulae.

Tangential section.—The section consists of about two-thirds of tissue and one-third of galleries. The tissue consists of inosculating plates which are transversely fibrous with a thin, median, dark line. Laminae and pillars can scarcely be differentiated, but the structures are mostly pillars. The galleries are oval, vermicular and inosculating, some with thin tabulae.

Amphipora ramosa (Phillips) is characterized by small, vermicular coenostea, with axial tubes and heavy, fibrous tissue, with a dark median line in the laminar and pillar tissue. Like Nicholson (1886), Lecompte (1951), and most other students of the genus, we limit the characters of *A. ramosa*, to the common form just diagnosed. We do not recognize the variations as different species at this time. The following groups of specimens occur within a centimeter or two of each other in rock samples:

1. Axial tube prominent, surrounded by a zone of thick tissue, galleries marginal mainly, peripheral lamina thin, tissue with dark median line, tabulae rare. Typical *A. ramosa*. Abundant.
2. Axial tube prominent, surrounded by tissue making an open network. Common.
3. Axial tube absent or vague, surrounded by thin, confluent laminae and pillars forming a polygonal pattern. Common.

Though the genus is anomalous as a stromatoporoid, there is a suggestion of a laminar-pillar type structure as in typical stromatopoids; the skeletal tissue is similar to the transversely fibrous tissue in *Anostylostroma*. The pillar tissue of *A. meshbergerense* has a dark median line and coarse transverse fibers on either side, much like that in *A. ramosa*, and there are tabular dissepiments in the galleries and tubes as is commonly the case in stromatoporoids.

A. ramosa is one of the best index stromatoporoids we have encountered for the Middle Devonian.

Occurrence.—We have many samples from the Independent quarry, four miles south of Dupont, Indiana. Each sample is a coquina-like mass containing hundreds of individual specimens. *Amphipora* silicified and as molds occur in profusion in the lower part of the Jeffersonville limestone, in the facies referred to by geologists as "buhrstone", in Bartholomew and Jennings counties, Indiana.

Plesiotypes.—Indiana University Paleontological Collections, slides 285-55, 56, 57; 306, 3, 4, 5, 6, 7. Cat. No. 5371, 5372.

CHECK LIST OF DEVONIAN GENERA AND SPECIES OF STROMATOPOROIDEA

The following list of genera and species of Devonian Stromatoporoidea of the world is as complete as it has been possible for us to make.* Wherever descriptions and figures are adequate, we have corrected the genus under which a species should belong according to our understanding of the genera. Where we have seen a reference to a species but have not seen the original description, the date is omitted after the author's name.

The check list may be used as a finding list for original descriptions by referring in the bibliography to the author and date after a species in the list. Another use is to aid in avoiding homonyms, though one should keep in mind that the list does not include Ordovician and Silurian species, so that further checking is necessary before establishing a new specific name.

The list includes 30 valid varietal names, 16 invalid varietal names, 384 valid specific names, 126 invalid specific names, 23 valid generic names, and 13 invalid generic names.

Synonyms and species belonging to other genera than originally designated are in italics. Where the genus has been changed, the original name is in parentheses.

* Just as our paper was submitted for publication, we received Yavorsky's, "Stromatoporoidea of the Soviet Union", (1955, p. 1-173) in which he described two new genera, *Ferestromatopora and Paramphipora,* 86 new species, and 12 new varieties from the Devonian. Many of the Russian forms are similar to those in North America and will require additional study to determine their relationships to American species. Yavorsky's new genera will be considered in a paper on the classification of the Stromatoporoidea in preparation by the senior author.

The asterisk denotes species occurring in North America, of which 57 were previously described; 53 new species are added. Eight formerly described species are new to North America.

A question mark is placed after a name which is in doubt.

Actinodictyon Parks, 1909
Actinodictyon vagans Parks, 1936
Actinodictyon vaucellense Lecompte, 1951 = Anostylostroma vaucellense (Lecompte), 1951
Actinostroma Nicholson, 1886
Actinostroma bifarium Nicholson, 1889
Actinostroma clathratum Nicholson, 1886
Actinostroma clathratum intricatum Lecompte, 1951
Actinostroma clathratum polonica Gürich, 1896
Actinostroma compactum Ripper, 1933
Actinostroma conglomeratum Lecompte, 1951
Actinostroma ? contextum Počta, 1894
Actinostroma contortum Gorsky, 1935 = Anostylostroma contortum (Gorsky), 1935
Actinostroma contortum Ripper, 1936 = a junior homonym of *Actinostroma contortum* Gorsky, 1935
Actinostroma couvinense Lecompte, 1951
Actinostroma crassum Yavorsky, 1951 = a coral
Actinostroma crassepilatum Lecompte, 1951
Actinostroma dehorneae Lecompte, 1951
Actinostroma dehorneae constrictum Lecompte, 1951
Actinostroma dehorneae densicolumnatum Lecompte, 1951
Actinostroma densatum Lecompte, 1951
Actinostroma devonense Lecompte, 1951
Actinostroma derzavini (Yavorsky), 1951; (*Hermatostroma derzavini* Yavorsky)
Actinostroma dobrolubovi Riabinin
*Actinostroma expansum (Hall and Whitfield), 1873; (*Stromatopora expansa* Hall and Whitfield)
*Actinostroma fenestratum Nicholson, 1889
Actinostroma ferganense Riabinin

Actinostroma filitextum Lecompte, 1951
Actinostroma frustulum Počta, 1894
Actinostroma fungiforme Le Maître, 1931 = Anostylostroma fungiforme (Le Maître), 1931
Actinostroma furcatopilosum Gorsky, 1935 = Trupetostroma ? furcatopilosum (Gorsky), 1935
Actinostroma geminatum Lecompte, 1951
Actinostroma hebbornense Nicholson, 1886
Actinostroma irregulare Nicholson, 1889
Actinostroma istokense Yavorsky, 1951 = Stictostroma istokense (Yavorsky), 1951
Actinostroma lamellatum Le Maître, 1931
Actinostroma mamontovi Yavorsky, 1931
Actinostroma moosensis (Parks), 1904 = Stromatoporella moosensis (Parks), 1904
Actinostroma papillosum (Bargatzky), 1881; (*Stromatopora papillosa* Bargatzky)
Actinostroma perlaminatum Lecompte, 1951
Actinostroma perspicum Počta, 1894
Actinostroma pseudosquamosum Špinar, 1940 = Anostylostroma pseudosquamosum (Špinar), 1940
Actinostroma reversum Lecompte, 1951
Actinostroma salairicum Yavorsky
Actinostroma septatum Lecompte, 1951
Actinostroma septatum robustum Lecompte, 1951
Actinostroma sertiforme Lecompte, 1951
Actinostroma ? squamosum Le Maître, 1931
Actinostroma stellulatum Nicholson, 1886
Actinostroma ? stellulatum distans Ripper, 1936
Actinostroma stellulatum maureri Heinrich, 1914
Actinostroma stellulatum nicholsoni Heinrich, 1914
Actinostroma stellulatum tuberculatum Heinrich, 1914
Actinostroma tabulatum Lecompte, 1951
Actinostroma tabulatum crassum Lecompte, 1951
Actinostroma talovense (Yavorsky), 1951; (*Hermatostroma episcopale talovense* Yavorsky)

Actinostroma timanicum Riabinin
Actinostroma trautscholdi Riabinin, 1941 = Anostylostroma trautscholdi (Riabinin), 1941
*Actinostroma tuberosum, n. sp.
*Actinostroma tyrrelli Nicholson, 1891
Actinostroma uralicum Yavorsky, 1947
Actinostroma ? vastum Počta, 1894
Actinostroma verrucosum (Goldfuss), 1826; (*Ceriopora verrucosa* Goldfuss)
*Actinostroma whiteavesi Nicholson, 1891
Actinostroma yavorskyi Riabinin
Amphipora Schulz, 1883
Amphipora angusta Lecompte, 1952
Amphipora laxeperforata Lecompte, 1952
Amphipora patokensis Riabinin
Amphipora patokensis minor Riabinin
Amphipora pervesiculata Lecompte, 1952
*Amphipora ramosa (Phillips), 1841; (*Caunopora ramosa* Phillips)
Amphipora ramosa desquamata Lecompte, 1952
Amphipora ramosa minor Riabinin
Amphipora rudis Lecompte, 1952
Amphipora vetustior Gürich, 1896
Anostylostroma Parks, 1936
Anostylostroma aggregatum (Lecompte), 1951; (*Atelodictyon aggregatum* Lecompte)
Anostylostroma amygdaloides (Lecompte), 1951; (*Clathrodictyon amygdaloides* Lecompte)
Anostylostroma aperturatum Le Maître, 1949
Anostylostroma aquisgranense (Dantz), 1893; (*Clathrodictyon aquisgranense* Dantz)
*Anostylostroma arvense (Parks), 1936; (*Clathrodictyon arvense* Parks)
Anostylostroma clarum (Počta), 1894; (*Clathrodictyon clarum* Počta)
*Anostylostroma columnare (Parks), 1936; (*Clathrodictyon laxum columnare* Parks)
*Anostylostroma compactum, n. sp.

*Anostylostroma confluens, n. sp.
Anostylostroma contortum (Gorsky), 1935; (*Actinostroma contortum* Gorsky)
Anostylostroma cracoviense (Gürich), 1904; (*Stromatoporella cracoviensis* Gürich)
*Anostylostroma crebricolumnare, n. sp.
Anostylostroma dehéei (Le Maître), 1931; (*Clathrodictyon dehéei* Le Maître)
Anostylostroma delicatulum (Ripper), 1937; (*Clathrodictyon convictum delicatula* Ripper)
*Anostylostroma dupontense, n. sp.
Anostylostroma fungiforme (Le Maître), 1931; (*Actinostroma fungiforme* Le Maître)
*Anostylostroma hamiltonense Parks, 1936
Anostylostroma hamiltonense papillatum Parks, 1936 = Anostylostroma papillatum Parks, 1936
*Anostylostroma humile, n. sp.
Anostylostroma imperceptum (Gorsky), 1938; (*Stylostroma imperceptum* Gorsky)
*Anostylostroma insulare (Parks), 1936; (*Clathrodictyon insulare* Parks)
*Anostylostroma jewetti (Girty), 1895; (*Clathrodictyon jewetti* Girty)
Anostylostroma lamellatum (Le Maître) 1931; (*Clathrodictyon lamellatum* Le Maître)
Anostylostroma latifistulatum (Lecompte), 1951; (*Clathrodictyon latifistulatum* Lecompte)
*Anostylostroma laxum (Nicholson), 1887; (*Clathrodictyon laxum* Nicholson)
Anostylostroma loutougini (Yavorsky), 1931; (*Stromatoporella loutougini* Yavorsky)
Anostylostroma mamillatum (Le Maître), 1947; (*Clathrodictyon mamillatum* Le Maître)
*Anostylostroma mediale, n. sp.
*Anostylostroma meshbergerense, n. sp.
*Anostylostroma microcolumnare, n. sp.
*Anostylostroma microtuberculatum (Riabinin), 1941; (*Stromatopora microtuberculata* Riabinin)

Anostylostroma neglectum (Počta), 1894; (*Clathrodictyon neglectum* Počta)

*Anostylostroma papillatum Parks, 1936; (*Anostylostroma hamiltonense papillatum* Parks)

Anostylostroma paramygdaloides (Lecompte), 1951; (*Clathrodictyon paramygdaloides* Lecompte)

Anostylostroma parvum (Le Maître), 1934; (*Labechia parva* Le Maître)

Anostylostroma ? phyloclymenium (Frech), 1885; (*Stromatopora phyloclymenia* Frech)

*Anostylostroma pipecreekense, n. sp.

*Anostylostroma ponderosum (Nicholson), 1875; (*Stromatopora ponderosa* Nicholson)

Anostylostroma praetenerum (Yavorsky), 1931; (*Clathrodictyon praetenerum* Yavorsky)

Anostylostroma pseudocolumnare (Riabinin), 1941; (*Clathrodictyon pseudocolumnare* Riabinin)

Anostylostroma pseudosquamosum (Špinar), 1940; (*Actinostroma pseudosquamosum* Špinar)

*Anostylostroma pulpitense, n. sp.

*Anostylostroma retiforme (Nicholson and Murie), 1878; (*Stylodictyon retiforme* Nicholson and Murie)

*Anostylostroma subcolumnare, n. sp.

*Anostylostroma substriatellum (Nicholson), 1875; (*Stromatopora substriatella* Nicholson)

Anostylostroma subtile (Počta), 1894; (*Clathrodictyon subtile* Počta)

Anostylostroma tessellatum (Le Maître), 1931; (*Clathrodictyon tessellatum* Le Maître)

Anostylostroma trautscholdi (Riabinin), 1941; (*Actinostroma trautscholdi* Riabinin)

Anostylostroma tuberculatum (Riabinin), 1941; (*Clathrodictyon tuberculatum* Riabinin)

Anostylostroma variabile (Riabinin), 1932; (*Clathrodictyon variabile* Riabinin)

Anostylostroma vaucellense (Lecompte), 1951; (*Actinodictyon vaucellense* Lecompte)

Anostylostroma vilvense (Yavorsky), 1951; (*Clathrodictyon variabile vilvense* Yavorsky)
Atelodictyon Lecompte, 1951
Atelodictyon aggregatum Lecompte, 1951 = Anostylostroma aggregatum (Lecompte), 1951
Atelodictyon fallax Lecompte, 1951
*Atelodictyon intercalare, n. sp.
Atelodictyon pseudostriatellum (Yavorsky), 1931; (*Clathrodictyon pseudostriatellum* Yavorsky)
Atelodictyon strictum Lecompte, 1951
Caunopora Phillips, 1841 = a composite of various stromatoporoids and corals
Caunopora bücheliensis Bargatzky, 1881 = Parallelopora bücheliensis (Bargatzky), 1881
Caunopora hüpschii Bargatzky, 1881 = Stromatopora hüpschi (Bargatzky), 1881
Caunopora planulata Hall and Whitfield, 1873 = Parallelopora planulata (Hall and Whitfield), 1873
Caunopora ramosa Phillips, 1841 = Amphipora ramosa (Phillips), 1841
Caunopora verticillata McCoy, 1855 = Stachyodes verticillata (McCoy), 1855
Ceriopora Goldfuss, 1826 = a bryozoan
Ceriopora verrucosa Goldfuss, 1826 = Actinostroma verrucosum (Goldfuss), 1826
Clathrocoilona Yavorsky, 1931
*Clathrocoilona abeona Yavorsky, 1931
Clathrocoilona crassitexta (Lecompte), 1951; (*Stromatoporella crassitexta* Lecompte)
Clathrocoilona eifeliensis (Nicholson), 1886; (*Stromatoporella eifeliensis* Nicholson)
*Clathrocoilona fibrosa, n. sp.
Clathrocoilona intscherepense Yavorsky, 1951
Clathrocoilona irregularis (Lecompte), 1951; (*Stromatoporella irregularis* Lecompte)
Clathrocoilona kirgisica (Yavorsky), 1947; (*Stromatopora kirgisica* Yavorsky)

*Clathrocoilona ? lata (Parks), 1936; (*Clathrodictyon latum* Parks)
Clathrocoilona lemnisca (Lecompte), 1951; (*Stromatoporella lemnisca* Lecompte)
Clathrocoilona ? remeši (Špinar), 1940; (*Stromatoporella remeši* Špinar)
*Clathrocoilona restricta, n. sp.
Clathrocoilona saginata (Lecompte), 1951; (*Stromatoporella saginata* Lecompte)
*Clathrocoilona subclathrata, n. sp.
Clathrodictyon Nicholson and Murie, 1878
Clathrodictyon actinostromiforme Riabinin, 1941 = Trupetostroma actinostromiforme (Riabinin), 1941
Clathrodictyon amygdaloides Lecompte, 1951 = Anostylostroma amygdaloides (Lecompte), 1951
Clathrodictyon amygdaloides subvesiculosum Lecompte, 1951 = Stromatoporella subvesiculosa (Lecompte), 1951
Clathrodictyon aquisgranense Dantz, 1893 = Anostylostroma aquisgranense (Dantz), 1893
Clathrodictyon arvense Parks, 1936 = Anostylostroma arvense (Parks), 1936
Clathrodictyon cellulosum Nicholson and Murie, 1878 = Stromatoporella cellulosa (Nicholson and Murie), 1878
Clathrodictyon clarum Počta, 1894 = Anostylostroma clarum (Počta), 1894
*Clathrodictyon confertum Nicholson, 1889
Clathrodictyon convictum delicatula Ripper, 1937 = Anostylostroma delicatulum (Ripper), 1937
Clathrodictyon dehéei Le Maître, 1931 = Anostylostroma dehéei (Le Maître), 1931
Clathrodictyon incubonum Yavorsky
Clathrodictyon insulare Parks, 1936 = Anostylostroma insulare (Parks), 1936
Clathrodictyon jewetti Girty, 1895 = Anostylostroma jewetti (Girty), 1895
Clathrodictyon katavense Yavorsky
Clathrodictyon lamellatum Le Maître, 1931 = Anostylostroma lamellatum (Le Maître), 1931

Clathrodictyon latifistulatum Lecompte, 1951 = Anostylostroma latifistulatum (Lecompte), 1951

Clathrodictyon latum Parks, 1936 = Clathrocoilona ? lata (Parks), 1936

Clathrodictyon laxum Nicholson, 1887 = Anostylostroma laxum (Nicholson), 1887

Clathrodictyon laxum columnare Parks, 1936 = Anostylostroma columnare (Parks), 1936

Clathrodictyon mamillatum Le Maître, 1947 = Anostylostroma mamillatum (Le Maître), 1947

Clathrodictyon ? montis castii Frech, 1911

Clathrodictyon moosense proximale Parks, 1936 = Anostylostroma retiforme (Nicholson and Murie), 1878

Clathrodictyon neglectum Počta, 1894 = Anostylostroma neglectum (Počta), 1894

Clathrodictyon ? ohioense Parks, 1936

Clathrodictyon paramygdaloides Lecompte, 1951 = Anostylostroma paramygdaloides (Lecompte), 1951

Clathrodictyon praetenerum Yavorsky, 1931 = Anostylostroma praetenerum (Yavorsky), 1931

Clathrodictyon problematicum Parks, 1904 = Stictostroma problematicum (Parks), 1904

Clathrodictyon pseudocolumnare Riabinin, 1941 = Anostylostroma pseudocolumnare (Riabinin), 1941

Clathrodicyton pseudostriatellum Yavorsky, 1931 = Atelodictyon pseudostriatellum (Yavorsky), 1931

Clathrodictyon ? regulare carnicum Vinassa de Regny, 1910

Clathrodictyon regulare uralicum Riabinin

Clathrodictyon ? spongiosum Gürich, 1896

Clathrodictyon subtile Počta, 1894 = Anostylostroma subtile (Počta), 1894

Clathrodictyon tessellatum Le Maître, 1931 = Anostylostroma tessellatum (Le Maître), 1931

Clathrodictyon townsendi Parks, 1936 = Anostylostroma insulare (Parks), 1936

Clathrodictyon tschussovense Yavorsky

Clathrodictyon tuberculatum Riabinin, 1941 = Anostylostroma tuberculatum (Riabinin), 1941

Clathrodictyon undulatum Parks, 1936 = Stromatoporella ? undulata (Parks), 1936

Clathrodictyon variabile Riabinin, 1932 = Anostylostroma variabile (Riabinin), 1932

Clathrodictyon variabile vilvense Yavorsky, 1951 = Anostylostroma vilvense (Yavorsky), 1951

Clathrodictyon vulgare Parks, 1936 = Anostylostroma retiforme Nicholson and Murie, 1878

Clathrodictyon yavorskyi Riabinin

Coenostroma Winchell, 1867 = Stromatopora Goldfuss, 1826

Coenostroma ristigouchensis Spencer, 1884 = Parallelopora ristigouchensis (Spencer), 1884

Dendrostroma Lecompte, 1951

Dendrostroma gracile (Lecompte), 1952; (*Stachyodes gracilis* Lecompte)

Dendrostroma oculatum (Nicholson), 1886; (*Idiostroma oculatum* Nicholson)

Dendrostroma paralleloporoides (Lecompte), 1952; (*Stachyodes paralleloporoides* Lecompte)

Diapora Bargatzky, 1881 = a composite of various stromatoporoids and corals

Diapora laminata Bargatzky, 1881 = Stromatoporella laminata (Bargatzky), 1881

Fistulipora McCoy, 1850 = a bryozoan

Fistulipora porosa Roemer, 1855 = Stromatoporella stellifera (Roemer), 1855

Gerronostroma Yavorsky, 1931

Gerronostroma batschatensis Yavorsky, 1931

Gerronostroma concentrica Yavorsky, 1931

Gerronostroma elegans Yavorsky, 1931

*Gerronostroma excellens, n. sp.

*Gerronostroma ? insolitum (Parks), 1936; (*Stictostroma insolitum* Parks)

*Gerronostroma plectile, n. sp.

Hermatostroma Nicholson, 1886

Hermatostroma beuthi (Bargatzky), 1881; (*Stromatopora beuthii* Bargatzky)

Hermatostroma derzavini Yavorsky, 1951 = Actinostroma derzavini (Yavorsky), 1951
Hermatostroma ? dolica Yavorsky, 1931
Hermatostroma episcopale Nicholson, 1892
Hermatostroma episcopale buchanensis Ripper, 1936 = Stictostroma ? buchanense (Ripper), 1936
Hermatostroma episcopale talovense Yavorsky, 1951 = Actinostroma talovense (Yavorsky), 1951
Hermatostroma hainensis (Maurer), 1885; (*Stromatopora hainensis* Maurer)
*Hermatostroma logansportense, n. sp.
Hermatostroma parksi Lecompte, 1952
Hermatostroma perseptatum Lecompte, 1952
Hermatostroma polymorphum Lecompte, 1952
Hermatostroma pustulosum Lecompte, 1952
Hermatostroma schlüteri Nicholson, 1886
Hermatostroma sibirica Yavorsky, 1931 = Syringostroma ? sibiricum (Yavorsky), 1931
Idiostroma Winchell, 1867
*Idiostroma caespitosum (Winchell), 1866; (*Stromatopora caespitosa* Winchell)
Idiostroma crassum Lecompte, 1952 = Stachyodes crassa (Lecompte), 1952
Idiostroma elegans Yavorsky, 1951 = Trupetostroma elegans (Yavorsky), 1951
Idiostroma fililaminatum Lecompte, 1952
Idiostroma forresti Gregory, 1925
*Idiostroma gordiaceum Winchell, 1867
*Idiostroma nattresi Grabau, 1909
Idiostroma oculatum Nicholson, 1886 = Dendrostroma oculatum (Nicholson), 1886
Idiostroma roemeri Nicholson, 1886
Idiostroma yulangensis Reed, 1911
Labechia Edwards and Haime, 1851
Labechia compacta Gorsky, 1935 = Syringostroma compacta (Gorsky), 1935
Labechia densa Gorsky, 1938
Labechia devonica Riabinin, 1932

Labechia geometrica Solomko, 1886 (may not be Devonian)
Labechia macrostylophora Riabinin
Labechia parva Le Maître, 1934 = Anostylostroma parvum (Le Maître), 1934
Labechia mugodijarica Yavorsky, 1931
Labechia polaris Gorsky, 1938
Labechia pskovensis Riabinin, 1941 = Trupetostroma pskovense (Riabinin), 1941
Labechia recessa Gorsky, 1938
Labechia regularis Riabinin, 1932
Labechia serotina Nicholson, 1886 = Labechiella serotina (Nicholson), 1886
Labechia ? stylophora Nicholson, 1891
Labechia variabilis Riabinin, 1932 (may not be Devonian)
Labechiella Yabe and Sugiyama, 1930
Labechiella serotina (Nicholson), 1886; (*Labechia serotina* Nicholson)
Lioplacocyathus Ludwig, 1886 = Stromatopora Goldfuss, 1826
Parallelopora Bargatzky, 1881
Parallelopora bücheliensis (Bargatzky), 1881; (*Caunopora bücheliensis* Bargatzky)
*Parallelopora campbelli, n. sp.
Parallelopora capitata (Goldfuss), 1826; (*Tragos capitatum* Goldfuss)
Parallelopora dartingtonensis (Carter), 1880; (*Stromatopora dartingtonensis* Carter)
Parallelopora dartingtonensis filitexta Nicholson, 1891
Parallelopora eifeliensis Bargatzky, 1881 = Stromatoporella ? eifeliensis (Bargatzky), 1881
*Parallelopora eumamillata, n. sp.
Parallelopora ? gentilis (Gortani), 1912; (*Stromatopora columnaris gentilis* Gortani)
Parallelopora goldfussi Bargatzky, 1881
Parallelopora heckeri Riabinin, 1941 = Trupetostroma ? heckeri (Riabinin), 1941
*Parallelopora nodulata (Nicholson), 1875; (*Stromatopora nodulata* Nicholson)

*Parallelopora ostiolata Bargatzky, 1881
Parallelopora parva Riabinin
Parallelopora paucicanaliculata Lecompte, 1952
*Parallelopora planulata (Hall and Whitfield), 1873; (*Caunopora planulata* Hall and Whitfied)
Parallelopora polonica Gürich, 1896
*Parallelopora pulchra, n. sp.
*Parallelopora ristigouchensis (Spencer), 1884; (*Coenostroma ristigouchensis* Spencer)
*Parallelopora snoufferensis, n. sp.
Parallelopora socialis Riabinin, 1941 = Stictostroma ? socialis (Riabinin), 1941
Parallelopora stellaris Bargatzky, 1881
*Parallelopora typicalis, n. sp.
Parallelopora volensis Riabinin
Prisciturben Kunth, 1870 = Stromatopora Goldfuss, 1826
Pseudolabechia Yabe and Sugiyama, 1930
Pseudolabechia aequivesiculosa (Gorsky), 1938; (*Stylostroma ramosum aequivesiculosum* Gorsky) (may not be Devonian)
Pseudolabechia crassa (Gorsky), 1938; (*Stylostroma crassum* Gorsky) (may not be Devonian)
Pseudolabechia ramosa (Gorsky), 1938; (*Stylostroma ramosa* Gorsky) (may not be Devonian)
Rosenella Nicholson, 1886
Rosenella labechioides Gorsky, 1935 (may not be Devonian)
Rosenella latevesiculosa Gorsky, 1935 (may not be Devonian)
Rosenella miniarensis Riabinin, 1932 (may not be Devonian)
Rosenella normalis Riabinin, 1932 (may not be Devonian)
Rosenella plativesiculosa Gorsky, 1938 (may not be Devonian)
Sphaerostroma Gürich, 1896 = Stachyodes Bargatzky, 1881
Sphaerostroma exiguum Gürich, 1896 = Stachyodes exigua (Gürich), 1896
Stachyodes Bargatzky, 1881
Stachyodes caespitosa Lecompte, 1952
Stachyodes costulata Lecompte, 1952
Stachyodes crassa (Lecompte), 1952; (*Idiostroma crassum* Lecompte)

Stachyodes exigua (Gürich), 1896; (*Sphaerostroma exiguum* Gürich)
Stachyodes fasciculata Heinrich, 1914
Stachyodes gracilis Lecompte, 1952 = Dendrostroma gracile (Lecompte), 1952
Stachyodes monostiolata (Bargatzky), 1881; (*Stromatopora monostiolata* Bargatzky)
Stachyodes paralleloporoides Lecompte, 1952 = Dendrostroma paralleloporoides (Lecompte), 1952
Stachyodes ? polyostiolata (Bargatzky), 1881; (*Stromatopora polyostiolata* Bargatzky)
Stachyodes radiata Lecompte, 1952
Stachyodes stalagmites Heinrich, 1914
Stachyodes verticillata (McCoy), 1885; (*Caunopora verticillata* McCoy)
Stachyodes verticillata angustellata Gürich, 1896
Stachyodes verticillata irregularis Heinrich, 1914
Stachyodes verticillata latestellata Gürich, 1896
Stachyodes verticillata pesanseris Heinrich, 1914
Stictostroma Parks, 1936
*Stictostroma alpenense Parks, 1936
Stictostroma ? buchanense (Ripper), 1936; (*Hermatostroma episcopale buchanensis* Ripper)
*Stictostroma elevatum (Parks), 1936; (*Stromatoporella elevata* Parks)
Stictostroma eriense Parks, 1936 = Stromatoporella eriensis (Parks), 1936
Stictostroma huronense Parks, 1936 = Stromatoporella huronensis (Parks), 1936
Stictostroma insolitum Parks, 1936 = Gerronostroma ? insolitum (Parks), 1936
Stictostroma istokense (Yavorsky), 1951; (*Actinostroma istokense* Yavorsky)
*Stictostroma jeffersonvillense, n. sp.
*Stictostroma kayi (Parks), 1936; (*Stromatoporella kayi* Parks)
Stictostroma latum (Lecompte), 1951; (*Syringostroma microfibrosum latum* Lecompte)

Stictostroma lensiforme (Lecompte), 1951; (*Syringostroma lensiforme* Lecompte)

*Stictostroma mamilliferum new name; (*Stromatopora mammillata* Nicholson, 1873)

*Stictostroma mcgraini, n. sp.

Stictostroma microfibrosum (Lecompte), 1951; (*Syringostroma microfibrosum* Lecompte)

Stictostroma micropertusum (Lecompte), 1951; (*Syringostroma micropertusum* Lecompte)

Stictostroma minutitextum (Lecompte), 1951; (*Syringostroma minutitextum* Lecompte)

Stictostroma obliteratum (Lecompte), 1951; (*Stromatoporella obliterata* Lecompte)

Stictostroma percanaliculatum (Lecompte), 1951; (*Cyringostroma percanaliculatum* Lecompte)

*Stictostroma problematicum (Parks), 1904; (*Clathrodictyon problematicum* Parks)

Stictostroma ? socialis (Riabinin), 1941; (*Parallelopora socialis* Riabinin)

Stromatocerium Hall, 1847

Stromatocerium ? eximium Gorsky, 1935

Stromatopora Goldfuss, 1826

Stromatopora alaica Riabinin

Stromatopora angulata Yavorsky, 1947

Stromatopora baccata (Lecompte), 1951; (*Syringostroma baccatum* Lecompte)

Stromatopora beuthii Bargatzky, 1881 = Hermatostroma beuthi (Bargatzky), 1881

Stromatopora beuthii radiata Vinassa de Regny, 1918 = Syringostroma beuthi radiata (Vinassa de Regny), 1918

Stromatopora bücheliensis crassa Vinassa de Regny, 1918 = Syringostroma bücheliensis crassa (Vinassa de Regny), 1918

Stromatopora bücheliensis digitata Nicholson, 1891

Stromatopora caespitosa Winchell, 1866 = Idiostroma caespitosum (Winchell), 1866

Stromatopora capitata (Goldfuss), 1826; (*Tragos capitatum* Goldfuss)

Stromatopora cardonai Vinassa de Regny, 1918 = Syringostroma cardonai (Vinassa de Regny), 1918

Stromatopora celloniensis Charlesworth, 1914 = Hermatostroma beuthi (Bargatzky), 1881
Stromatopora ? columnaris Barrande, 1894
Stromatopora columnaris carnica Vinassa de Regny, 1918
Stromatopora columnaris gentilis Gortani, 1912 = Parallelopora ? gentilis (Gortani) 1912
Stromatopora compta Počta, 1894
Stromatopora concentrica Goldfuss, 1826
Stromatopora concentrica astrigera Nicholson, 1891
Stromatopora concentrica colliculata Nicholson, 1891
*Stromatopora conicomamillata, n. sp.
Stromatopora cooperi Lecompte, 1952
*Stromatopora corallifera Parks, 1909
*Stromatopora coralvillensis Thomas, 1923
*Stromatopora cumingsi, n. sp.
Stromatopora curiosa Bargatzky, 1881 = Stromatoporella curiosa (Bargatzky), 1881
Stromatopora dartingtonensis Carter, 1880 = Parallelopora dartingtonensis (Carter), 1880
Stromatopora derzavini Yavorsky, 1947
*Stromatopora divergens, n. sp.
*Stromatopora dubia Lecompte, 1952
Stromatopora elegans Carter, 1879 (a homonym of *S. elegans* Rosen, 1867) = Parallelopora dartingtonensis (Carter), 1880
Stromatopora elegans Rosen 1867 = Stromatopora discoides (Lonsdale), 1889
*Stromatopora ? erratica Hall and Whitfield, 1873
*Stromatopora eumaculosa, n. sp.
Stromatopora expansa Hall and Whitfield, 1873 = Actinostroma expansum (Hall and Whitfield)
Stromatopora florida Novak, in Počta, 1894
Stromatopora florigera Nicholson, 1891
Stromatopora forojuliensis Vinassa de Regny, 1918 = Syringostroma forojuliensis (Vinassa de Regny), 1918
*Stromatopora foveolata (Girty), 1895; (*Syringostroma foveolatum* Girty)
Stromatopora goldfussi mixta Lecompte, 1952 = Stromatopora mixta Lecompte, 1952

Stromatopora granulata Nicholson, 1873 = Stromatoporella granulata (Nicholson), 1873
Stromatopora hainensis Maurer, 1885 = Hermatostroma hainensis (Maurer), 1885
*Stromatopora hüpschi (Bargatzky), 1881; (*Caunopora hüpschii* Bargatzky)
*Stromatopora ? incrustans Hall and Whitfield, 1873
Stromatopora indubia Maurer, 1885 = Stromatopora hüpschi (Bargatzky), 1881
Stromatopora inequalis Nicholson, 1891
Stromatopora ischyrum Le Maître, 1949
Stromatopora kirgisica Yavorsky, 1947 = Clathrocoilona kirgisica (Yavorsky), 1947
Stromatopora kudebensis Riabinin, 1941
*Stromatopora laminosa Lecompte, 1952
*Stromatopora larocquei, n. sp.
Stromatopora ? latens Počta, 1894
Stromatopora lilydalensis Ripper, 1936
Stromatopora longitubulata Riabinin, 1941
Stromatopora maculata Lecompte, 1952
Stromatopora maculosa Maurer, 1885 = Stromatoporella maculosa (Maurer), 1885
*Stromatopora magnimamillata, n. sp.
Stromatopora mammillata Nicholson, 1873 (a homonym of Stromatopora mammillata Schmidt, 1858) = Stictostroma mamilliferum, new name
*Stromatopora marpleae, n. sp.
Stromatopora ? microlaminata Riabinin, 1941
Stromatopora microtuberculata Riabinin, 1941 = Anostylostroma microtuberculatum (Riabinin), 1941
Stromatopora miniarensis Riabinin
Stromatopora mixta Lecompte, 1952; (*Stromatopora goldfussi mixta* Lecompte)
*Stromatopora mononensis n. sp.
Stromatopora monostiolata Bargatzky, 1881 = Stachyodes monostiolata (Bargatzky), 1881
*Stromatopora monticulifera Winchell, 1866

Stromatopora nodulatum Nicholson, 1875 = Parallelopora nodulata (Nicholson), 1875
*Stromatopora ? nulliporoides Nicholson, 1874
*Stromatopora nux Winchell, 1866
*Stromatopora obscura, n. sp.
*Stromatopora pachytexta Lecompte, 1952
Stromatopora papillosa Bargatzky, 1881 = Actinostroma papillosum (Bargatzky), 1881
*Stromatopora ? perforata Nicholson, 1874
Stromatopora phyloclymenia Frech, 1885 = Anostylostroma ? phyloclymenium (Frech), 1885
Stromatopora placenta Roemer, 1855 = Stromatoporella stellifera (Roemer), 1855
Stromatopora polymorpha Goldfuss, 1826 (diversified and incompletely known);
  in part (pl. 64, fig. 8d) = Stromatoporella curiosa (Bargatzky), 1881
  in part (pl. 64, fig. e) = Stachyodes monostiolata (Bargatzky), 1881
  in part (pl. 64. fig. f) = Stachyodes ? polyostiolata (Bargatzky), 1881
Stromatopora polymorpha stellifera Roemer, 1855 = Stromatopora stellifera (Roemer), 1855
Stromatopora polyostiolata Bargatzky, 1881 = Stachyodes ? polyostiolata (Bargatzky), 1881
Stromatopora ponderosum Nicholson, 1875 = Anostylostroma ponderosum (Nicholson), 1875
Stromatopora porosa (Lecompte), 1952; (*Trupetostroma porosum* Lecompte)
*Stromatopora pustulifera Winchell, 1866
*Stromatopora pustulosa Grabau, 1910
Stromatopora rugosa Le Maître, 1931
Stromatopora ruedemanni (Lecompte), 1952; (*Trupetostroma ruedemanni* Lecompte)
Stromatopora ? schelonensis Riabinin, 1941
*Stromatopora solidula Hall and Whitfield, 1873
Stromatopora spheroidalis Riabinin

Stromatopora ? spissa (Lecompte), 1951; (*Stromatoporella spissa* Lecompte)
Stromatopora stricta Lecompte, 1952
Stromatopora sublamellata (Lecompte), 1952; (*Trupetostroma sublamellatum* Lecompte)
*Stromatopora submixta, n. sp.
Stromatopora substriatella Nicholson, 1875 = Anostylostroma substriatellum (Nicholson), 1875
Stromatopora tuberculata Nicholson, 1873 = Stromatoporella tuberculata (Nicholson), 1873
Stromatopora turgidecolumnata Maurer, 1885 = Hermatostroma beuthi (Bargatzky), 1881
Stromatopora tyrganica Yavorsky, 1947
Stromatopora undata Riabinin
Stromatopora varssanofieve Riabinin
Stromatopora vesiculosa Gregory, 1925
Stromatopora vogulica Riabinin
Stromatopora wortheni Rominger, 1886; an invalid composite of two old species.
Stromatopora ylychensis Riabinin
Stromatoporella Nicholson, 1886
Stromatoporella abensis Yavorsky, 1950
Stromatoporella alveolata Lecompte, 1951 = Trupetostroma alveolatum (Lecompte), 1951
Stromatoporella arachnoidea Nicholson, 1886
Stromatoporella basilii Yavorsky, 1950
Stromatoporella batschatensis Yavorsky, 1950
Stromatoporella bifida Lecompte, 1951
Stromatoporella boutovi Yavorsky, 1950
*Stromatoporella cellulosa (Nicholson and Murie), 1878; (*Clathrodictyon cellulosum* Nicholson and Murie)
Stromatoporella convicta Yavorsky, 1950
*Stromatoporella columbusensis, n. sp.
Stromatoporella convicta Yarvorsky, 1950
Stromatoporella cracoviensis Gürich, 1904 = Anostylostroma cracoviense (Gürich), 1904
Stromatoporella crassitexta Lecompte, 1951 = Clathrocoilona crassitexta (Lecompte), 1951

*Stromatoporella cryptoannulata, n. sp.
Stromatoporella curiosa (Bargatzky), 1881; (*Stromatopora curiosa* Bargatzky)
Stromatoporella curiosa carnica Gortani, 1912
Stromatoporella damnoniensis Nicholson, 1886
Stromatoporella decora Lecompte, 1951
Stromatoporella devonica Yavorsky, 1950
Stromatoporella ? eifeliensis (Bargatzky), 1881; (*Parallelopora eifeliensis* Bargatzky)
Stromatoporella eifeliensis Nicholson, 1886 = Clathrocoilona eifeliensis (Nicholson), 1886
Stromatoporella elevata Parks, 1936 = Stictostroma elevatum (Parks), 1936
*Stromatoporella eriensis (Parks), 1936; (*Stictostroma eriense* Parks)
Stromatoporella gapeevi Yavorsky, 1950
Stromatoporella gracilis Lecompte, 1951
*Stromatoporella granulata (Nicholson), 1873; (*Stromatopora granulata* Nicholson)
*Stromatoporella granulata distans Parks, 1936
*Stromatoporella huronensis (Parks), 1936; (*Stictostroma huronense* Parks)
Stromatoporella insolita Yavorsky, 1950
Stromatoporella irregularis Lecompte, 1951 = Clathrocoilona irregularis (Lecompte), 1951
Stromatoporella karpinskyi Yavorsky
Stromatoporella kayi Parks, 1936 = Stictostroma kayi (Parks), 1936
Stromatoporella kettneri Špinar, 1940
*Stromatoporella kirki, n. sp.
Stromatoporella kumpani Yavorsky
Stromatoporella kuznetskensis Yavorsky, 1950
Stromatoporella laminata (Bargatzky), 1881; (*Diapora laminata* Bargatzky)
Stromatoporella laminata undulosa Gürich, 1896
Stromatoporella lemnisca Lecompte, 1951 = Clathrocoilona lemnisca (Lecompte), 1951

Stromatoporella loutougini Yavorsky, 1931 = Anostylostroma loutougini (Yavorsky), 1931
Stromatoporella maculosa (Maurer), 1885; *Stromatopora maculosa* Maurer)
Stromatoporella mamelonsa Yavorsky, 1950
*Stromatoporella moosensis (Parks), 1904; (*Actinostroma moosensis* Parks)
*Stromatoporella morelandensis, n. sp.
Stromatoporella obliterata Lecompte, 1951 = Stictostroma obliteratum (Lecompte), 1951
Stromatoporella pankratovi Yavorsky, 1931
*Stromatoporella parasolitaria, n. sp.
*Stromatoporella perannulata, n. sp.
Stromatoporella pertabulata Lecompte, 1951
*Stromatoporella ? planulata (Hall and Whitfield), 1873; (*Caunopora planulata* Hall and Whitfield)
Stromatoporella regularis Yavorsky, 1950
Stromatoporella remeši Špinar, 1940 = Clathrocoilona ? remeši (Špinar), 1940
Stromatoporella saginata Lecompte, 1951 = Clathrocoilona saginata (Lecompte), 1951
*Stromatoporella selwyni Nicholson, 1892
Stromatoporella sniatkovi Yavorsky, 1931
Stromatoporella socialis Nicholson, 1892
Stromatoporella socialis conferta Gortani, 1912
*Stromatoporella solitaria Nicholson, 1886
Stromatoporella spissa Lecompte, 1951 = Stromatopora ? spissa (Lecompte), 1951
Stromatoporella spissa latitexta Lecompte, 1951 = Stromatopora ? spissa (Lecompte), 1951
Stromatoporella stellifera (Roemer), 1855
Stromatoporella subvesiculosa (Lecompte), 1951; (*Clathrodictyon amygdaloides subvesiculosum* Lecompte)
Stromatoporella tchernyschevi Yavorsky, 1950
Stromatoporella tchernyschevi kostenkovensis Yavorsky, 1950
*Stromatoporella tuberculata (Nicholson), 1873; (*Stromatopora tuberculata* Nicholson)

Stromatoporella turensis Yavorsky, 1947
Stromatoporella tyrganensis Yavorsky, 1950
Stromatoporella undata Yavorsky, 1950
*Stromatoporella ? undulata (Parks), 1936; (*Clathrodictyon undulatum* Parks)
Stromatoporella ussowi Yavorsky, 1950
Stromatoporella volaica Charlesworth, 1914
Stromatoporella voltschensis Yavorsky, 1950
Stromatoporella yegorovi Yavorsky, 1947
Stylodictyon Nicholson and Murie, 1878
Stylodictyon columnare (Nicholson), 1875; (*Syringostroma columnaris* Nicholson)
Stylodictyon retiforme Nicholson and Murie, 1878 = Anostylostroma retiforme (Nicholson and Murie), 1878
Stylostroma Gorsky, 1938 = Pseudolabechia Yabe and Sugiyama, 1930
Stylostroma crassum Gorsky, 1938 = Pseudolabechia crassa (Gorsky), 1938
Stylostroma ramosum Gorsky, 1938 = Pseudolabechia ramosa (Gorsky), 1938
Stylostroma ramosum aequivesiculosum Gorsky, 1938 = Pseudolabechia aequivesiculosa (Gorsky), 1938
Stylostroma imperceptum Gorsky, 1938 = Anostylostroma imperceptum (Gorsky), 1938
Synthetostroma Lecompte, 1951
Synthetostroma actinostromoides Lecompte, 1951
Synthetostroma ? vesiculosum (Lecompte), 1951; (*Syringostroma vesiculosum* Lecompte)
Syringostroma Nicholson, 1875
Syringostroma baccatum Lecompte, 1951 = Stromatopora baccata (Lecompte), 1951
*Syringostroma ? barretti Girty, 1895
Syringostroma beuthi radiata (Vinassa de Regny), 1918; (*Stromatopora beuthii radiata* Vinassa de Regny)
*Syringostroma bicrenulatum, n. sp.
Syringostroma bücheliensis crassa (Vinassa de Regny), 1918; (*Stromatopora bücheliensis crassa* Vinassa de Regny)

Syringostroma cardonai (Vinassa de Regny), 1918; (*Stromatopora cardonai* Vinassa de Regny)
*Syringostroma centrotum Girty, 1895
Syringostroma columnaris Nicholson, 1875 = Stylodictyon columnare (Nicholson), 1875
Syringostroma compacta (Gorsky), 1935; (*Labechia compacta* Gorsky)
*Syringostroma ? consimile Girty, 1895
*Syringostroma densum Nicholson, 1875
Syringostroma forojuliensis (Vinassa de Regny), 1918; (*Stromatopora forojuliensis* Vinassa de Regny)
Syringostroma foveolatum Girty, 1895 = Stromatopora foveolata (Girty), 1895
*Syringostroma fuscum, n. sp.
Syringostroma geba Yavorsky, 1931 = Trupetostroma gebum (Yavorsky), 1931
Syringostroma lensiforme Lecompte, 1951 = Stictostroma lensiforme (Lecompte), 1951
Syringostroma microfibrosum Lecompte, 1951 = Stictostroma microfibrosum (Lecompte), 1951
Syringostroma microfibrosum latum Lecompte, 1951 = Stricto-stroma latum (Lecompte), 1951
Syringostroma micropertusum Lecompte, 1951 = Stictostroma micropertusum (Lecompte), 1951
*Syringostroma microporum Girty, 1895
Syringostroma minutitextum Lecompte, 1951 = Stictostroma minutitextum (Lecompte), 1951
*Syringostroma papillatum, n. sp.
Syringostroma percanaliculatum Lecompte, 1951 = Stictostroma percanaliculatum (Lecompte), 1951
*Syringostroma perdensum, n. sp.
Syringostroma perfectum Lecompte, 1951
*Syringostroma perfuscum, n. sp.
*Syringostroma radicosum, n. sp.
*Syringostroma sanduskyense, n. sp.
Syringostroma ? sibirica (Yavorsky), 1931; (*Hermatostroma sibirica* Yavorsky)
Syringostroma ? strahlenbergi Yavorsky, 1931

*Syringostroma subfuscum, n. sp.
*Syringostroma superdensum, n. sp.
Syringostroma tschichatschevi Yavorsky, 1931 = Trupetostroma tschichatschevi (Yavorsky), 1931
*Syringostroma tuberosum, n. sp.
Syringostroma vesiculosum Lecompte, 1951 = Synthetostroma? vesiculosum (Lecompte), 1951
Tienodictyon Yabe and Sugiyama, 1941 = a sphaeractinoid
Tienodictyon zonatum Yabe and Sugiyama, 1941 = a sphaeractinoid
Tragos capitatum Goldfuss, 1826 = Stromatopora capitatum (Goldfuss), 1826
Trupetostroma Parks, 1936
Trupetostroma actinostromiformi (Riabinin), 1941; (*Clathrodictyon actinostromiforme* Riabinin)
Trupetostroma alveolatum (Lecompte), 1951; (*Stromatoporella alveolata* Lecompte)
Trupetostroma bassleri Lecompte, 1952
Trupetostroma ? cellulosum Lecompte, 1952
Trupetostroma cimacense Lecompte, 1952
*Trupetostroma coalescens, n. sp.
Trupetostroma ? compressum Lecompte, 1952
Trupetostroma crassum Lecompte, 1952
Trupetostroma elegans (Yavorsky), 1951; (*Idiostroma elegans* Yavorsky)
Trupetostroma ? furcatopilosum (Gorsky), 1935; (*Actinostroma furcatopilosum* Gorsky)
Trupetostroma gebum (Yavorsky), 1931; (*Syringostroma geba* Yavorsky)
Trupetostroma ? heckeri (Riabinin), 1941; (*Parallelopora heckeri* Riabinin)
*Trupetostroma iowense Parks, 1936
Trupetostroma laceratum Lecompte, 1952
Trupetostroma macrostylum Le Maître, 1949
*Trupetostroma maculosum Parks, 1936
Trupetostroma maillieuxi Lecompte, 1952
Trupetostroma ? pingue Lecompte, 1952

Trupetostroma porosum Lecompte, 1952 = Stromatopora porosa (Lecompte), 1952

Trupetostroma pskovensia (Riabinin), 1941; (*Labechia pskovensis* Riabinin)

*Trupetostroma ? raricystosum, n. sp.

Trupetostroma ruedemanni Lecompte, 1952 = Stromatopora ruedemanni (Lecompte), 1952

Trupetostroma sublamellatum Lecompte, 1952 = Stromatopora sublamellata (Lecompte), 1952

Trupetostroma tschichatschevi (Yavorsky), 1931; (*Syringostroma tschichatschevi* Yavorsky)

Trupetostroma tenuilamellatum Lecompte, 1952

Trupetostroma thomasi Lecompte, 1952

Trupetostroma thomasi arduennense Lecompte, 1952

*Trupetostroma warreni Parks, 1936

REFERENCES

The following references include only 150 of the most important papers dealing with the Stromatoporoidea. A bibliography of over 500 items was published in the Journal of Paleontology, vol. 30, Jan. 1956, p. 170.

Bargatzky, A.

1881a. *Stachyodes, eine neue Stromatoporengattung.* Zeitschr. Deutschen Geol. Ges., vol. 33, pp. 688-691.

1881b. *Die Stromatoporen des rheinisches Devons.* Verhandl. naturhist. Vereins Preuss. Rheinlande Westfalens, vol. 38, pp. 233-304; separate pp. 1-79, 11 text figures.

Bassler, R. S.

1932. *The stratigraphy of the Central Basin of Tennessee.* Geol. Survey Tennessee, Bull. 38, pp. 214, 226, pl. 16, fig. 9; pl. 22, figs. 10, 11.

1935. *Descriptions of Paleozoic fossils from the Central Basin of Tennessee.* Jour. Washington Acad. Sci., vol. 25, pp. 404, 405.

Billings, E.

1857. *Ordovician and Silurian rocks of North America.* Geol. Survey Canada, Rept. Prog. 1853-56, pp. 343-345.

1865. *Notes on some of the more remarkable genera of Silurian and Devonian fossils.* Canadian Nat. and Geol., ser. 2, vol. 2, pp. 405-409, figs. 1, 2.

Boehnke, K.

1915. *Die Stromatoporen der nordischen Silurgeschiebe in Norddeutschland und in Holland.* Paleontolographica, Beitr. Natur. Vorzeit, vol. 61, pp. 147-190, pls. 16-18, 35 text figures.

Carter, H. J.

1877. *On the close relationship of Hydractinia, Parkeria, and Stromatopora.* Ann. Mag. Nat. Hist., ser. 4, vol. 19, pp. 44-76.

1878a. *On new species of Hydractiniidae, Recent and fossil and on the identity in structure of Millepora alcicornis with Stromatopora.* Ann. Mag. Nat. Hist., ser. 5, vol. 1, pp. 298-311.

1878b. *On the probable nature of the animal which produced the Stromatoporoidea traced through Hydractinia, Millepora alcicornis and Caunopora to Stromatopora.* Ann. Mag. Nat. Hist., ser. 5, vol. 2, pp. 304-324.

1879. *On the mode of growth of Stromatopora including the commensalism of Caunopora.* Ann. Mag. Nat. Hist., ser. 5, vol. 4, pp. 101-106.

1880. *On Stromatopora dartingtoniensis n. sp. with the tabulation in the larger branches of the astrorhiza.* Ann. Mag. Nat. Hist., ser. 5, vol. 6, pp. 339-347.

Charlesworth, J. K.

1915. *Die Fauna des devonischen Riffkalkes. IV. Korallen und Stromatoporoiden.* Zeitschr. Deutschen Geol. Ges., vol. 66, for 1914, pp. 384-389, pl. 34, figs. 4-6, 8 (Anhang.) *Obersilurische Korallen vom Westabhang des Findenig-Kofels bei paularo. Ibid.,* pp. 397, 398.

Cloud, Preston E., Jr.

1942. *Notes on stromatolites.* Am. Jour. Sci., vol. 240, pp. 363-379, pls. 1, 2, 1 text fig.

Cumings, E. R.

1908. *The stratigraphy and paleontology of the Ordovician rocks of Indiana.* 32d Ann. Rept. Geol. and Nat. Res. Indiana for 1907, pp. 700-703, pl. 1.

Cumings, E. R., and Shrock, R. R.

1928. *The geology of the Silurian rocks of northern Indiana.* Indiana Dept. Cons., Div. Geol., publ. 75, pp. 59, 189.

Dehée, R.

1929. *Description de la faune d'Etroeungt.* Mém. Soc. Géol. France, new ser. vol. 5, fasc. 2, Mém. 11, p. 48, pl. 8, figs. 6, 6a.

Dehorne, Y.

1916. *Stromatopores du Givétien de Glageon (Nord).* Bull. Soc. Géol. France, ser. 4, vol. 16, pp. 180-185, pl. 5.

Eastman, C. R.

1913. In Zittel-Eastman *Text-book of Paleontology.* MacMillan and Co. Ltd., London, 2d ed., pp. 121-124, figs. 189-192.

Endo, R.

1932. *The Canadian and Ordovician formations and fossils of South Manchuria.* United States Nat. Mus., Bull. 164, p. 40.

Etheridge, R., Jr.

1917. *An Australian Amphipora.* Rec. Australian Mus., vol. 11, pp. 239-241, pls. 54, 55.

1921. *Occasional descriptions of New South Wales fossils IV, Clathodictyon in the Upper Silurian of the Trundle District, New South Wales.* Rec. Geol. Survey New South Wales, vol. 10, pp. 7-9, pl. 5.

Felix, J.

1905. *Ueber die Gattung Amphipora.* Sitzungsbericht Naturforsch. Ges. Leipzig, vols. 30, 31, pp. 73-76, text figs. 1-3.

Fenton, Carroll Lane

1931. *Niagaran stromatoporoid reefs of the Chicago region.* Am. Mid. Nat., vol. 12, pp. 203-212, figs. 1-3.

Fenton, M. A.

1931. *A Devonian stromatoporoid reef.* Am. Mid. Nat., vol. 12, pp. 195-202, 2 pls., 2 text figs.

Flügel, Erik

1956. *Zur Bibliographie der Stromatoporen.* Mitteil. Naturw. vereins Steiermark, Bd. 86, pp. 26-31.

Foerste, A. F.

1909. *Preliminary notes on Cincinnatian and Lexington fossils.* Bull. Sci. Lab. Denison Univ., vol. 14, pp. 298-300, pls. 7-9.

1910. *Preliminary notes on Cincinnatian and Lexington fossils of Ohio, Indiana, Kentucky, and Tennessee.* Bull. Sci. Lab. Denison Univ., vol. 16, pp. 86, 87, pl. 1.

1916. *Notes on Cincinnatian fossil types.* Bull. Sci. Lab. Denison Univ., vol. 18, pp. 297-304, pls. 1, 2.

Foord, A. H.

1883. *Contributions to the micro-palaeontology of the Cambro-Silurian rocks of Canada.* Geol. Nat. Hist. Survey Canada, p. 25, pl. 7, fig. 1.

Fritz, M. A.

1941. *Catalogue of types in the Royal Ontario Museum of Paleontology.* Contrib. Roy. Ontario Mus. Paleont., No. 5, pt. 1, pp. 17-41.

Galloway, J. J., and **St. Jean, J., Jr.**

1955. *The type of the stromatoporoid species Stromatocerium rugosum Hall.* Am. Mus. Novitates, No. 1728, pp. 1-11, figs. 1-7.

1956. *A bibliography of the order Stromatoporoidea.* Jour. Paleontology, vol. 30, pp. 170-185.

Garwood, E. J.

1914. *Some new rock-building organisms from the Lower Carboniferous beds of Westmoreland.* Geol. Mag., ser. 5, vol. 11, p. 268, pl. 21, figs. 3, 4.

Girty, G. H.

1895. *A revision of the sponges and coelenterates of the Lower Helderberg group of New York.* 48th Ann. Rept., New York State Geol., vol. 2, pp. 289-298, pls. 6, 7.

Goldfuss, A.

1826. *Petrefacta Germaniae.* List and Francke, Leipzig, 1st ed., p. 21, pl. 8, figs. 5a-c. 2d ed., 1862.

Gorsky, I. I.

1935. *Some Coelenterata from the Lower Carboniferous beds of Novaya Zemlya.* Trans. Arctic Inst., vol. 28, pp. 7, 9-23, 70, 71, 73-76, 82-97, pls. 1-5, text figs. 1-4. (Russian with English summary.)

1938. *Some Stromatoporoidea from Palaeozoic beds of Novaya Zemyla;* in Gorsky, I. I., and others. *Paleontology of the Soviet Arctic.* Arctic Inst. U. S. S. R., vol. 101, pt. 3, pp. 7-45, pls. 1-7. (Russian with English summary.)

Grabau, A. W.

1910. In Grabau and Sherzer. *The Monroe formation of southern Michigan and adjoining regions.* Michigan Geol. Biol. Survey, publ. 2, geol. ser. 1, pp. 87-94, pls. 8, 9, 13, 16.

1913. *Principles of stratigraphy.* A. G. Seiler and Co., New York, pp. 385, 416-433, 444, 485, 943, figs. 85-90.

Grabau, A. W., and **Shimer, H. W.**

1909. *North American index fossils.* A. G. Seiler and Co., New York, vol. 1, pp. 34-47, figs. 56-74.

Gürich, G.

1904. *Eine Stromatoporoide aus dem Kohlenkalke Galiziens.* Beitr. Paläont. Geol. Österr. Ungarns Orients, vol. 17, pp. 1-5, pl. 1.

Hall, James

1847. *Palaeontology of New York.* Nat. Hist. New York. vol. 1, pp. 48, 323, pl. 12, figs. 2, 2a, 2b.

Hall, James, and **Whitfield, R. P.**

1873. *Descriptions of new species of fossils from the Devonian rocks of Iowa.* 23rd Ann. Rept. Reg. Univ. State of New York, pp. 233-243, pls. 9-10.

Hayes, C. W., and **Ulrich, E. O.**

1903. *Description of the Columbia quadrangle.* U. S. Geol. Survey Geol. Atlas, Columbia folio, No. 95, pp. 2, 5; faunal chart, figs 23, 24.

Hickson, S. J.

1934. *On Gypsina plana and on the systematic position of the stromatoporoids.* Quart. Jour. Micro. Sci., new ser. 303, vol. 76, pp. 433-480, 2 pls., 13 figs.

Johnson, J. H.

1951. *An introduction to the study of organic limestones.* Quart. Colorado Sch. Mines, vol. 46, No. 2, pp. 54-63, pls. 26, 27, 29-31.

Johnson, J. H., and **Pfender, J.**

1939. *Parallelopora goldfussi from the Devonian near Cody, Wyoming.* Jour. Paleontology, vol. 13, pp. 515, 516, pl. 60. (A species of *Stromatopora*).

Kühn, O.

1927. *Zur Systematik und Nomenklatur der Stromatoporen.* Zentralb. Min. Geol. Paläont., Abt. B, pp. 546-551.

1928. *Fossilium Catalogus* 1. *Animalia.* Pars 36. *Hydrozoa.* W. Junk, Berlin, pp. 1-114.

1939a. *Eine neue Familie der Stromatoporen.* Zentralbl. Min. Geol. Paläont., Abt. B., pp. 338-345, figs. 1-3.

1939b. *Hydrozoa.* In Schindewolf, *Handbuch der Paläozoologie.* Band 2A, pp. A36-A68, figs. 51-96.

Kunth, A.

1870. *Beiträge zur Kenntnis fossiler Korallen.* Zeitschr. Deutschen Geol. Ges., vol. 22, p. 82.

Lecompte, M.

1938. *Quelques types de "Récifs" Siluriens et Dévoniens de l'Amérique du Nord. Essai de comparaison avec les récifs coralliens Actuels.* Bull. Mus. Roy Hist. Nat. Belgique, vol. 14, No. 39, pp. 1-51, pls. 1-5.

1951-1952. *Les Stromatoporoides du Dévonien moyen et supérieur du Bassin de Dinant.* Inst. Roy. Sci. Nat. Belgique, Mém. 116, pp. 1-215, pls. 1-35; Mém. 117, pp. 216-369, pls. 36-70.

Le Maitre, D.

1931. *Les Stromatoporoides de la zone d'Etroeungt.* (*Note Préliminaire*). Ann. Soc. Géol. Nord. vol. 56, pp. 207-212.

1933. *Description des Stromatoporoides de l'assise Etroeungt.* Soc. Géol. France, Mém., new ser., vol. 9, pp. 1-32, pls. 1-7.

1937. *Etude de la faune corallienne des calcaires Givétiens de la Ville-De-d'Ardin (Deux-Sèvres).* Bull. Soc. Géol. France, ser. 5, vol. 7, pp. 105-128, pls. 7-10.

1949. *Sur quelques genres de Stromatopores Dévoniens et leur micro-structure.* Bull. Soc. Géol. France, ser. 5, vol. 19, pp. 513-526, pls. 16-18, figs. 1-8.

Lindstrom, G.

1873. *Nagra Anteckningar om Anthozoa tabulata.* Ofvers Kongl. Vetenskaps-Akad. Fohr., No. 4, pp. 3-20. Translation, 1876, Ann. Mag. Nat. Hist., ser. 4, vol. 18, pp. 4, 5, 11, 16.

Lonsdale, W., in **Murchison, R. I.**

1839. *Corals. The Silurian system, founded on geological researches.* John Murray, London, pt. 2, pp. 676, 680, 681, 711, pl. 15, figs. 31, 31a-d.

Ludwig, R.

1865-1866. *Corallen aus paläolithischen Formationen.* Palaeontographica. Beitr. Naturgesch. Vorwelt, Bd. 14, pp. 139, 142, pl. 72, figs. 1, 1a, b.

McCoy, F.

1844. *A synopsis of the characters of the Carboniferous limestone fossils of Ireland.* University Press, Dublin, pp. 193, 194.

Miller, S. A.

1889. *North American geology and palaeontology:* Western Methodist Book Concern, Cincinnati, Ohio, pp. 155-158, 165, 166, 310, figs. 96, 100, 123-125; First appendix, 1892, pp. 668, 685.

Milne-Edwards, H., and **Haime, J.**

1851. *Monographie des polypiers fossiles des terrains paléozoïques précédée d'un tableau general de la classification des polypes.* Archives du Museum d'Hist. Nat., Paris, vol. 5, pp. 279, 280.

Newell, N. D.

1935. *Some mid-Pennsylvanian invertebrates from Kansas and Oklahoma*: II. *Stromatoporoidea, Anthozoa, and Gastropoda.* Jour. Paleontology, vol. 9, p. 341, pl. 34, figs. 6-10. (A sponge.)

Nicholson, H. A.

1873. *On some new species of Stromatopora.* Ann. Mag. Nat. Hist., ser. 4, vol. 12, pp. 89-95, pl. 4.

1874. *On the affinities of the genus Stromatopora with descriptions of two new species.* Ann. Mag. Nat. Hist., ser. 4, vol. 13, pp. 4-14, figs. 1-3.

1875. *Descriptions of Amorphozoa from the Silurian and Devonian formations.* Geol. Survey Ohio, vol. 2, pt. 2, pp. 245-255, pl. 24.

1879. *On the structure and affinities of the tabulate corals of the Palaeozoic period.* Edinburgh and London, pp. 28, 29, 330-337, figs. 12, 44; pl. 15, figs 4, 4a.

1886a. *On some new or imperfectly known species of stromatoporoids.* Ann. Mag. Nat. Hist., ser. 5, vol. 17, pp. 225-239, pls. 6-8.

1886b. *On some new or imperfectly known species of stromatoporoids.* Ann. Mag. Nat. Hist., ser. 5, vol. 18, pp. 8-82, pls. 1, 2.

1887. *On some new or imperfectly known species of stromatoporoids.* Ann. Mag. Nat. Hist., ser. 5, vol. 19, pp. 1-17, pls. 1-3.

1891a. *On some new or imperfectly known species of stromatoporoids.* Ann. Mag. Nat. Hist., ser. 6, vol. 7, pp. 309-328, pls. 8-10.

1886c, 1889, 1891b, 1892. *A monograph of the British stromatoporoids.* Palaeont. Soc. London, vols. 39, 42, 44, 46, pts. 1-4, pp. 1-234, pls. 1-29.

Nicholson, H. A., and Murie, J.

1878. *The minute structure of the skeleton of Stromatopora and its allies.* Jour. Linn. Soc. London, Zoology, vol. 14, pp. 187-246, pls. 1-4. (Published August 31, 1878)

Okulitch, V. J.

1943. *North American Pleospongia.* Geol. Soc. America, Special Paper 48, p. 83, pls. 16, 17.

öpik, A.

1935. *Amphipora ramosa (Phillips) in the marine Devonian of Estonia.* Ann. Nat. Soc. Tartu Univ., Pub. Geol. Inst. 41, pp. 1-8, pls. 1, 2.

Oxley, P.

1951. *Chazyan reef facies relationships in the northern Champlain Valley.* Bull. Sci. Lab. Denison Univ., vol. 42, pp. 92, 95, 97, 98, 100, 102, 104, 105.

Ozaki, Kin-Emon

1938. *On some stromatoporoids from the Ordovician limestone of Shantung and south Manchuria.* Jour. Shanghai Sci. Inst., sec. 2, vol. 2, pp. 205-233, pls. 23-34.

Parks, W. A.

1904. *Devonian fauna of Kwataboahegen River.* Ontario Bur. Mines, 13th Rept., pt. 1, p. 184, pl. 4, figs. 5, 6.

1907. *The stromatoporoids of the Guelph formation in Ontario.* Univ. Toronto Studies, Geol. Ser., No. 4, pp. 1-40, pls. 1-6.

1908. *Niagara stromatoporoids.* Univ. Toronto Studies, Geol. Ser., No. 5, pp. 1-68, pls. 7-15.

1909. *Silurian stromatoporoids of America.* Univ. Toronto Studies, Geol. Ser., No. 6, pp. 1-52, pls. 16-20.

1910. *Ordovician stromatoporoids,* Univ. Toronto Studies, Geol. Ser., No. 7, pp. 1-52, pls. 21-25.

1933. *New species of stromatoporoids, sponges, and corals from the Silurian strata of Baie des Chaleurs.* Univ. of Toronto Studies, Geol. Ser., No. 33, pp. 4-32, pls. 1-6, 8.

1935. *Systematic position of the Stromatoporoidea.* Jour. Paleontology, vol. 9, pp. 18-29, pls. 6, 7; 1934, abstract; Geol. Soc. America Proc. for 1933, pp. 344, 345.

1936. *Devonian stromatoporoids of North America.* Univ. Toronto Studies, Geol. Ser., No. 39, pp. 1-125, pls. 1-19.

Paul, H.

1939. *Die Etrouengt-Schichten des Bergischen Landes.* Jahrb. Preuss. geol. Landesanstalt, vol. 59, pp. 720-722, pls. 39-42.

Phillips, J.

1841. *Figures and descriptions of the Palaeozoic fossils of Cornwall, Devon, and West-Somerset.* Longman, Brown, Green and Longmans, London, pp. 18, 19, 143, 173, 203, 205, 210, pls. 8, 10.

Plummer, J. T.

1843. *Suburban geology or rocks, soil and water, about Richmond, Wayne County, Indiana.* Am. Jour. Sci., vol. 44, pp. 293, 294, fig. 8.

Počta, P.

1894. *Bryozoaires, Hydrozoaires, et partie des Anthozoairies;* in Barrande, *System Silurien du Centre de la Bohême.* Prague, pt. 1, vol. 8, pp. 133-164, pls. 18, 18 bis, 19, 19 bis.

Quenstedt, F. A.

1876-1879. *Petrefaktenkunde Deutschlands.* Tübingen, Abt. 1, Bd. 5, 612 pp., 28 pls.

Raymond, P. E.

1914. *A Beatricea-like organism from the Middle Ordovician.* Canada Dept. Mines, Geol. Surv. Mus. Bull. 5, pp. 1-19, pls. 1-4.

1924. *The oldest coral reef.* Rept. State Geol. Vermont, vol. 14, pp. 72-75, 1 text fig.

1931. *Notes on invertebrate fossils, with descriptions of new species.* Bull. Museum Comp. Zoology, Harvard College, Geol. Ser., vol. 9, pp. 177-184, pls. 2, 3.

Reed, F. R. C.

1927. *Palaeozoic and Mesozoic fossils from Yunnan.* Mem. Geol. Surv. India, Pal. Indica, vol. 10, No. 1.

Riabinin, V. N.

1932. *On some Upper Devonian Stromatoporoidea.* Bull. United Geol. Prosp. Serv. U. S. S. R., vol. 51, pp. 1125-1133, pls. 1, 2.

Riabinin, V. N., in Hecker et al.

1941. *Fauna of the Main Devonian field.* U. S. S. R. Acad. Sci., Paleont. Inst., vol. 1, pp. 85-106 (Russ.), pp. 106-109 (English summary), 8 figs. 5 pls.

Ripper, E. A.

1933. *The stromatoporoids of the Lilydale limestone. Part I — Actinostroma and Clathrodictyon.* Roy. Soc. Victoria, Proc., new ser. vol. 45, pp. 152-164, figs. 1-6.

1937a. *A note on the occurrence of Amphipora ramosa (Phillips) in Western Australia.* Roy Soc. Western Australia, Jour., vol. 23, pp. 37-41, 1 pl., 3 text figs.

1937b. *The stromatoporoids of the Lilydale limestone. Part II — Syringostroma, Stromatopora, and other genera.* Roy. Soc. Victoria Proc. new ser., vol. 49, pp. 178-205, pls. 8, 9, text figs. 1-4.

1937c. *On some stromatoporoids from Griffith's quarry, Loyola, Victoria.* Roy. Soc. Victoria Proc., new ser. vol. 50, pp. 1-8, pl. 1.

1937d. *On the stromatoporoids of the Buchan district, Victoria.* Roy. Soc. Victoria Proc., new ser. vol. 50, pp. 11-38, pls. 2-5.

1938. *Notes on the middle Palaeozoic stromatoporoid faunas of Victoria.* Roy. Soc. Victoria Proc., new ser. vol. 50, pp. 221-243, figs. 1-4.

Roemer, C. F.

1844. *Das rheinische Uebergangesgebirge.* Hannover, 96 pp., 6 pls.

1880. *Note on the genus Caunopora, of Phillips.* Geol. Mag., vol. 7, pp. 343-345.

Rominger, C. L.
1886. *Minute structure of Stromatopora and its allies.* Proc. Acad. Nat. Sci. Philadelphia, vol. 38, pp. 39-56.

Rosen, F. B.
1867. *Ueber die Natur der Stromatoporen und über die Erhaltung der Hornfaser der Spongien im fossilen Zustande.* Verhandlgn. Russ. Kaiserl. Min. Ges., St. Petersburg, ser. 2, vol. 4, pp. 1-98, pls. 1-11.

Safford, J. M.
1869. *Geology of Tennessee.* S. C. Mercer, Printer to the State, Nashville, Tennessee, p. 285.

Schuchert, C.
1919. *The proper name for the fossil hydroid Beatricea.* Am. Jour. Sci., vol. 47, pp. 293-296, fig. 1.

Schulz, E.
1893. *Die Eifelkalkmulde von Hillesheim. Nebst einem palaeontolog Anhang.* Jahrg. Königl. Preuss. geol. Landesanstalt und Bergakad., for 1882, Abhandl., pp. 160, 182-184, 187, 197, 200, 208, 245-247, pl. 22, figs. 5-7; pl. 23, fig. 1.

Seely, H. M.
1904. *The stomatoceria of Isle La Motte, Vermont.* Rept. State Geol. Vermont, vol. 4, pp. 144-152.

Shimer, H. W., and **Shrock, R. R.**
1944. *Index fossils of North America.* John Wiley and Sons, Inc., New York; Chapman and Hall, Ltd., London, pp. 58-63, pls. 18, 19.

Shrock, R. R., and **Raasch, G. O.**
1937. *Stratigraphy and structure of the area of disturbed Ordovician Rocks near Kentland, Indiana.* Am. Midland Naturalist, vol. 18, pp. 484, 489, 491, 492, 498-501, 507, 511-513, 515, 536-538, pl. 2, figs. 1-3.

Smith, S.
1932. *Labechia carbonaria nov. sp. a Lower Carboniferous stromatoporoid from West Cumberland.* Summary Prog. Geol. Surv. Great Britain and Mus. Practical Geol. for 1931, pt. 2, pp. 23-33, pl. 1. (Includes description and figures of *Labechia conferta* Lonsdale from the Middle Silurian).

Spencer, J. W.
1883. *Stromatoporidae of the Upper Silurian.* Bull. Mus. Univ. Missouri, vol. 1, pp. 43-52.
1886. *Niagara fossils.* Trans. St. Louis Acad. Sci., vol. 4, pp. 593-602, pls. 1-9.

Spinar, Z.
1946. *The stromatoporoids of the Devonian of Moravia.* Bull. Intern. Acad. Tchèque Sci., vol. 47, No. 17, pp. 1-10, pls. 1-4. (English summary.)

Stauffer, C. R.
1930. *The Devonian of California.* Univ. California Pub. Geol. Sci., vol. 19, pp. 86-90, 95, 98, 100, 106, pls. 10-12.

Steinmann, G.
1878. *Ueber fossile Hydrozoen aus der Familie der Coryniden.* Palaeontographica, Beitr. Naturgeschichte Vorzeit., vol. 25, pp. 102, 104, 106-108, 112-115, pl. 12, figs. 10-12.

Stuckenberg, A.

1895. *Korallen und Bryozoen der Steinkalenablagerungen des Ural und des Timan.* Mem. Com. Geol., vol. 10, no. 3, pp. 1-244.

Sugiyama, T.

1939. *Geological and geographical distribution of stromatoporoids in Japan, with notes on some interesting forms.* Yabe Jubilee Pub., vol. 1, pp. 427-456, pls. 24-26.

1940. *Stratigraphical and paleontological studies of the Gotlandian deposits of the Kitakami Mountainland.* Sci. Rep. Tôhoku Imp. Univ., ser. 2, vol. 21, pp. 86, 88-91, 93-96, 98-114, pls. 13-18, 22, 23, 25, 29, 31, 32.

1941. *A new form of the genus Labechiellata from Chosen (Korea).* Jour. Geol. Soc. Japan, vol. 48, pp. 461-463, figs. 1-3.

1942. *Amphipora from the Devonian of China.* Jour. Geol. Soc. Japan, vol. 49. no. 587, pp. 112-116, pls. 4 (3), 5(4).

Swartz, C. K., in **Swartz, C. K., Schuchert, C.,** and **Prosser, C. S.**

1913. *Lower Devonian.* Maryland Geol. Surv., pp. 100, 102, 103, 105, 108, 109, 124, 139-141, 143-145, 148, 149, 152, 154, 156, 158, 162, 165, 166, 170, 221-227, pls. 27-30.

Tripp, K.

1929. *Untersuchungen über den Skelettbau von Hydractinien zu einer vergleichenden Betrachtung der Stromatoporen.* Neues Jahrb. Min. Geol. Paläont. Beilage-Band, vol. 62, pt. B, pp. 467-508, pls. 21-30, 29 text figs.

Twenhofel, W. H.

1927. *Geology of Anticosti Island.* Canada Dept. Mines, Geol. Survey Mem. 154, no. 135, pp. 16, 24, 27, 28, 30, 31, 35, 37, 44-46, 49-54, 56, 60, 64-67, 69, 70, 75, 83, 104, 107.

Twitchell, G. B.

1928-1929. *The structure and relationship of the true stromatoporoids.* Am. Midland Naturalist, vol. 11, pp. 270-306, pls. 18-24, figs. 1-2.

Vinassa de Regny, P. E.

1918. *Coralli mesodevonici della Carnia.* Palaeontographia Italica, Mem. Paleont., vol. 24, pp. 61, 64, 65, 109-119, pls. 9-12.

Waagen, W., and **Wentzel, J.**

1887. *Salt Range fossils.* Paleont. Indica, ser. 13, pp. 925-939, 943, pls. 120, 121.

Whiteaves, J. F.

1906. *The fossils of the Silurian (Upper Silurian) rocks of Keewatin, Manitoba, the northeastern shore of Lake Winnipegosis, and the lower Saskatchewan River.* Geol. Survey Canada, Palaeozoic Fossils, vol. 3, pt. 4, pp. 244, 276.

Wilson, A. E.

1947. *The Algae, Spongiae, Anthozoa, Stromatoporoidea, Graptolitoidea, Vermes, conodonts, and trails of the Ottawa formation within the Ottawa-St. Lawrence Lowland.* Roy. Soc. Canada Proc., ser. 3, vol. 41, p. 192.

1948. *Miscellaneous classes of fossils, Ottawa formation, Ottawa-St. Lawrence Valley.* Canada Geol. Survey Bull. 11, pp. 5, 45-50, pls. 22-25.

Wilson, C. W., Jr.

1949. *Pre-Chattanooga stratigraphy in central Tennessee.* Tennessee Dept. Cons., Div. Geol. Bull. 56, pp. 4, 37, 50, 56, 61, 66, 67, 119, 129, 138, 139, 143, 150, 151, 153, 192, 337, pl. 6, figs. 4, 5; pl. 12, figs. 6, 7; pl. 21, fig. 4.

Winchell, A.

1866. *Appendix to a report on the Grand Traverse region.* Michigan Geol. Survey, pp. 90-92.

1867. *Stromatoporidae: their structure and zoological affinities.* Proc. Am. Assoc. Adv. Sci., for 1866, vol. 15, pp. 91-99.

Yabe, H., and **Sugiyama, T.**

1930a. *On some Ordovician stromatoporoids from South Manchuria, North China and Chôsen (Corea), with notes on two new European forms.* Sci. Repts. Tôhoku Imp. Univ., ser. 2, vol. 14, pp. 47-62, pls. 17-23.

1930b. *Notes on two stromatoporoids from Chôsen (Corea).* Jap. Jour. Geol. Geog., vol. 8, pp. 9, 10, pls. 3, 4.

1933. *Discovery of Amphipora and Clathrodictyon in the Permian of Japan.* Jap. Jour. Geol. Geog. vol. 11, p. 19, 3 text figs.

1935. *Jurassic stromatoporoids from Japan.* Sci. Rep. Tôhoku Imp. Univ., ser. 2, vol. 14, p. 176.

Yavorsky, V. I.

1929. *Silurian stromatoporoids.* Bull. Com. Géol., vol. 48, no. 1, pp. 77-114, pls. 5-12. (Russian and English.)

1931. *Some Devonian stromatoporoids from the outskirts of the Kuznetsk Basin, the Ural, and other localities.* Bull. United Geol. Prosp. Serv., U. S. S. R., vol. 50, fasc. 94, pp. 1387-1415, pls. 1-4.

1932. *Eine Stromatoporenfund in Cambrium.* Centralbl. Min. Geol. Palaeont., Abt. B, pp. 613-616, 5 figs.

1943. *Devonian Stromatoporellidae and their role in the study of the stratigraphy of the Kuznetsk Basin.* Acad. Sci. U. S. S. R., Comptes Rendus (Doklady), vol. 39, pp. 369, 370.

1947. *On some Palaeozoic and Mesozoic Hydrozoa, Tabulata and Algae.* Palaeont. U. S. S. R. Mon., vol. 20, pt. 1, pp. 4, 9-15, 27, 30, 31, 33, pls. 1, 2, 4-7. (Russian with English summary.)

1950. *Devonskie Stromatoporella i ikh znachenie dlia Stratigraphii.* Voprosy Paleontol., vol. 1, pp. 243-263, pls. 1-7 (Russian).

1951. *Nekotory Paleozoiskie Stromatoporoidei.* Minist. Geol., All Union Geol. Inst., Moscow, pp. 1-32, pls. 1-6, (Russian).

1955. *Stromatoporoidea Sovetskogo Soyuza.* Tr. Vsesoyuz. Nauchno-issledov. Geol. Inst. Minist. Geol. Okhr. Nedr, nov. ser., vol. 8, pp. 1-173, pls. 1-89, text figs. 1-11. (Russian)

Zittel, K. A.

1877. *Beiträge zur Systematik der fossilen Spongien.* Ann. Mag. Nat. Hist., ser. 4, vol. 20, pp. 515-517.

1879. *Handbuch der Palaeontologia.* vol. 1, Leiferg. 2, p. 284.

SELECTED STRATIGRAPHIC REFERENCES

Campbell, Guy

1942. *Middle Devonian stratigraphy of Indiana.* Geol. Soc. America Bull. 53, pp. 1055-1072.

Cooper, G. A.

1933. *Stratigraphy of the Hamilton group of eastern New York.* Am. Jour. Sci., 5th ser., vol. 26, pp. 537-551.

1941. *New Devonian stratigraphic units.* Washington Acad. Sci., Jour., vol. 31, No. 5, pp. 179-181.

Cooper, G. A., and **Warthin, A. S.**

1942. *New Devonian (Hamilton) correlations.* Geol. Soc. America Bull. 53, pp. 873-888, 3 figs.

Cooper, G. A., et al.

1942. *Correlation of the Devonian sedimentary formations of North America.* Geol. Soc. America Bull. 53, pp. 1729-1794, 1 fig., 1 pl.

Cumings, E. R.

1922. *Handbook of Indiana Gelogy, Devonian.* Indiana Dept. of Conservation, Div. of Geol., pp. 463-475.

Dawson, T. A.

1941. *The Devonian formations of Indiana.* Part 1. *Outcrop in southern Indiana.* State of Indiana, Dept. of Conservation, pp. 1-48, 20 text figs.

Grabau, A. W.

1902. *Stratigraphy of the Traverse group of Michigan.* Michigan Geol. Survey Rept. 1901, pp. 163-210.

Lecompte, M.,

1938. *Quelque types de "Récifs" Siluriens et Dévonien de l'Amérique du Nord. Essai de comparaison avec les récifs coralliens Actuels.* Bull. Mus. Roy. Hist. Nat. Belgique, vol. 14, no. 39, pp. 1-51, pls. 1-5, 7 text figs.

McFarlan, A. C.

1950. *Geology of Kentucky.* The University of Kentucky, pp. 45-56.

Pohl, E. R.

1930. *Devonian formations of the Mississippi Basin.* Tennessee Acad. Sci. Jour., vol. 5, pp. 54-63.

Savage, T. E.

1910. *The Grand Tower (Onondaga) formation of Illinois, and its relation to the Jeffersonville beds of Indiana.* Illinois State Acad. Sci., Trans., vol. 3, pp. 116-132.

Stauffer, C. R.

1909. *The Middle Devonian of Ohio.* Geol. Surv. Ohio, 4th ser., Bull. 10, pp. 1-204.

Teichert, Curt

1943. *The Devonian of Western Australia.* Am. Jour. Sci., vol. 241, pp. 69-94, 167-184.

Ulrich, E. O.
1911. *Revision of the Paleozoic Systems.* Geol. Soc. America Bull. 22, pp. 281-680, pls. 25-29.

Warthin, A. S., Jr., and **Cooper, G. A.**
1935. *New formation names in the Michigan Devonian.* Washington Acad. Sci., Jour., vol. 25, pp. 524-526.

Weller, J. M.
1944. *Symposium on Devonian stratigraphy.* Illinois State Geol. Surv. Bull. 67-A, 222 pp.

Whitlatch, G. I., and **Huddle, H. W.**
1932. *The stratigraphy and structure of a Devonian limestone area in Clark County, Indiana.* Proc. Indiana Acad. Sci., for 1931, vol. 41, pp. 363-390, 7 figs.

PLATES

Explanation of Plate 1

All figured specimens are catalogued and deposited in the Indiana University Paleontological Collections. All figures are times 10 unless otherwise indicated. The numbers in parentheses are numbers of slides from which the photographs were taken. The figures have been moderately retouched, to bring out characters which are frequently obscure. About two-fifths of each specimen is deposited in the United States National Museum, Washington, D. C.

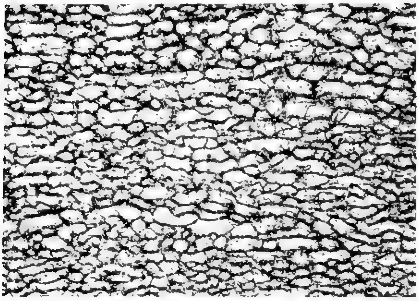
Figure — Page

1. **Clathrodictyon vesiculosum** Nicholson and Murie 92
   a. Vertical section of a typical specimen of the type species showing cysts end to end rather than regular laminae and pillars, as in *Anostylostroma*. b. Tangential section; Middle Silurian, Louisville limestone, quarry at Charlestown, Ind. (303-65, 66). Plesiotype, No. 5365.

2. **Clathrodictyon confertum** Nicholson 93
   a. Vertical section; the cysts are smaller than in *C. vesiculosum* and tend to be in horizontal lines. b. Tangential section; Columbus limestone, Dublin, Ohio. (305-97, 98); Ohio State Univ. Mus. specimen, No. 3760. Plesiotype, No. 5394.

3. **Anostylostroma columnare** (Parks) 97
   a. Vertical section; note laminae and pillars, rather than cysts as in *Clathrodictyon;* a topotype of the species. b. Tangential section; Columbus limestone, old quarry, Marblehead, Ohio. (282-66, 69). Plesiotype, No. 5395.

4. **Anostylostroma mediale** Galloway and St. Jean, n. sp. 98
   a. Vertical section, showing thick, transversely porous laminae, transversely fibrous pillars, and foramina. b. Tangential section; Logansport limestone, France Lime and Stone Co. quarry, 5 miles east of Logansport, Ind. (304-5, 6). Holotype, No. 5324.



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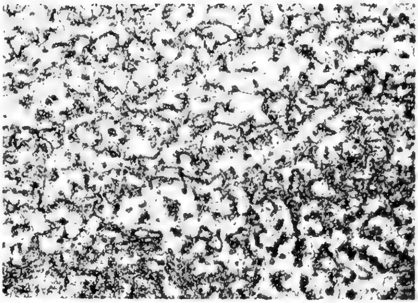

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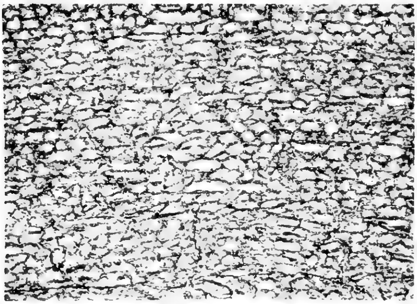

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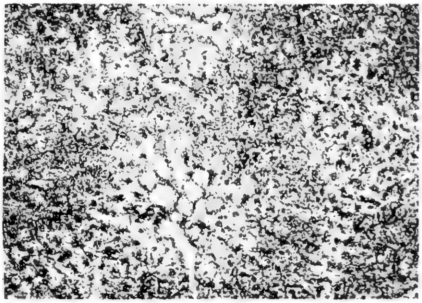

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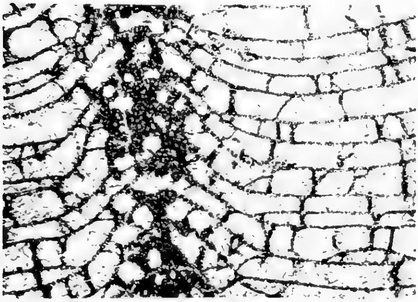

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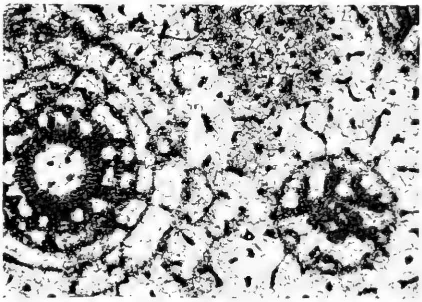

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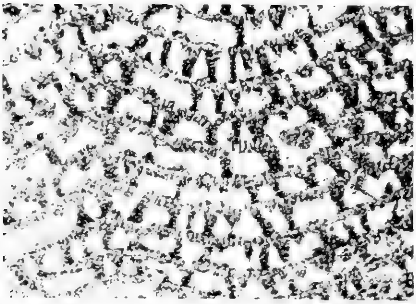

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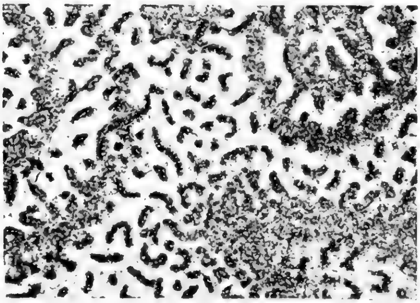

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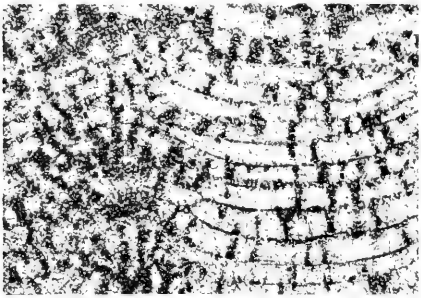

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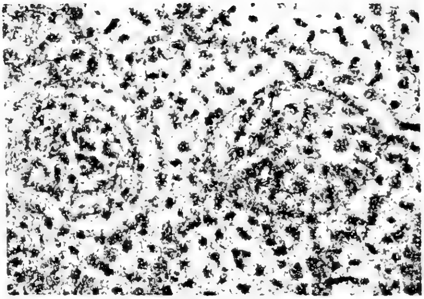

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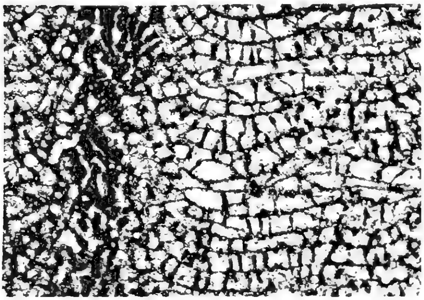

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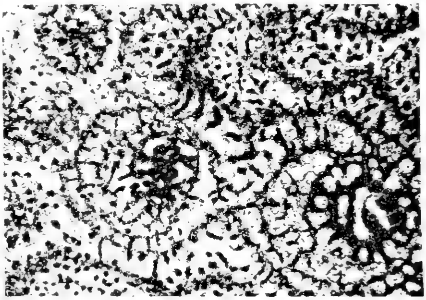

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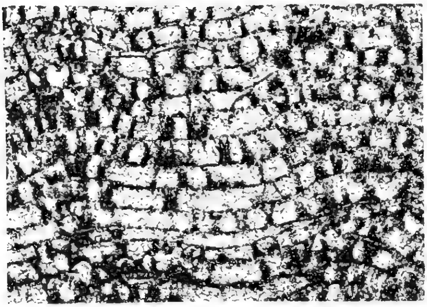

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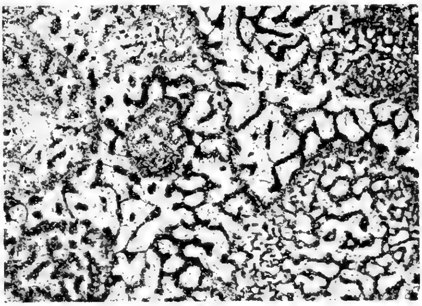

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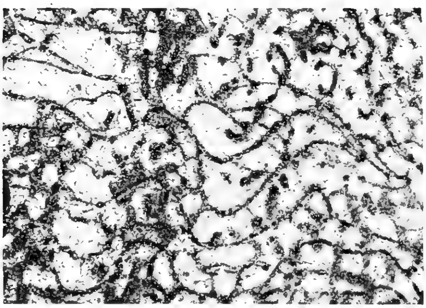

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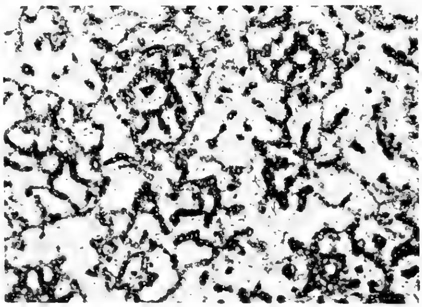


4b

Explanation of Plate 2

All figures are times 10. The numbers in parentheses are numbers of slides from which the photographs were taken.

Figure | Page

1. **Anostylostroma pulpitense** Galloway and St. Jean, n. sp. 100
   a. Vertical section. b. Tangential section; Logansport limestone, Pulpit Rock, 3 miles east of Logansport, Ind. (303-51, 52). Holotype, No. 5343.

2. **Anostylostroma subcolumnare** Galloway and St. Jean, n. sp. 101
   a. Vertical section. b. Tangential section; Jeffersonville limestone, Highway 42, 3.3 miles southwest of Prospect, Ky. (305-34, 35). Holotype, No. 5387.

3. **Anostylostroma confluens** Galloway and St. Jean, n. sp. 103
   a. Vertical section. b. Tangential section; Logansport limestone, Pipe Creek Falls, 10 miles southeast of Logansport, Ind. (285-24, 26). Holotype, No. 5352.

4. **Anostylostroma crebricolumnare** Galloway and St. Jean, n. sp. 104
   a. Vertical section, showing the highly undulose laminae, short pillars and small columns. b. Tangential section; Little Rock Creek limestone, France Lime and Stone Co. quarry, 5 miles east of Logansport, Ind. (294-85, 86). Holotype, No. 5344.

Explanation of Plate 3

All figures are times 10. The numbers in parentheses are numbers of slides from which the photographs were taken.

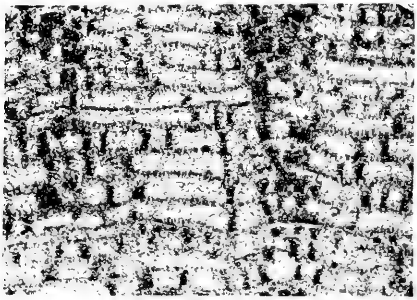
Figure | Page

1. **Anostylostroma microcolumnare** Galloway and St. Jean, n. sp. 105
   a. Vertical section. b. Tangential section; Logansport limestone, Pipe Creek Falls, 10 miles southeast of Logansport, Ind. (304-87, 89). Holotype, No. 5353.

2. **Anostylostroma microtuberculatum** (Riabinin) 106
   a. Vertical section. b. Tangential section; Little Rock Creek limestone, France Lime and Stone Co. quarry, 5 miles east of Logansport, Ind. (294-97, 98). Plesiotype, No. 5345.

3. **Anostylostroma compactum** Galloway and St. Jean, n. sp. 108
   a. Vertical section. b. Tangential section; Logansport limestone, Pipe Creek Falls, 10 miles southeast of Logansport, Ind. (305-48, 49). Holotype, No. 5354.

4. **Anostylostroma dupontense** Galloway and St. Jean, n. sp. 109
   a. Vertical section. b. Tangential section; Jeffersonville limestone, Independent quarry, 4 miles south of Dupont, Ind. (305-40, 41). Holotype, No. 5366.



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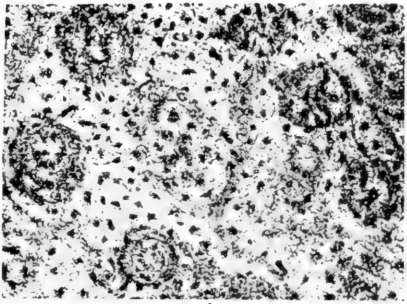

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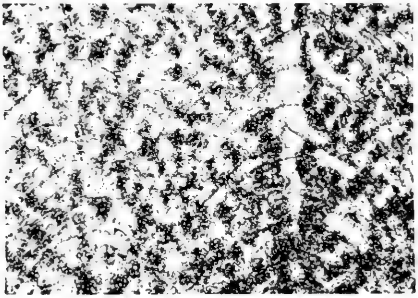

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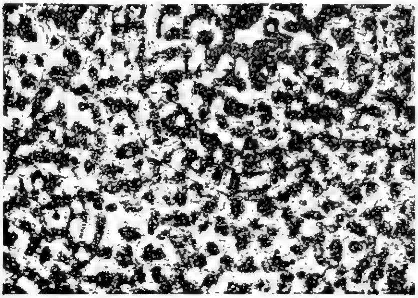

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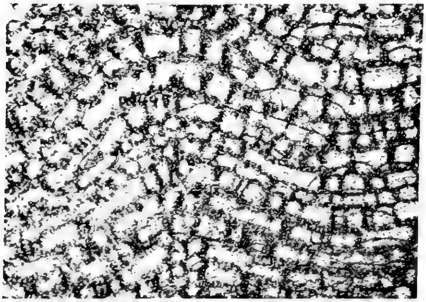

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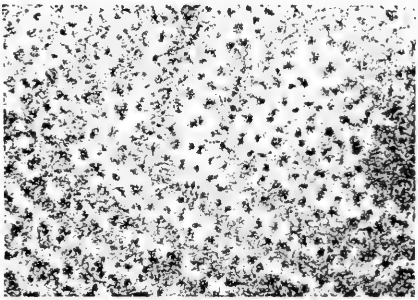

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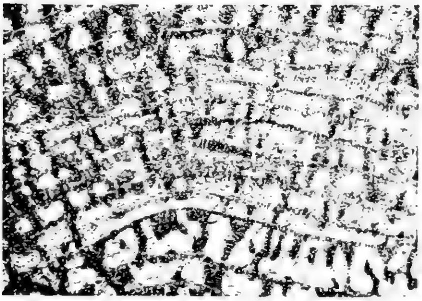

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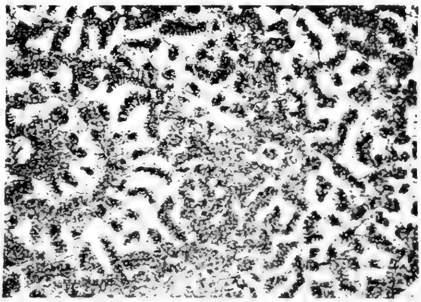

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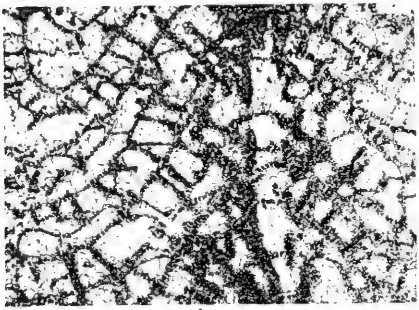

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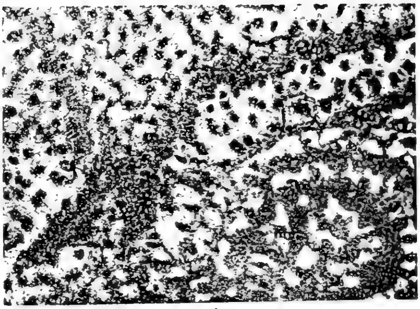

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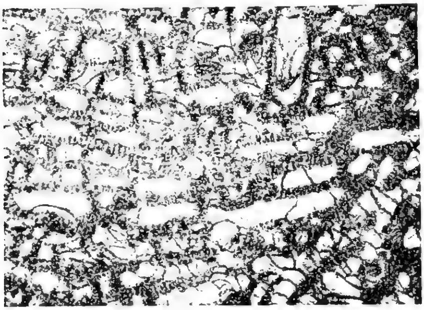

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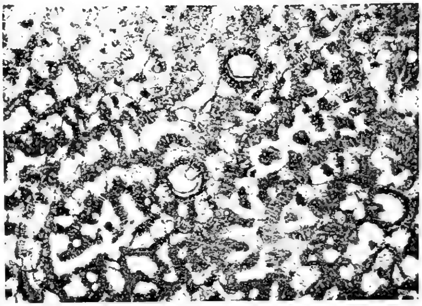

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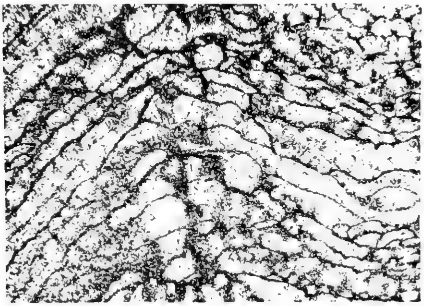

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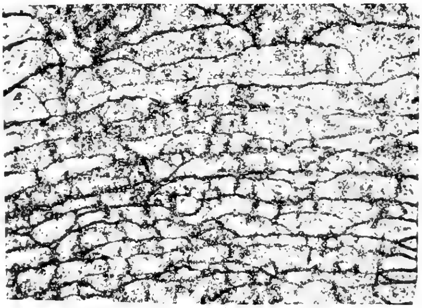

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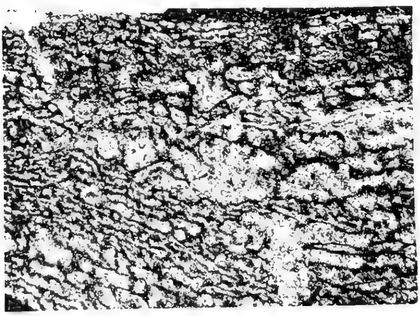

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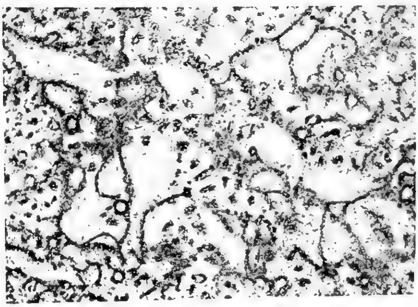


3d

Explanation of Plate 4

All figures are times 10. The numbers in parentheses are numbers of slides from which the photographs were taken.

Figure Page

1. **Anostylostroma arvense** (Parks) 110
a. Vertical section. b. Tangential section; Columbus limestone, Marblehead, Ohio. (282-72; 303-77). Plesiotype, No. 5396.

2. **Anostylostroma ponderosum** (Nicholson) 111
a. Vertical section. b. Tangential section; Jeffersonville limestone, Independent quarry, 4 miles south of Dupont, Ind. The large tubes are *Syringopora*. (285-74; 304-91). Plesiotype, No. 5367.

3. **Anostylostroma insulare** (Parks) 113
a. Vertical section in a mamelon center, with several mamelon tubes. b. Vertical section in an intermamelon area, showing wrinkled laminae, indistinct pillars, long and short dissepiments, and spheroidal vesicles. c. Vertical section of distorted laminae and pillars and spheroidal vesicles, from the same thin section as figure b. d. Tangential section through a mamelon, cutting astrorhizal canals obliquely, and showing round and oblong pillars and spheroidal vesicles; Columbus limestone, Kelleys Island, Ohio. (305-65, 67, 68). Plesiotype, No. 5397.

Explanation of Plate 5

All figures are times 10. The numbers in parentheses are numbers of slides from which the photographs were taken.

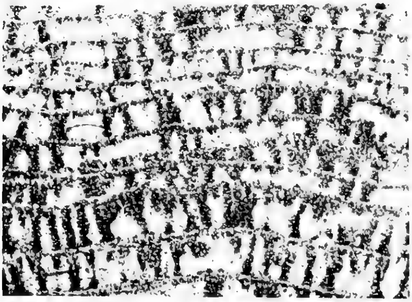
Figure — Page

1. **Anostylostroma humile** Galloway and St. Jean, n. sp. 115
a. Vertical section. b. Tangential section; Logansport limestone, France Lime and Stone Co. quarry, 5 miles east of Logansport, Ind. (294-4, 5). Holotype, No. 5325.

2. **Anostylostroma laxum** (Nicholson) 116
a. Vertical section showing sporadic mamelon with short tube. b. Tangential section with sporadic mamelon; Columbus limestone, Snouffer's quarry, 5 miles northwest of Columbus, Ohio. (282-52, 53). Plesiotype, No. 5399.

3. **Anostylostroma meshbergerense** Galloway and St. Jean, n. sp. 118
a. Vertical section, showing undulating laminae and pillars with dark centers. b. Tangential section, showing round pillars, and rings; Jeffersonville limestone, Meshberger Stone Co. quarry, 8 miles southeast of Columbus, Ind. (304-90, 93). Holotype, No. 5368.

4. **Anostylostroma substriatellum** (Nicholson) 119
a. Vertical section. b. Tangential section; Columbus limestone, old quarry, Marblehead, Ohio. (282-55, 57). Plesiotype, No. 5398.



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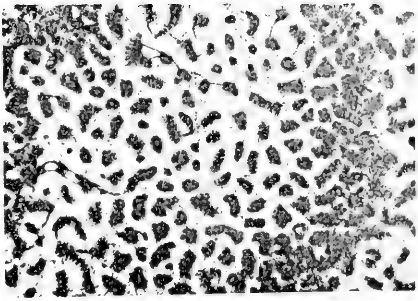

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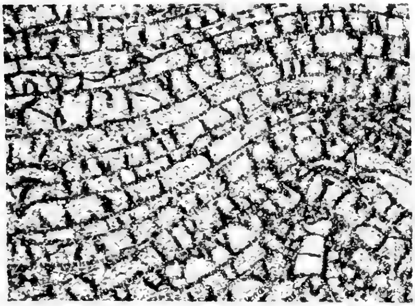

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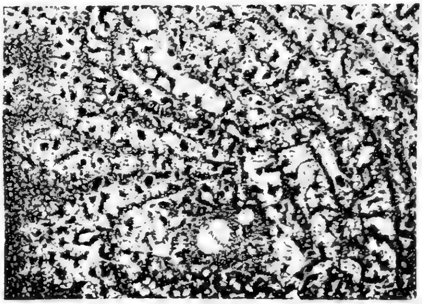

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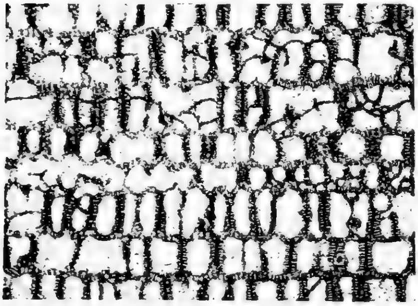

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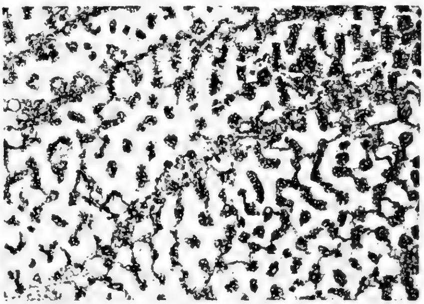

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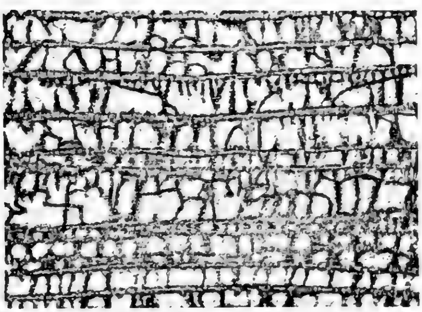

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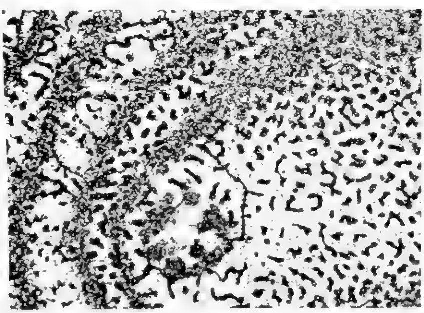

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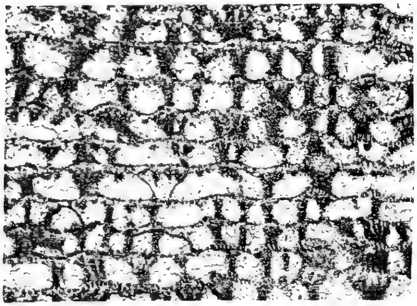

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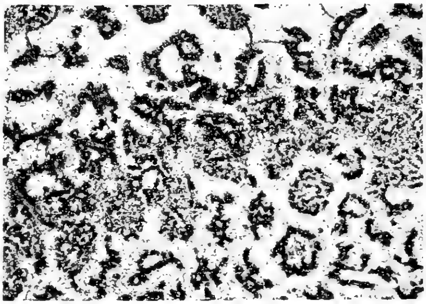

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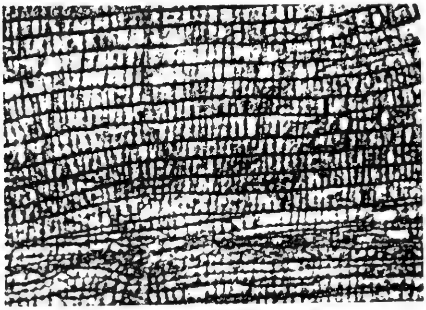

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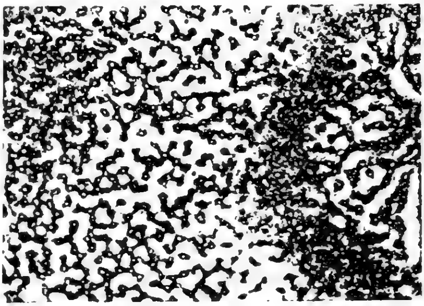

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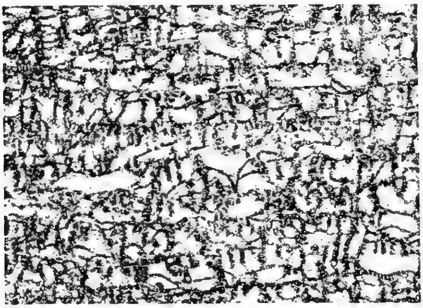

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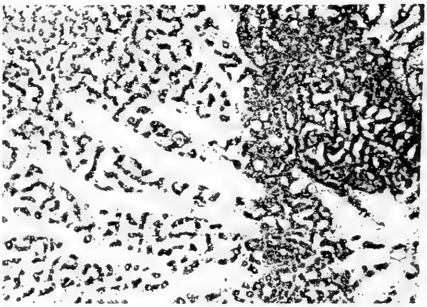

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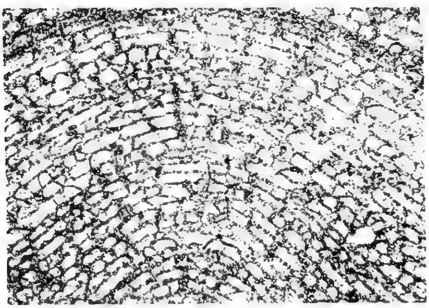

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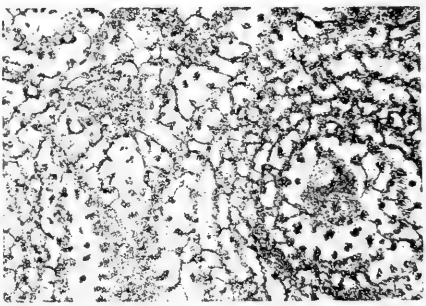


4b

Explanation of Plate 6

All figures are times 10 unless otherwise indicated. The numbers in parentheses are numbers of slides from which the photographs were taken.

Figure	Page

1. **Anostylostroma pipecreekense** Galloway and St. Jean, n. sp. 120
   a. Vertical section; b. Tangential section; Logansport limestone, Pipe Creek Falls, 10 miles southeast of Logansport, Ind. (304-61, 62). Holotype, No. 5355.

2. **Atelodictyon fallax** Lecompte 122
   a. Vertical section X4.6. b. Tangential section X8; *Calceola sandalina* beds, Couvinian, Dinant Basin, Belgium. (Type figures from Lecompte, 1951, pl. 15, figs. 1a, 1d).

3. **Atelodictyon intercalare** Galloway and St. Jean, n. sp. 123
   a. Vertical section. b. Tangential section; Jeffersonville limestone, Meshberger Stone Co. quarry, 8 miles southeast of Columbus, Ind. (300-7, 8). Holotype, No. 5369.

4. **Stictostroma mamilliferum** Galloway and St. Jean, new name 125
   a. Vertical section. b. Tangential section; Onondaga limestone, Ashton's quarry, 1½ miles east of Gorrie, Ont. (300-90, 91). Plesiotype, No. 5400.

Explanation of Plate 7

All figures are times 10. The numbers in parentheses are numbers of the slides from which the photographs were taken.

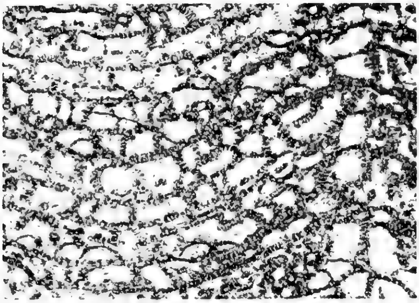
Figure	Page

1. **Stictostroma jeffersonvillense** Galloway and St. Jean, n. sp. 127
   a. Vertical section. b. Tangential section; Jeffersonville, limestone, Falls of the Ohio, Jeffersonville, Ind. (304-75, 76). Holotype, No. 5360.

2. **Stictostroma mcgraini** Galloway and St. Jean, n. sp. 128
   a. Vertical section. b. Tangential section; Jeffersonville limestone, Hgw. 42, 3.3 miles southwest of Prospect, Ky. (305-28. 30). Holotype, No. 5389.

3. **Stromatoporella granulata** (Nicholson) 131
   a. Vertical section. b. Tangential section showing repair tissue in the upper left corner; Hungry Hollow formation, George Coultis and Son's Brick and Tile Co. clay pit, Thedford, Ont. (282-38). Plesiotype, No. 5390.

4. **Stromatoporella morelandensis** Galloway and St. Jean, n. sp. 132
   a. Vertical section. b. Tangential section; "Onondaga limestone", probably Hamilton limestone, Moreland, Lincoln Co., Ky. (300-11, 12), Princeton University Paleontological Collections, specimen, No. 830. Holotype, No. 5388.



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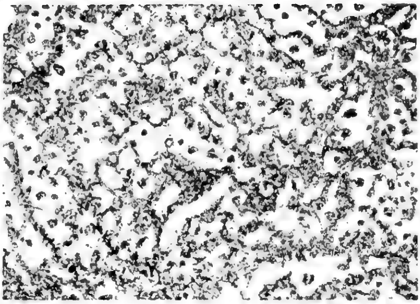

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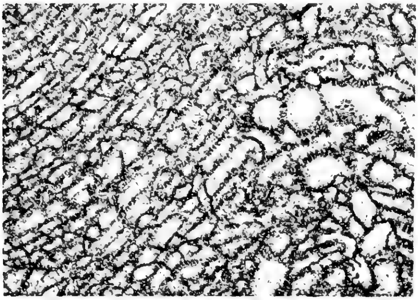

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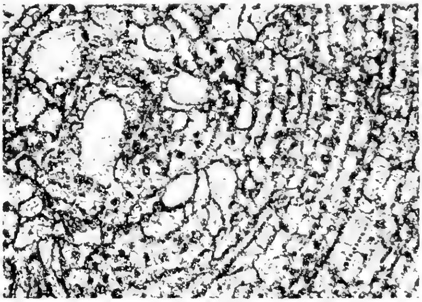

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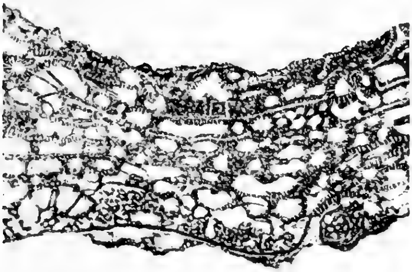

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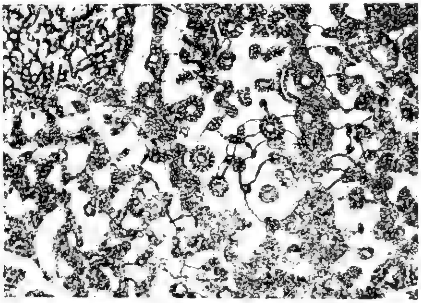

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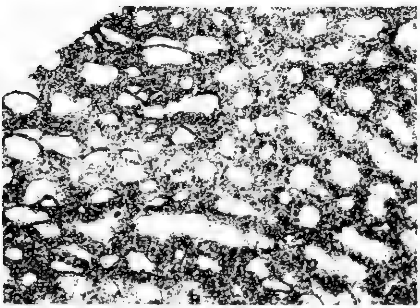

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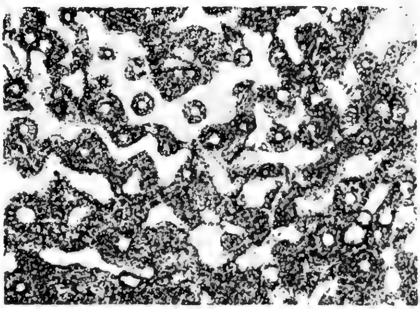

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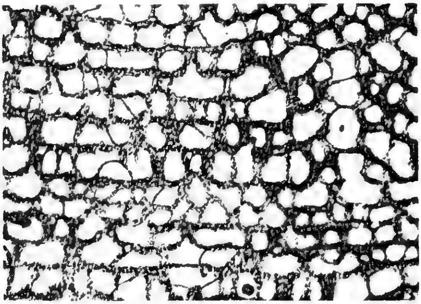
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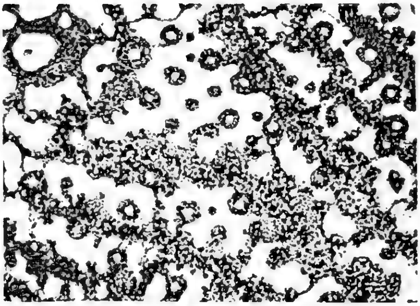
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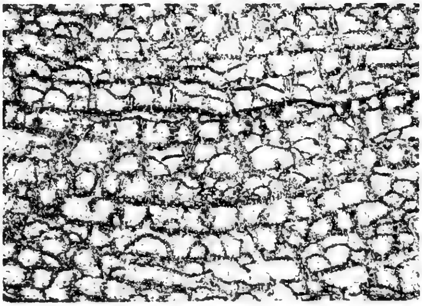
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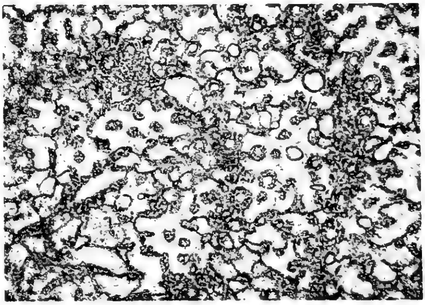
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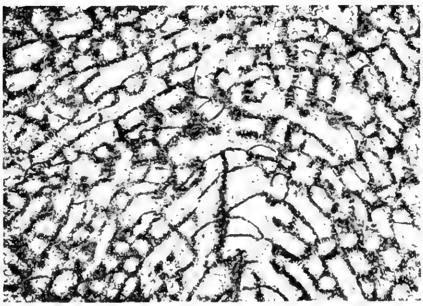
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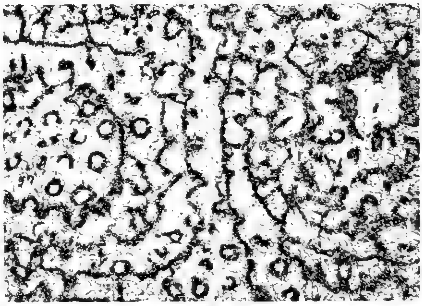
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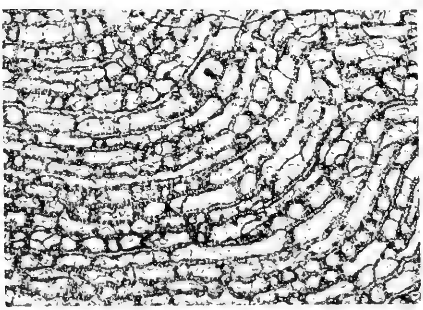
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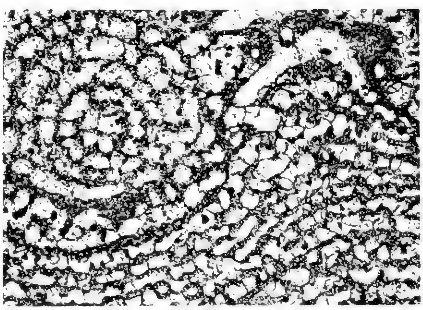
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Explanation of Plate 8

All figures are times 10. The numbers in parentheses are numbers of slides from which the photographs were taken.

Figure | Page
1. **Stromatoporella selwyni** Nicholson 133
a. Vertical section. b. Tangential section; basal Jeffersonville limestone, 1 mile northwest of Hanover, Ind. (295-58). Plesiotype, No. 5373.

2. **Stromatoporella kirki** Galloway and St. Jean, n. sp. 135
a. Vertical section. b. Tangential section; Jeffersonville limestone, Meshberger Stone Co. quarry, 8 miles southeast of Columbus, Ind. (306-15, 16). Holotype, No. 5370.

3. **Stromatoporella solitaria** Nicholson 136
a. Vertical section. b. Tangential section; Logansport limestone, France Lime and Stone Co. quarry, 5 miles east of Logansport, Ind. (303-4, 5). Plesiotype, No. 5326.

4. **Stromatoporella parasolitaria** Galloway and St. Jean, n. sp. 137
a. Vertical section. b. Tangential section; both ordinary pillars and ring-pillars are more common in some parts of the section. Jeffersonville limestone, Charlestown, Ind. (282-18, 19). Holotype, No. 5374.

Explanation of Plate 9

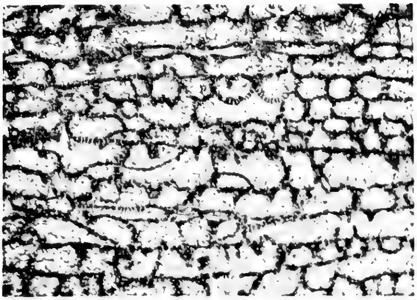
All figures are times 10. The numbers in parentheses are numbers of slides from which the photographs were taken.

Figure — Page

1. **Stromatoporella huronensis** (Parks) 139
a. Vertical section of an intermamelon area. b. Vertical section of a mamelon center (the specimen was crushed in the upper left-hand corner). c. Tangential section of an intermamelon area, ring-pillars common. d. Tangential section of a mamelon center, ring-pillars rare, pores in some of the laminae (all figures from the same specimen); Logansport limestone, loose in a yard at Camden, Carrol Co., Ind. (282-88, 90, 91). Plesiotype, No. 5375.

2. **Stromatoporella cryptoannulata** Galloway and St. Jean, n. sp. 141
a. Vertical section. b. Tangential section; Logansport limestone, France Lime and Stone Co. quarry, 5 miles east of Logansport, Ind. (294-8, 9). Holotype, No. 5327.

3. **Stromatoporella perannulata** Galloway and St. Jean, n. sp. 142
a. Vertical section. b. Tangential section; Jeffersonville limestone, Jefferson County quarry, 1.2 miles northeast of Louisville, Ky. city limits on Hgw. 42. (305-42, 52). Holotype, No. 5391.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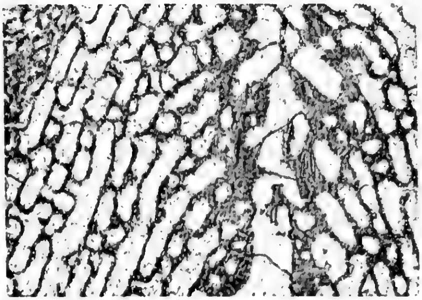
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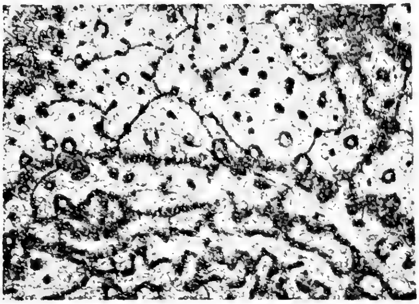
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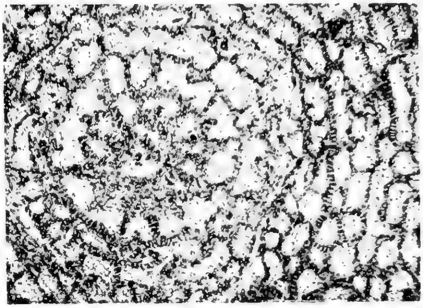
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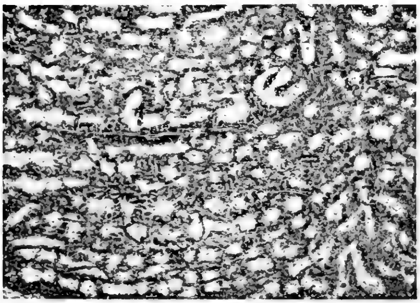
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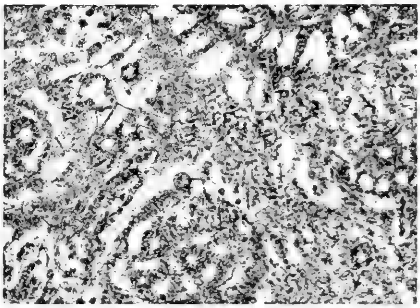
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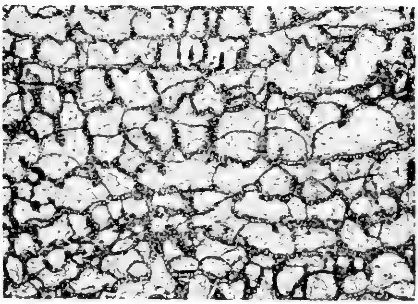
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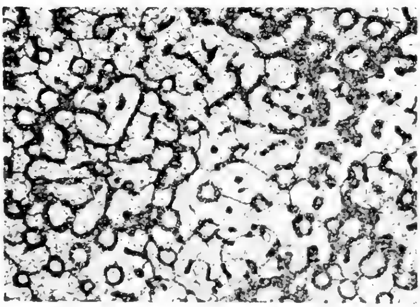
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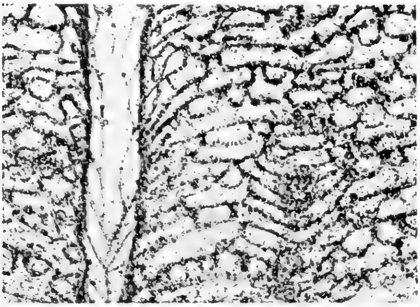
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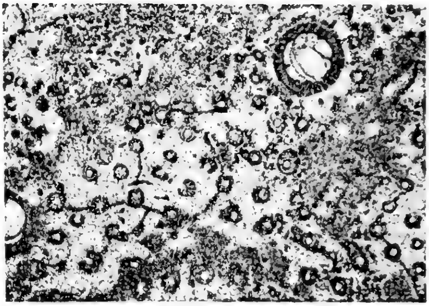
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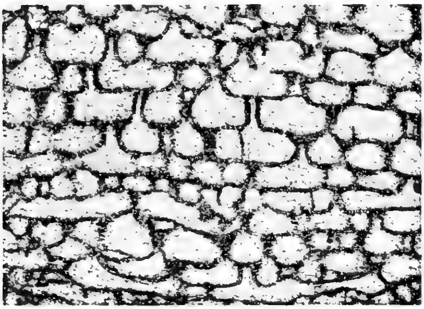
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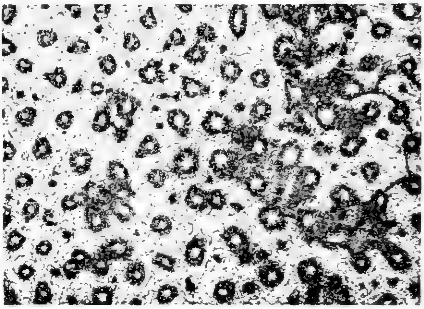
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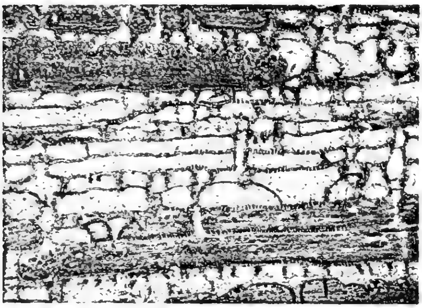
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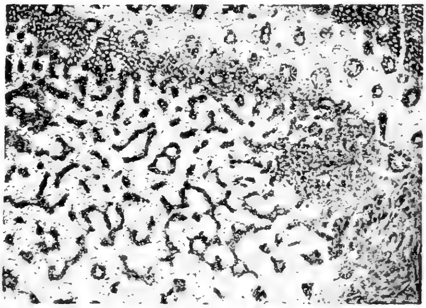
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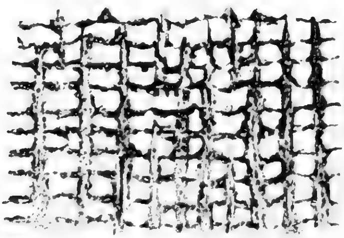
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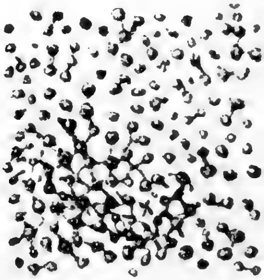
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Explanation of Plate 10

All figures are times 10 unless otherwise indicated. The numbers in parentheses are numbers of slides from which the photographs were taken.

Figure — Page

1. **Stromatoporella** cf. **cellulosa** (Nicholson and Murie) 144
a. Vertical section. b. Tangential section; Jeffersonville limestone, Big Spring, 2 miles west of Hanover, Ind. The large tubes are *Syringopora* (295-57; 305-51). Plesiotype, No. 5376.

2. **Stromatoporella eriensis** (Parks) 145
a. Vertical section, the laminae are farther apart than is normal in the section. b. Tangential section; Columbus limestone, Columbus, Ohio. (303-8, 9). Plesiotype, No. 5401.

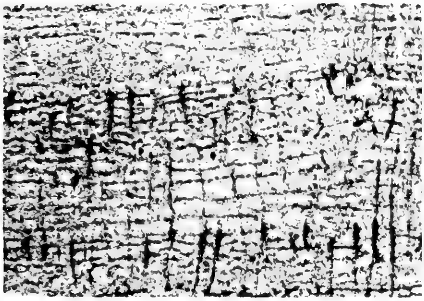
3. **Stromatoporella columbusensis** Galloway and St. Jean, n. sp. 147
a. Vertical section, the galleries are in part filled with mud. b. Tangential section; Columbus limestone, Snouffer's quarry, 5 miles northwest of Columbus, Ohio. (282-54). Holotype, No. 5402.

4. **Actinostroma clathratum** Nicholson 149
a. Vertical section X12. b. Tangential section X12; Middle Devonian, Gerolstein, Germany. Type figures from Nicholson, 1886, pl. 1, figs. 11, 12.

Explanation of Plate 11

All figures are times 10. The numbers in parentheses are numbers of slides from which the photographs were taken.

Figure	Page
1. **Actinostroma tyrrelli** Nicholson	150
a. Vertical section. b. Tangential section; Logansport limestone, France Lime and Stone Co. quarry, 5 miles east of Logansport, Ind. (303-67, 68). Plesiotype, No. 5328.
2. **Gerronostroma elegans** Yavorsky	152
a. Vertical section. b. Tangential section; Middle Devonian, Kuznetsk Basin, Russia (306-43, 44). Paratype, No. 5379.
3. **Gerronostroma plectile** Galloway and St. Jean, n. sp.	153
a. Vertical section. b. Tangential section; Jeffersonville limestone, Louisville Cement Co. quarry, Speed, Ind. (295-24, 25). Holotype, No. 5377.
4. **Gerronostroma excellens** Galloway and St. Jean, n. sp.	155
a. Vertical section. b. Tangential section; Jeffersonville limestone, quarry at Charlestown, Ind (282-12, 13). Holotype, No. 5378.



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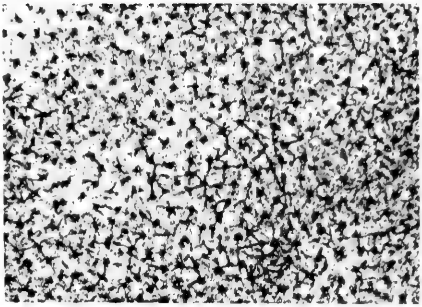

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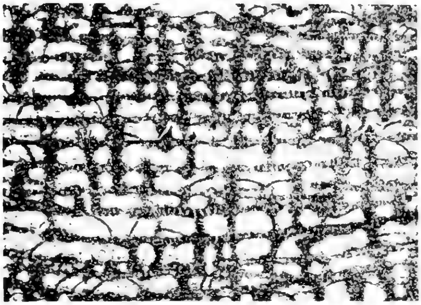

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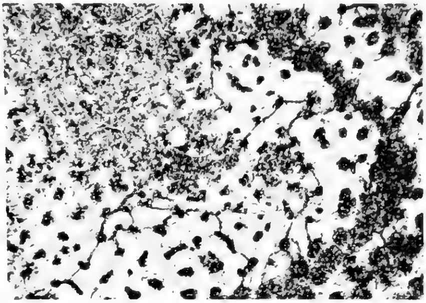

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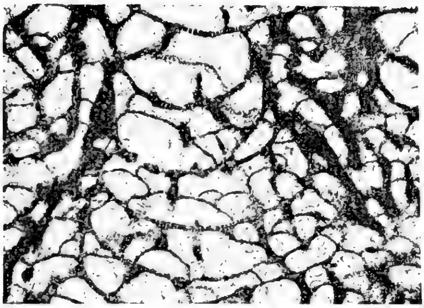

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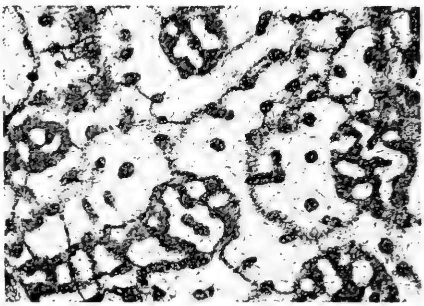

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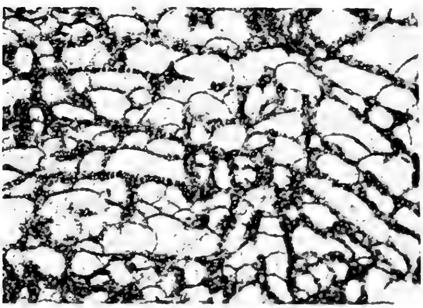

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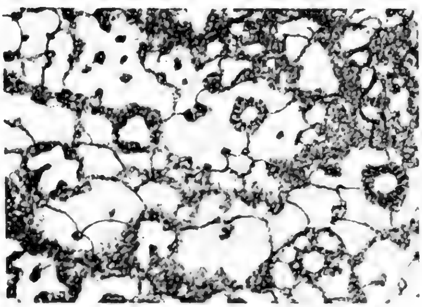

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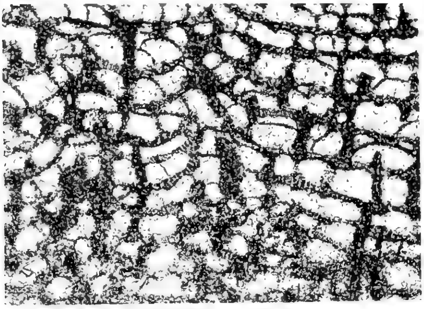

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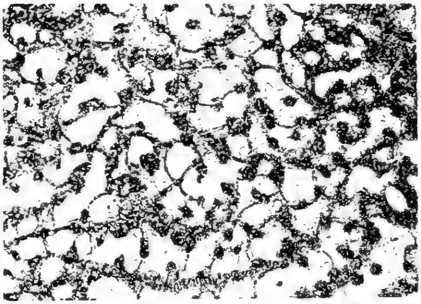

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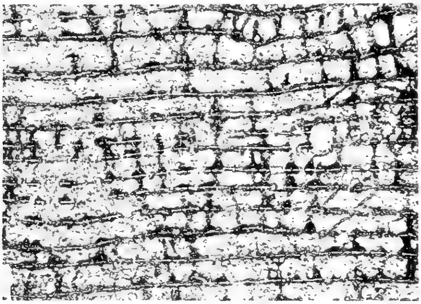

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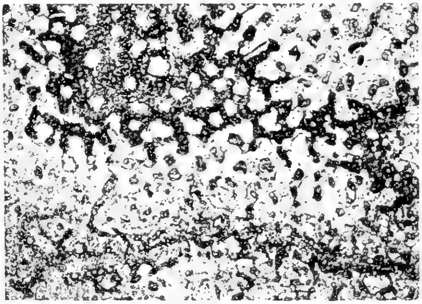

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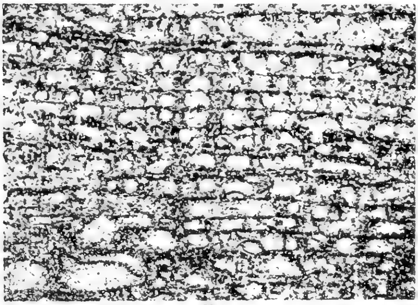

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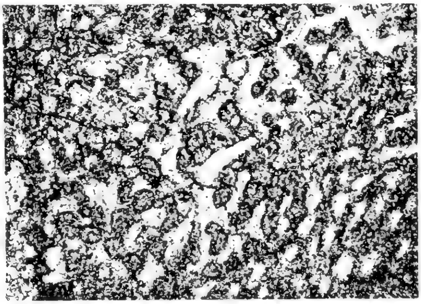

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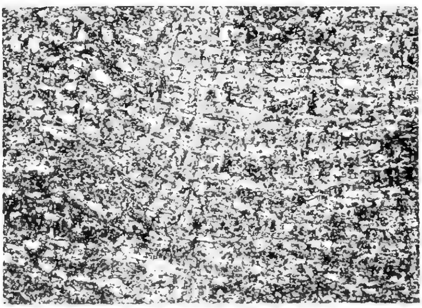

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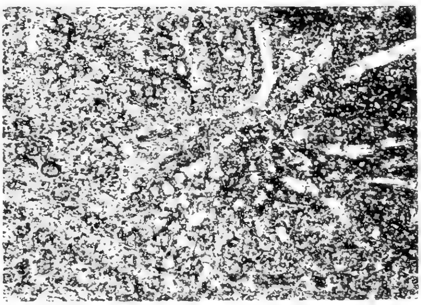


5b

Explanation of Plate 12

All figures are times 10. The numbers in parentheses are numbers of slides from which the photographs were taken.

Figure — Page

1. **Gerronostroma** cf. **insolitum** (Parks) 156
   a. Vertical section. b. Tangential section; Jeffersonville limestone, Falls of the Ohio, Jeffersonville, Ind. (305-57, 58). Plesiotype, No. 5361.

2. **Trupetostroma warreni** Parks 159
   a. Vertical section. b. Tangential section; Middle Devonian, Fort Creek shale, Hoosier Ridge, 22 miles down the Mackenzie River from Fort Norman, N.W.T., Canada (282-26) Plesiotype, No. 5380.

3. **Trupetostroma** ? **raricystosum** Galloway and St. Jean, n. sp. 161
   Vertical section from the holotype; Logansport limestone, France Lime and Stone Co. quarry, 5 miles east of Logansport, Ind. (294-14). Holotype, No. 5329.

4. **Trupetostroma** ? **raricystosum** Galloway and St. Jean, n. sp. 161
   Tangential section from a paratype; Logansport limestone, France Lime and Stone Co. quarry, 5 miles east of Logansport, Ind. (294-26). Paratype, No. 5330.

5. **Trupetostroma coalescens** Galloway and St. Jean, n. sp. 162
   a. Vertical section. b. Tangential section; Logansport limestone, France Lime and Stone Co. quarry, 5 miles east of Logansport, Ind. (304-71, 72). Holotype, No. 5346.

Explanation of Plate 13

All figures are times 10. The numbers in parentheses are numbers of slides from which the photographs were taken.

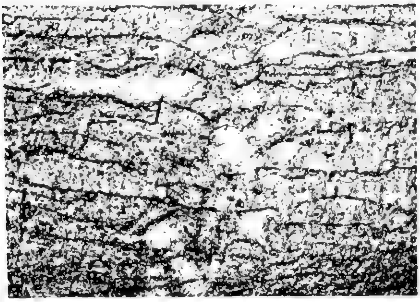
Figure Page

1. **Stromatopora marpleae** Galloway and St. Jean, n. sp. 169
a. Vertical section. b. Tangential section; Columbus limestone, southside quarry, Kelleys Island, Ohio. (306-34, 35). Holotype, No. 5403.

2. **Stromatopora obscura** Galloway and St. Jean, n. sp. 170
a. Vertical section. b. Tangential section; Jeffersonville limestone, 2 mi. south of Hartsville, Ind. (285-10, 11) Holotype, No. 5381.

3. **Stromatopora larocquei** Galloway and St. Jean, n. sp. 171
a. Vertical section. b. Tangential section; Columbus limestone, Marble Cliff quarry, east of Hgw. 33, north of Trabue road, Columbus, Ohio (306-30, 31). Holotype, No. 5404.

4. **Stromatopora divergens** Galloway and St. Jean, n. sp. 173
a. Vertical section. b. Tangential section; Logansport limestone, France Lime and Stone Co. quarry, 5 miles east of Logansport, Ind. (294-29, 30). Holotype, No. 5331.



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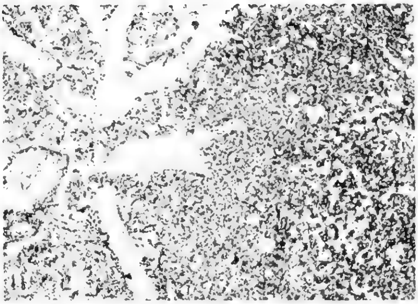

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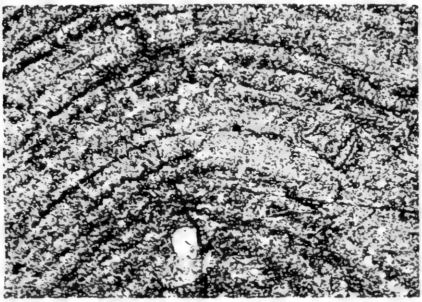

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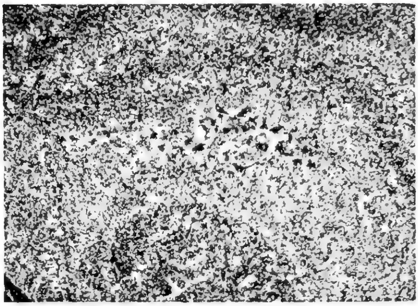

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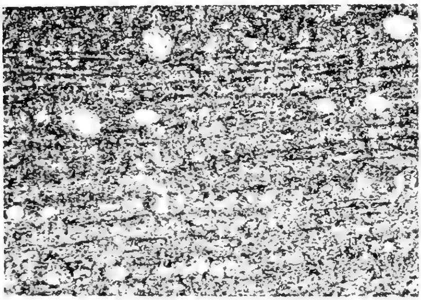

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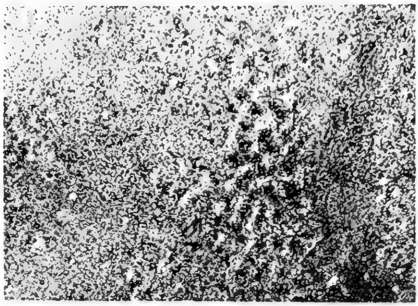

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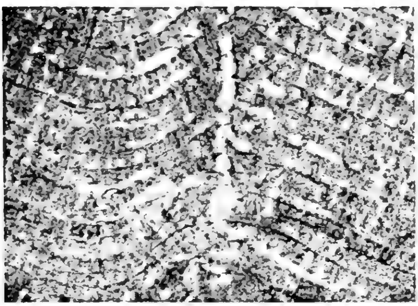

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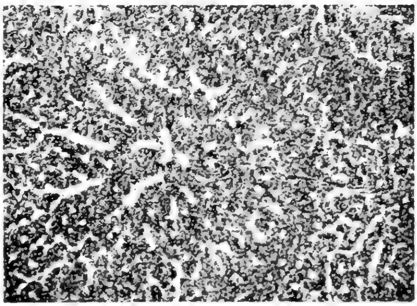

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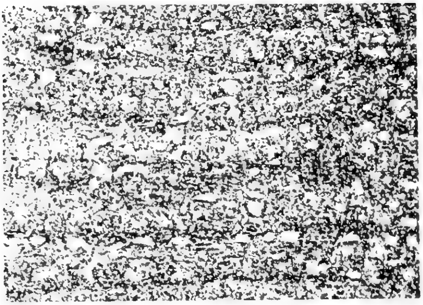

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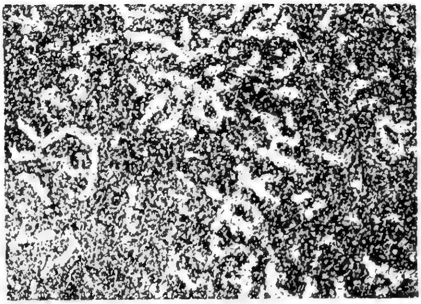

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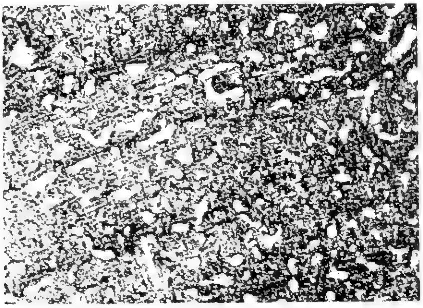

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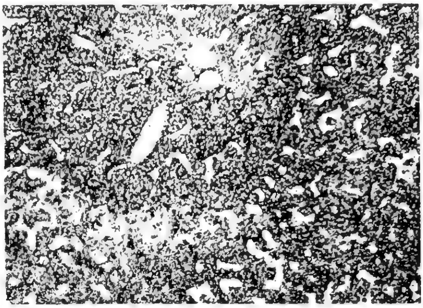

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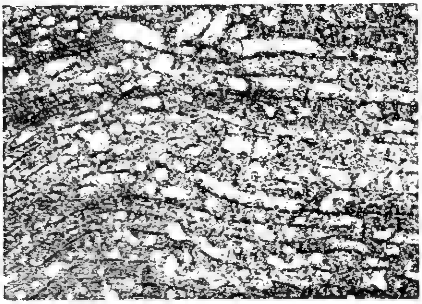

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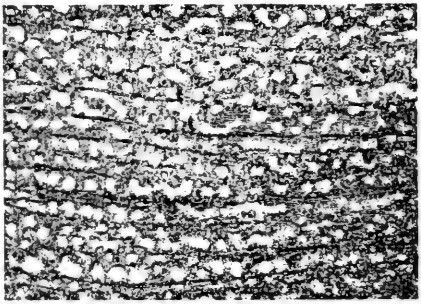

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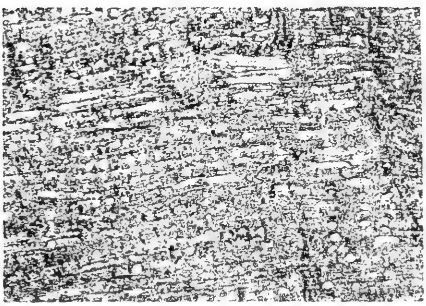

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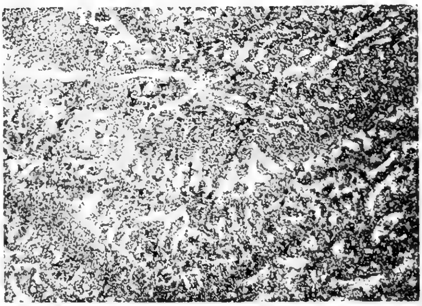

4b

Explanation of Plate 14

All figures are times 10. The numbers in parentheses are numbers of slides from which the photographs were taken.

Figure | Page

1. **Stromatopora laminosa** Lecompte 174
a. Vertical section. b. Tangential section; Logansport limestone, Pipe Creek Falls, 10 miles southeast of Logansport, Ind. (295-92, 93). Plesiotype, No. 5356.

2. **Stromatopora laminosa** Lecompte 174
Vertical section, showing the microlaminae which suggested the name *laminosa*. Logansport limestone, France Lime and Stone Co. quarry, 5 miles east of Logansport, Ind. (279-6). Plesiotype, No. 5332.

3. **Stromatopora dubia** Lecompte 176
a. Tangential section, showing coarse maculae. b. Vertical section in a mamelon center. c. Vertical section in an intermamelon area; Logansport limestone, France Lime and Stone Co. quarry, 5 miles east of Logansport, Ind. (285-94, 95). Plesiotype, No. 5333.

4. **Stromatopora eumaculosa** Galloway and St. Jean, n. sp. 177
a. Vertical section. b. Tangential section; Jeffersonville limestone, Falls of the Ohio, Jeffersonville, Ind. (304-3, 4). Holotype, No. 5362.

Explanation of Plate 15

All figures are times 10. The numbers in parentheses are numbers of slides from which the photographs were taken.

Figure Page

1. **Stromatopora mononensis** Galloway and St. Jean, n. sp. 178
   a. Vertical section. b. Tangential section; Logansport limestone, or Little Rock Creek limestone, 2 miles west of Monon, Ind. (278-21) Holotype, No. 5347.

2. **Stromatopora submixta** Galloway and St. Jean, n. sp. 180
   a. Vertical section. b. Tangential section; Logansport limestone, Pipe Creek Falls, 10 miles southeast of Logansport, Ind. (295-80, 81). Holotype, No. 5357.

3. **Stromatopora pachytexta** Lecompte 181
   a. Vertical section. b. Tangential section; Logansport limestone, Pipe Creek Falls, 10 miles southeast of Logansport, Ind. (296-1, 2). Plesiotype, No. 5358.

4 **Stromatopora cumingsi** Galloway and St. Jean, n. sp. 182
   a. Vertical section. b. Tangential section; Logansport limestone, France Lime and Stone Co. quarry, 5 miles east of Logansport, Ind. (304-47, 48). Holotype, No. 5334.

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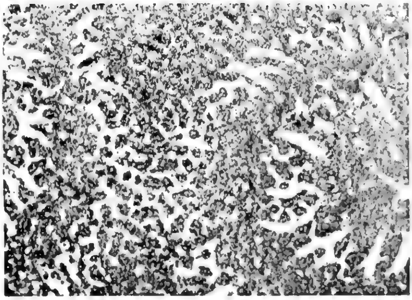

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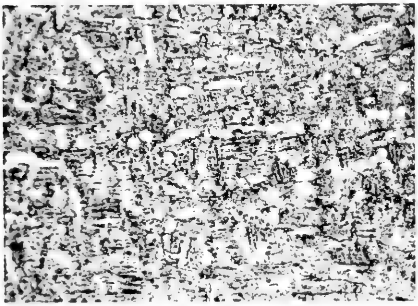

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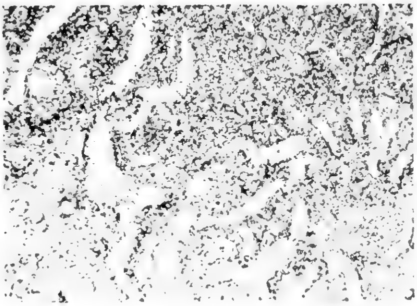

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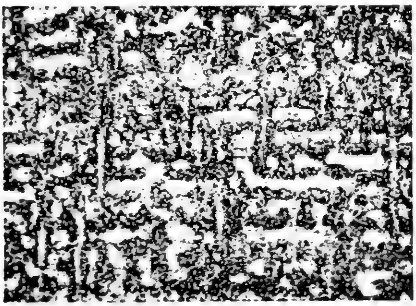

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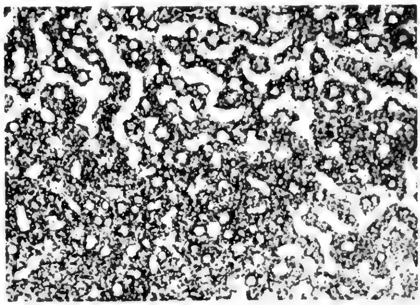

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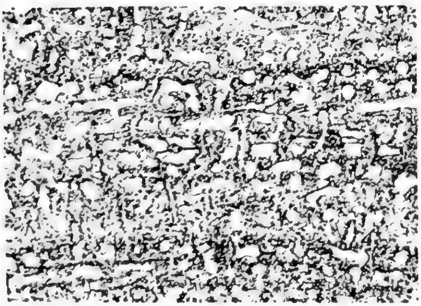

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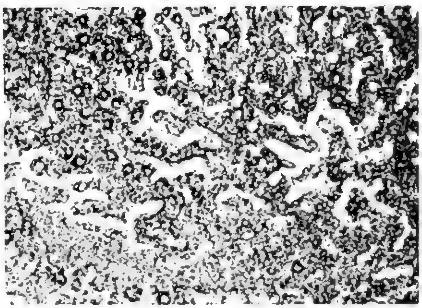

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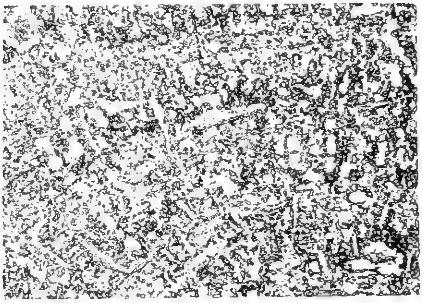

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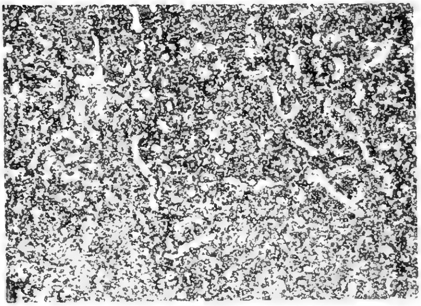

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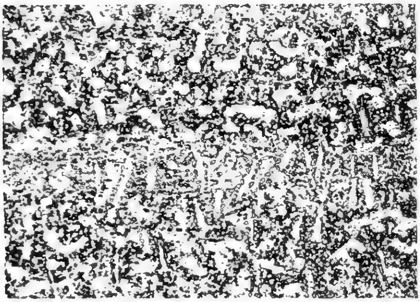

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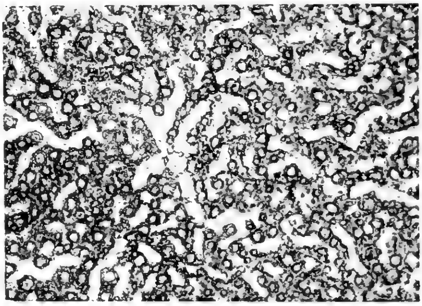

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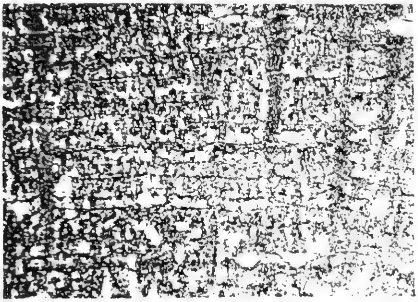

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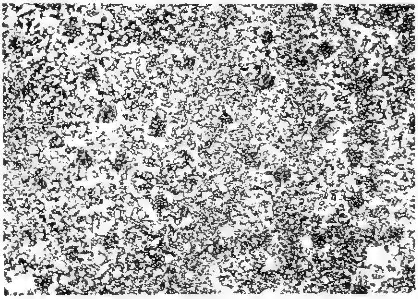

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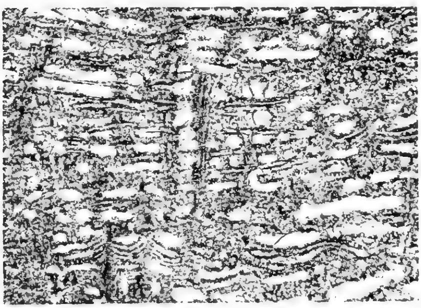

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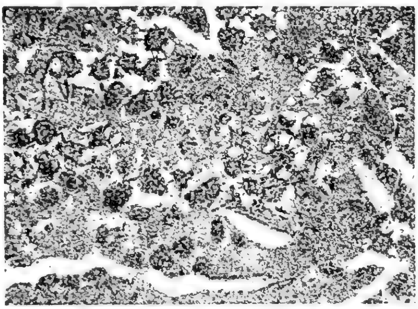


4b

Explanation of Plate 16

All figures are times 10. The numbers in parentheses are numbers of slides from which the photographs were taken.

Figure Page

1. **Stromatopora conicomamillata** Galloway and St. Jean, n. sp. 184
a. Vertical section. b. Tangential section; Logansport limestone, France Lime and Stone Co. quarry, 5 miles east of Logansport, Ind. (303-73, 74). Holotype, No. 5335.

2. **Stromatopora magnimamillata** Galloway and St. Jean, n. sp. 185
a. Vertical section. b. Tangential section; Logansport limestone, France Lime and Stone Co. quarry, 5 miles east of Logansport, Ind. (303-78, 79). Holotype, No. 5336.

3. **Syringostroma densum** Nicholson 188
a. Vertical section. b. Tangential section; Columbus limestone, north shore of Kelleys Island, Ohio. A topotype identical with Nicholson's descriptions and figures; the structure is not dense as seen under the microscope but lacy. (306-8, 9). Plesiotype, No. 5405.

4. **Syringostroma sanduskyense** Galloway and St. Jean, n. sp. 190
a. Vertical section. b. Tangential section; Columbus limestone, northern Ohio. (306-19, 20). Holotype, No. 5406.

Explanation of Plate 17

All figures are times 10. The numbers in parentheses are numbers of slides from which the photographs were taken.

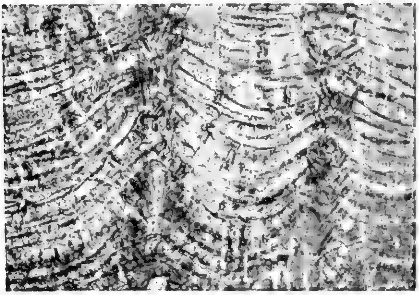
Figure Page

1. **Syringostroma perdensum** Galloway and St. Jean, n. sp. 192
a. Vertical section. b. Tangential section. Logansport limestone, France Lime and Stone Co. quarry, 5 miles east of Logansport, Ind. (303-37, 47). Holotype, No. 5337.

2. **Syringostroma superdensum** Galloway and St. Jean, n. sp. 193
a. Vertical section. b. Tangential section; Jeffersonville limestone, Falls of the Ohio, Jeffersonville, Ind. (285-27, 29). Holotype, No. 5363.

3. **Syringostroma papillatum** Galloway and St. Jean, n. sp. 195
a. Vertical section. b. Tangential section; Logansport limestone, France Lime and Stone Co. quarry, 5 miles east of Logansport, Ind. (278-5; 303-50). Holotype, No. 5338.

4. **Syringostroma tuberosum** Galloway and St. Jean, n. sp. 196
a. Vertical section. b. Tangential section; Jeffersonville limestone, 1 mile north of Kent, Ind. (296-20; 305-100). Holotype, No. 5382.



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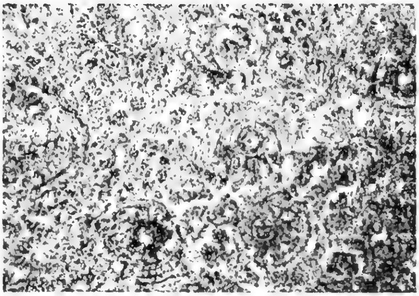

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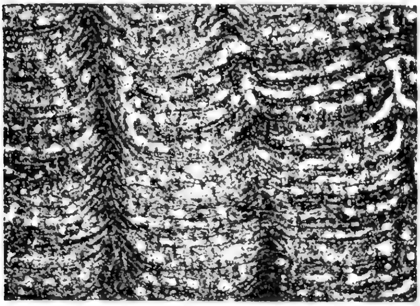

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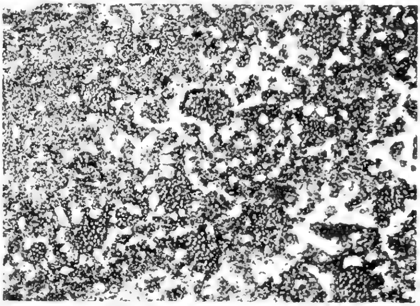

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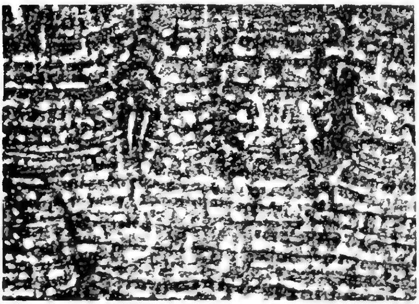

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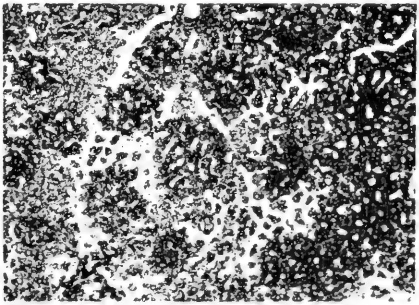

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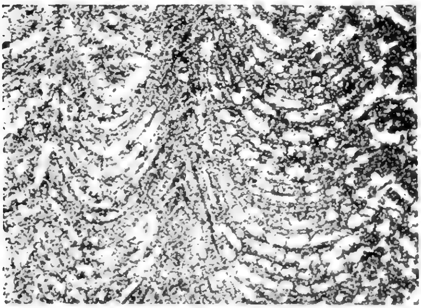

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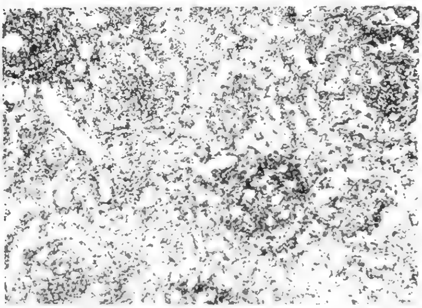

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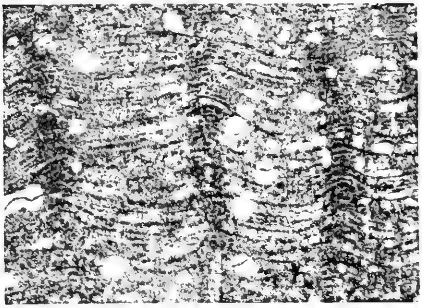
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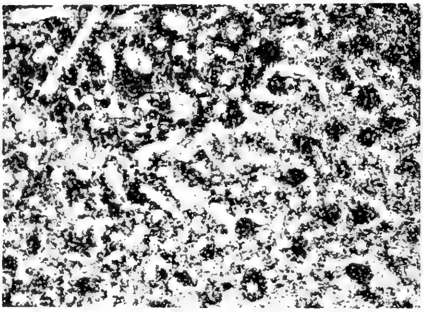
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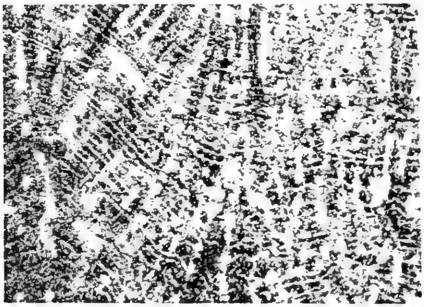
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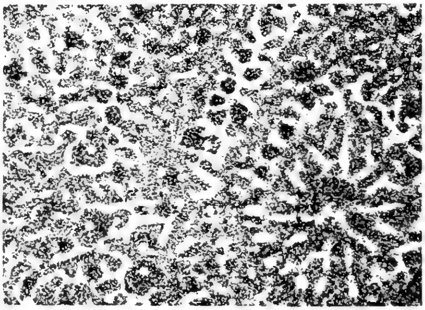
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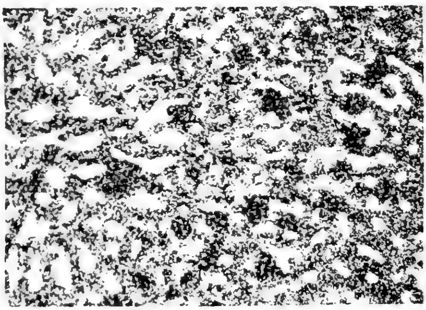

4b

Explanation of Plate 18

All figures are times 10. The numbers in parentheses are numbers of slides from which the photographs were taken.

Figure | Page

1. **Syringostroma radicosum** Galloway and St. Jean, n. sp. 198
   a. Vertical section. b. Tangential section; the astrorhizal center is at the middle of the left edge of the figure; Jeffersonville limestone, Jefferson County quarry, 1.2 miles northeast of the Louisville, Kentucky City limits on Hgw. 42. The specimen is not perfectly preserved. (305-88, 89). Holotype, No. 5392.

2. **Syringostroma fuscum** Galloway and St. Jean, n. sp. 199
   a. Vertical section, the section is cut between mamelons. b. Tangential section; Little Rock Creek limestone, France Lime and Stone Co. quarry, 5 miles east of Logansport, Ind. (294-66, 67). Holotype, No. 5348.

3. **Syringostroma subfuscum** Galloway and St. Jean, n. sp. 201
   a. Vertical section. b. Tangential section; Little Rock Creek limestone, France Lime and Stone Co. quarry, 5 miles east of Logansport, Ind. (303-44). Holotype, No. 5349.

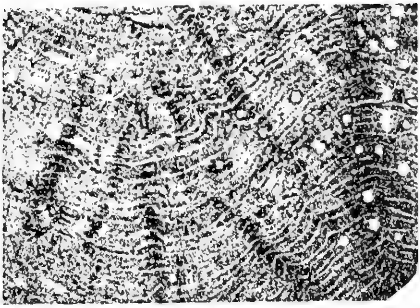
4. **Syringostroma perfuscum** Galloway and St. Jean, n. sp. 202
   a. Vertical section, slightly oblique. b. Tangential section; Little Rock Creek limestone, France Lime and Stone Co. quarry, 5 miles east of Logansport, Ind. (303-32, 45). Holotype, No. 5350.

Explanation of Plate 19

All figures are times ten. The numbers in parentheses are numbers of slides from which the photographs were taken.

Figure	Page

1. **Syringostroma bicrenulatum** Galloway and St. Jean, n. sp. 204
   a. Vertical section. b. Tangential section; Little Rock Creek limestone, France Lime and Stone Co. quarry, 5 mi. east of Logansport, Ind. (294-63; 303-26). Holotype, No. 5351.
2. **Parallelopora ostiolata** Bargatzky 207
   a. Vertical section. b. Tangential section; Upper Middle Devonian, Büchel, Germany. Figures of type specimen, from Lecompte, 1952, pl. 51, figs. 3a, 3c.
3. **Parallelopora campbelli** Galloway and St. Jean, n. sp. 208
   a. Vertical section, slightly oblique. b. Tangential section; Jeffersonville limestone, 1 mile north of Kent, Ind. The large, vertical astrorhizal tubes are not shown. (295-64; 303-64). Holotype, No. 5383.
4. **Parallelopora typicalis** Galloway and St. Jean, n. sp. 210
   a. Vertical section. b. Tangential section; Jeffersonville limestone, Falls of the Ohio, Jeffersonville, Ind. (295-7, 8). Holotype, No. 5364.



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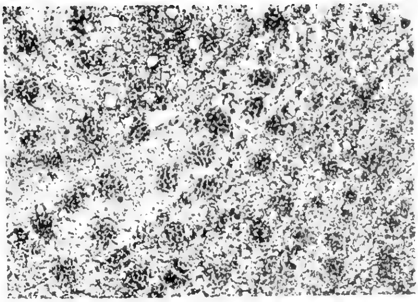

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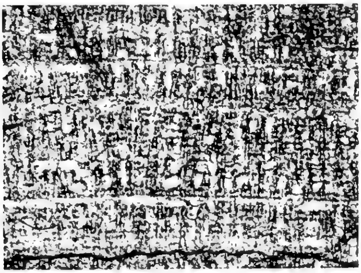

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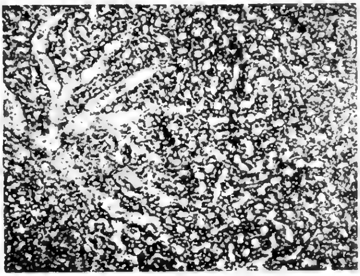

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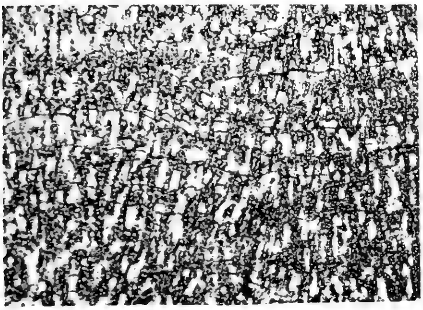

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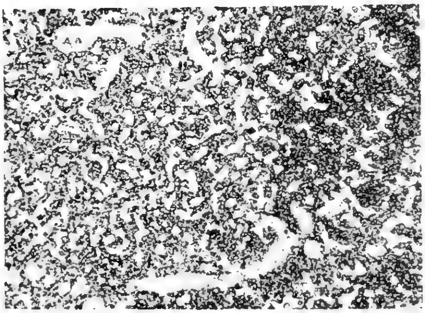

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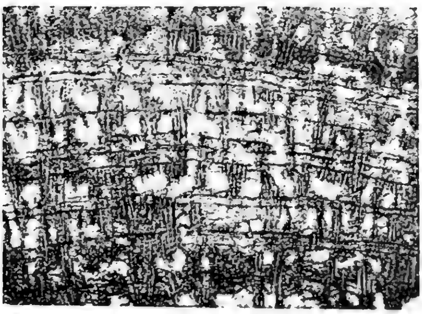

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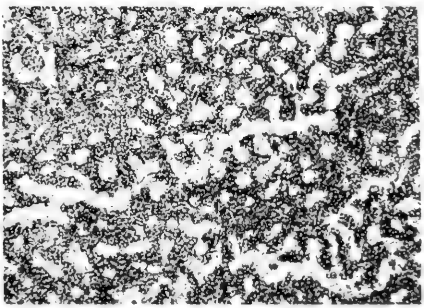

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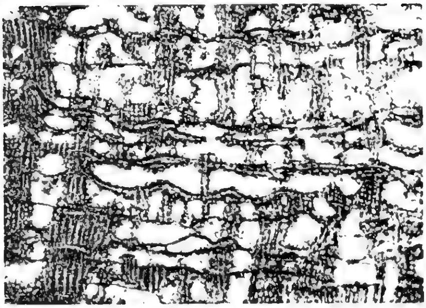

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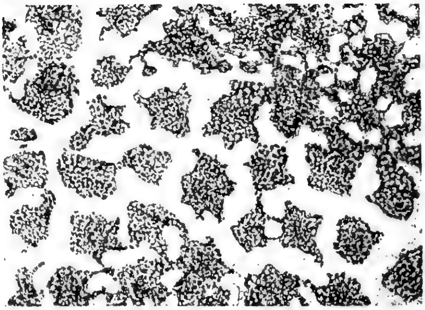

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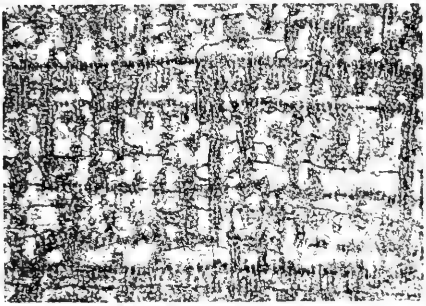

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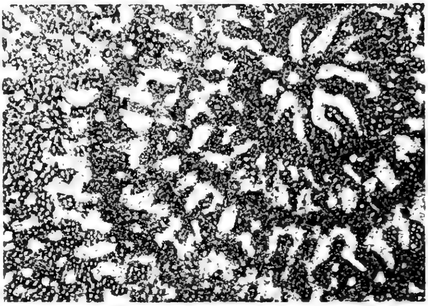

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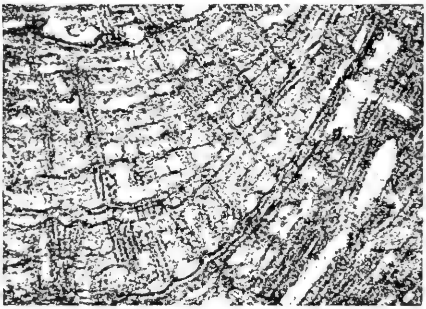

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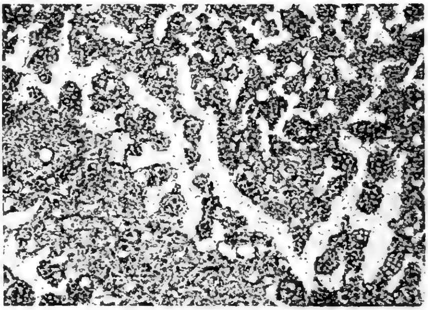

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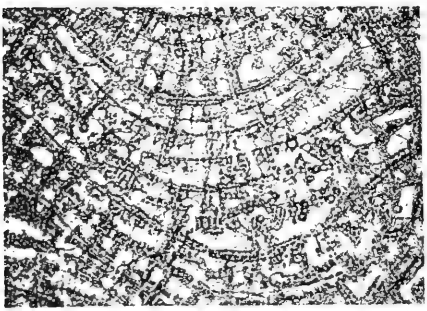

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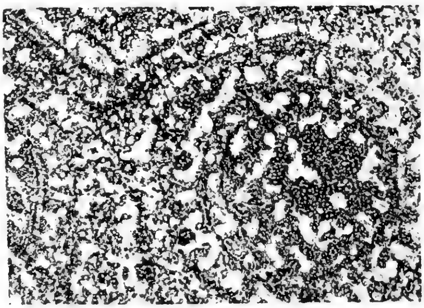


4b

Explanation of Plate 20

All figures are times 10. The numbers in parentheses are numbers of slides from which the photographs were taken.

Figure Page

1. **Parallelopora pulchra** Galloway and St. Jean, n. sp. 211
a. Vertical section. b. Tangential section; Jeffersonville limestone, 3 miles south of Westport, Decatur County, Ind. (282-47). Holotype, No. 5384.

2. **Parallelopora nodulata** (Nicholson) 212
a. Vertical section. b. Tangential section, showing coarsely maculate tissue outside a mamelon and finely maculate tissue in the mamelon. Columbus limestone, Kelleys Island, Ohio. (282-22, 23). Plesiotype, No. 5407.

3. **Parallelopora snoufferensis** Galloway and St. Jean, n. sp. 214
a. Vertical section. b. Tangential section; Columbus limestone, Snouffer's quarry, 5 miles northwest of Columbus, Ohio. (282-29, 32). Holotype, No. 5408.

4. **Parallelopora eumamillata** Galloway and St. Jean, n. sp. 216
a. Vertical section. b. Tangential section; Jeffersonville limestone, Jefferson County quarry, 1.2 miles northeast of the Louisville, Ky. city limits on Hgw. 42. (305-75, 76). Holotype, No. 5393.

Explanation of Plate 21

All figures are times 10. The numbers in parentheses are numbers of slides from which the photographs were taken.

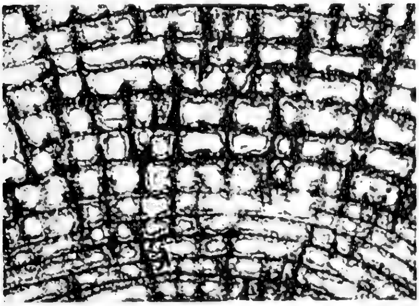
Figure Page

1. **Hermatostroma schlüteri** Nicholson 218
   a. Vertical section. b. Tangential section; Middle Devonian, Hebborn, Germany. Figures of the type specimen from Lecompte, 1952, pl. 45, figs. 1a, 1b.

2. **Hermatostroma logansportense** Galloway and St. Jean, n. sp. 219
   a. Vertical section. b. Tangential section; Logansport limestone, France Lime and Stone Co. quarry, 5 miles east of Logansport, Ind. (279-2, 3). Holotype, No. 5339.

3. **Clathrocoilona abeona** Yavorsky 222
   a. Vertical section. b. Tangential section; Logansport limestone, old dam on Eel River, 6 miles northeast of Logansport, Ind. (285-14, 15). Plesiotype, No. 5385.

4. **Clathrocoilona subclathrata** Galloway and St. Jean, n. sp. 224
   a. [left b]. Vertical section. b. Tangential section; Logansport limestone, France Lime and Stone Co. quarry, 5 miles east of Logansport, Ind. (304-7, 8). Holotype, No. 5340.



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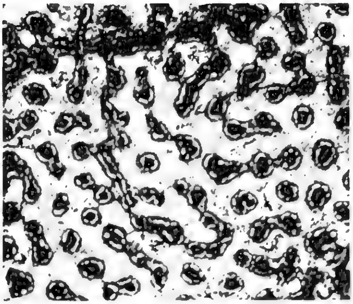

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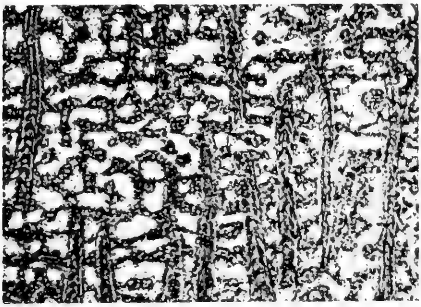

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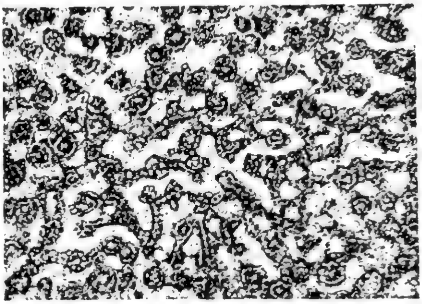

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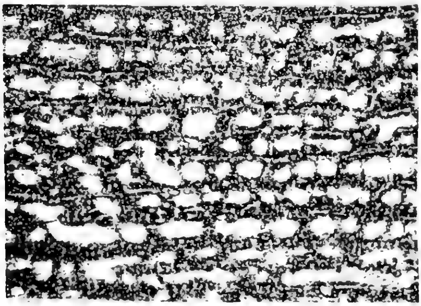

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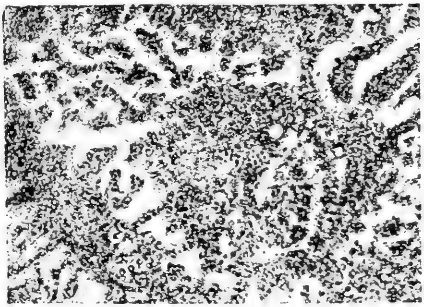

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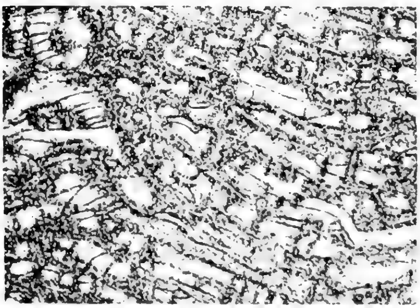

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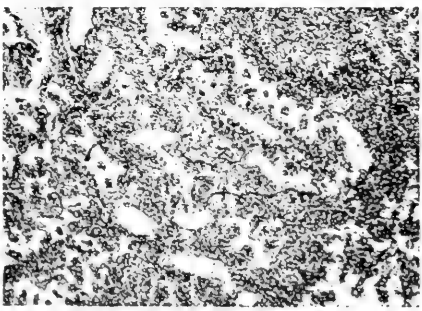

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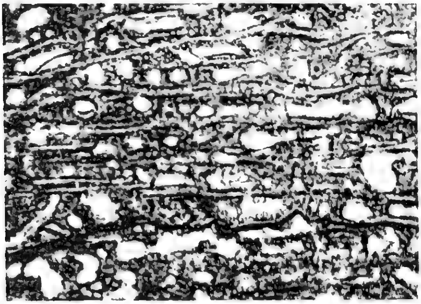

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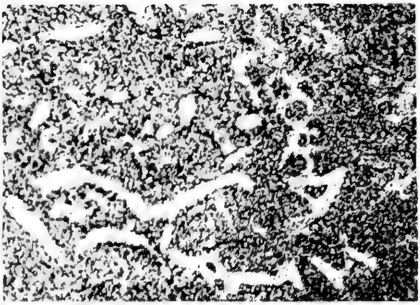

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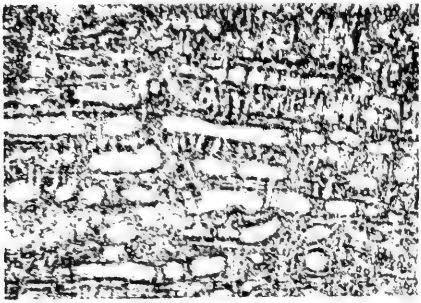

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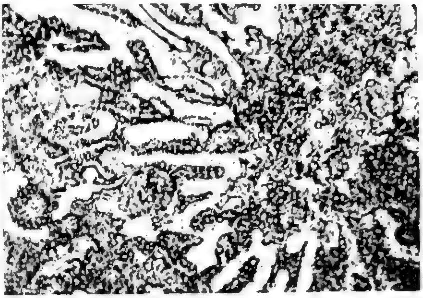

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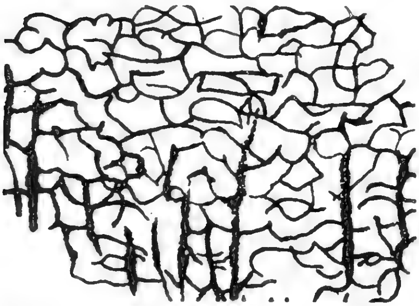

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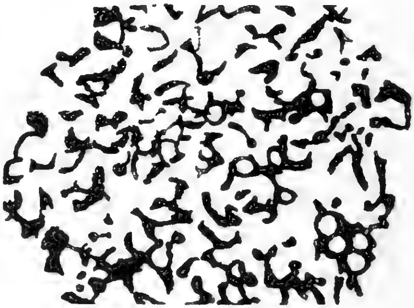

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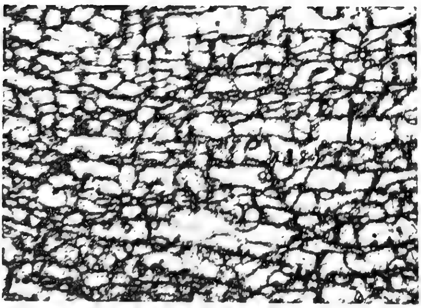

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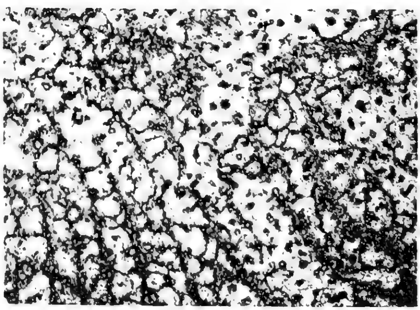


5b

Explanation of Plate 22

All figures are times 10. The numbers in parentheses are numbers of slides from which the photographs were taken.

Explanation of Plate 23

All figures are times 10 unless otherwise indicated. The numbers in parentheses are numbers of slides from which the photographs were taken.

Figure Page

1. **Clathrocoilona abeona** Yavorsky 222
   a. Vertical section, X 10. b. Tangential section, X 5; Middle Devonian, Kuznetsk Basin, left bank of Salairka River, left tributary to the stepnoe Bacht, Russia. Type figures from Yavorsky, 1931, pl. 1, fig. 9; pl. 2, fig. 1.

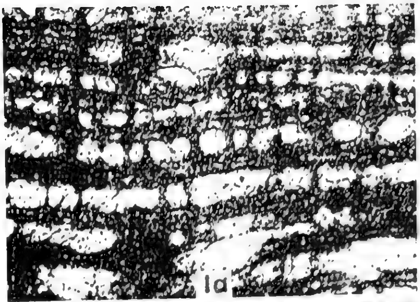
2. **Amphipora ramosa** (Phillips) 233
   Cross sections of typical specimens of ordinary size, 1.5 to 2 mm. in diameter with axial canals, heavy fibrous tissue, and marginal vacuoles, X 6.7; Jeffersonville limestone, Independent quarry, 4 mi. south of Dupont, Ind. (306-4). Plesiotype, No. 5371. Specimens figured in figs. 3-6 are from the same horizon and locality.

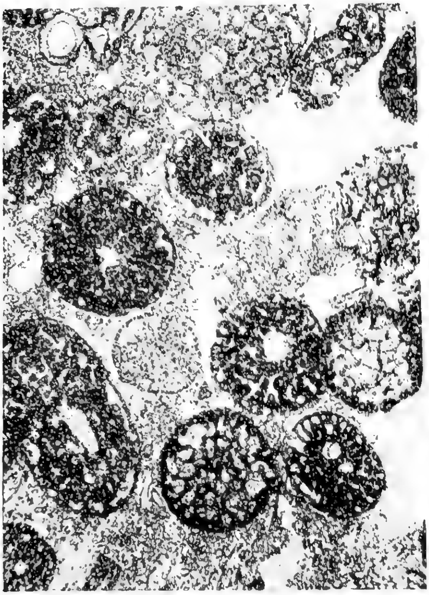
3. **Amphipora ramosa** (Phillips) 233
   Cross sections of typical coenostea, with axial tube, heavy tissue with fibers in whorls, marginal vacuoles and peripheral lamina (285-55). Plesiotype, No. 5372.

4. **Amphipora ramosa** (Phillips) 233
   Axial section of a small specimen, showing laminae, curved tabulae extending from the laminae across the large axial tube, indistinct pillars, galleries, marginal vacuoles and less dense tissue than that shown in Fig. 3. (306-6). Plesiotype, No. 5371.

5. **Amphipora ramosa** (Phillips) 233
   Oblique section, showing an arched lamina, flaring pillars, transversely fibrous tissue with dark, median line in the pillars, and tabulae in the superposed galleries (306-6). Plesiotype, No. 5371.

6. **Amphipora ramosa** (Phillips) 233
   Tangential section from inside the marginal vacuoles, showing one marginal vacuole with tabulae, irregular galleries and tripartite pillars (306-5). Plesiotype, No. 5371.





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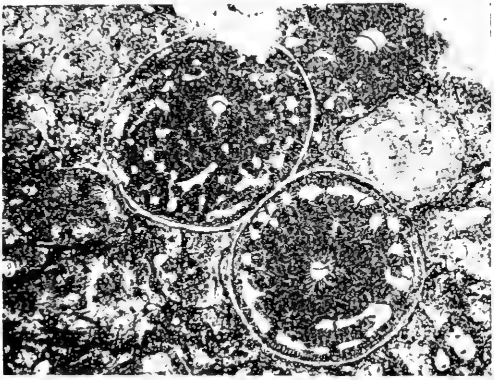

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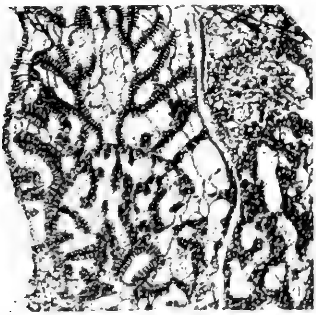

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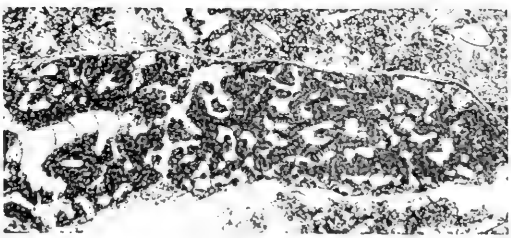

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Note: The left hand bold face figures refer to the plates. The right hand light figures refer to the pages. The names of species in the check list are not included in the index because they are already in alphabetical order and are not otherwise referred to in the present paper.

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LATE OLIGOCENE LARGER FORAMINIFERA FROM BARRO COLORADO ISLAND, PANAMA CANAL ZONE

(WITH A DETAILED ANALYSIS OF AMERICAN MIOGYPSINIDS AND HETEROSTEGINIDS)

By

W. Storrs Cole
Cornell University
and
U. S. Geological Survey

March 1, 1957

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LATE OLIGOCENE LARGER FORAMINIFERA FROM BARRO COLORADO ISLAND, PANAMA CANAL ZONE*

(WITH A DETAILED ANALYSIS OF AMERICAN MIOGYPSINIDS AND HETEROSTEGINIDS)

W. Storrs Cole

Cornell University
and
U. S. Geological Survey

ABSTRACT

Larger Foraminifera from six localities representing the upper part of the Bohio formation and the Caimito formation (both of late Oligocene age) on Barro Colorado Island, Panama Canal Zone, are listed. The classification of the American miogypsinids and heterosteginids is reviewed and keys for the identification are given. *Archaias compressus* (d'Orbigny), a living species, occurs in both formations.

INTRODUCTION

Recently, W. P. Woodring of the U. S. Geological Survey, referred six samples containing larger Foraminifera from the upper part of the Bohio formation and the Caimito formation from Barro Colorado Island, Panama Canal Zone, to me for identification of the species. Both the upper part of the Bohio and the Caimito formations are of late Oligocene age. Although no difficulty was found in identifying the various species of *Lepidocyclina*, the nomenclature of the miogypsinids has become so confused that it was decided to investigate this group more completely. At the same time it seemed advisable to critically survey the Eocene and Oligocene species of *Heterostegina*.

In two of the samples, one from the Bohio formation (locality 42*d*) and the other (locality 54*h*) from the Caimito formation, specimens of *Archaias compressus* (d'Orbigny) were found which seem to be identical with specimens still living in the Caribbean Sea.

The species found in the samples are shown in the following table.

The localities are on Barro Colorado Island and the description of each follows:

42*d*. Stream heading west of Miller Trail near Miller 17, about 100 meters above mouth.

42*h*. Stream east of Shannon Trail, about 335 meters southeast of Shannon 1.

*Publication authorized by the Director, U. S. Geological Survey

SPECIES OF LARGER FORAMINIFERA FROM BARRO COLORADO ISLAND

	Bohio fm.		Caimito fm.			
	42d	*42h*	*54f*	*54h*	*54k*	*54l*
Archaias compressus (d'Orbigny)	a			r		
Heterostegina antillea Cushman		a	r			
israelskyi Gravell and Hanna			a			r
Lepidocyclina (Lepidocyclina) canellei Lem. and R. Douvillé	r	r	r	c	a	c
parvula Cushman	r					r
waylandvaughani Cole	r					
(Nephrolepidina) vaughani Cushman	r					
Miogypsina (Miogypsina) antillea (Cushman)	r	c	a			c
gunteri Cole		r				
(Miolepidocyclina) panamensis (Cushman)			r			
Operculinoides panamensis (Cushman)						a

a = adundant; c = common; r = rare

SPECIES FOUND IN THE BOHIO AND CAIMITO FORMATIONS

	Bohio formation	Caimito formation
Archaias compressus (d'Orbigny)	X	X
Heterostegina antillea Cushman	X	X
israelskyi Gravell and Hanna		X
panamensis Gravell		X
Lepidocyclina (Lepidocyclina) asterodisca Nuttall		X
canellei Lem. and R. Douvillé	X	X
parvula Cushman	X	X
waylandvaughani Cole	X	X
yurnagunensis Cushman		X
morganopsis Vaughan	X	X
(Nephrolepidina) dartoni Vaughan		X
tournoueri Lem. and R. Douvillé		X
vaughani Cushman	X	X
(Eulepidina) favosa Cushman	X	
undosa Cushman		X
gigas Cushman	X	
Miogypsina (Miogypsina) antillea (Cushman)	X	X
gunteri Cole	X	
(Miolepidocyclina) panamensis (Cushman)		X
Operculinoides panamensis (Cushman)		X

54*f*. Stream crossing Standley Trail at Standley 11 plus 60 meters, about 30 meters downstream from trail.

54*h*. Mouth of first stream north of Zetek House.

54*k*. Stream crossing Conrad Trail at Conrad 2, about 60 meters above mouth.

54*l*. Second stream northwest of end of Armour Trail, about 60 meters above mouth.

The writer (1953, p. 7) listed previously from the Caimito formation from locality 53, a low garden islet 0.25 mile northeast of the landing at Barro Colorado Island, several species of larger Foraminifera. If these species as well as those found at other localities (Cole, 1953, p. 6, 7) in the Bohio and Caimito formations in Panama are subjoined to the species found on Barro Colorado Island, the included table shows the distribution of the species in the two formations.

There are in the two formations 19 species and one subspecies, of which seven species and the subspecies are common to both formations, three species appear to be restricted to the Bohio formation and nine species appear to occur in the Caimito formation only.

Study of other samples would undoubtedly demonstrate that more of these species are common to both formations. However, the information at hand demonstrates that the fauna of the upper part of the Bohio formation is closely related to that of the Caimito formation. Moreover, these faunas are the typical upper Oligocene association of the Caribbean region.

My appreciation is expressed to Dr. Hans Kugler of Trinidad Oil Company, Ltd. for specimens from Trinidad and to Dr. Herman Gunter, Director, Florida Geological Survey, for specimens from Florida. All the figured specimens will be deposited eventually in the U. S. National Museum. The cost of the printed plates was defrayed by the William F. E. Gurley Foundation for Paleontology of Cornell University.

AMERICAN MIOGYPSINIDS

In the upper Oligocene of the Caribbean region there appear to be five distinct species of miogypsinids belonging to two genera that are readily separated from each other. *Miogypsinoides* represented by a single species, *M. complanatus* (Schlumberger), does not have lateral chambers, whereas *Miogypsina* has well-developed tiers of lateral chambers. Therefore, the primary separation of the miogypsinids is based on the vertical section.

The genus *Miogypsina* is subdivided into two subgenera: *Miogypsina (Miogypsina)* and *M. (Miolepidocyclina)*. Their separation is based on the position of the embryonic apparatus and, therefore, oriented equatorial sections are needed. In *M. (Miogypsina)* the embryonic apparatus is apically situated so that either the embryonic chambers or the periembryonic chambers are in contact with the peripheral zone of the test. In *M. (Miolepidocyclina)* the embryonic apparatus is separated from the peripheral zone of the test by one or more rows of equatorial chambers.

Specific determination within the subgenera is based on the arrangement of the periembryonic chambers with relation to the embryonic chambers.

The following key based on the characters listed above has been found useful in identifying the American species of miogypsinids:

KEY TO GENERA AND SPECIES OF AMERICAN MIOGYPSINIDS

A. Lateral chambers absent .... *Miogypsinoides*

- 1. Periembryonic chambers in a distinct coil about 1½ volutions .... *Miogypsinoides complanatus* (Schlumberger).

B. Lateral chambers present and well developed .... *Miogypsina*

- 1. Embryonic apparatus apically situated without equatorial chambers between it and the periphery of the test .... *Miogypsina (Miogypsina)*
  - a. With periembryonic chambers between the embryonic chambers and the periphery of the test
    - 1.′ Periembryonic chambers in a distinct coil of slightly more than one volution .... *M. (Miogypsina) gunteri* Cole
  - b. Without periembryonic chambers between the embryonic chambers and the periphery of the test
    - 1.′ Periembryonic chambers in an indistinct coil of less than one volution .... *M. (Miogypsina) antillea* (Cushman)
- 2. Embryonic apparatus subapically to subcentrally situated with equatorial chambers between it and the periphery of the test .... *Miogypsina (Miolepidocyclina)*
  - a. Periembryonic chambers in a distinct coil of more than one volution and often composed of two or more rows of chambers at its distal end .... *M. (Miolepidocyclina) panamensis* (Cushman)
  - b. Periembryonic chambers in an indistinct coil either completely or partially surrounding the embryonic chambers .... *M. (Miolepidocyclina) staufferi* Koch

Although a large number of specific names have been proposed for the American species, the five species enumerated in the key appear to be sufficient to include all the differences upon which various authors believed specific separation possible.

Drooger (1952) studied a number of the American species and proposed a specific classification based largely on a statistical analysis of the embryonic apparatus. He recognized 13 species of *Miogypsina,* four of which he believed represented new species, and two species of *Miogypsinoides.* In addition he identified specimens from several localities as being intermediate between distinct species under the notation *"exemplum intercentrale,"* for example, *Miogypsina* ex interc. *irregularis-intermedia.*

If the sketches of the embryonic apparati given by Drooger (1952, pls. 1, 2) of specimens of the genus *Miogypsina* are analyzed, it is seen that the four subdivisions proposed in the above key can be readily recognized, and that all of his drawings can be assigned without hesitation to one or another of the proposed categories of the key.

The writer believes that Drooger's statistical approach was sound, but that he allowed himself to be overinfluenced by minor variations which occur in all the larger Foraminifera. These minor variations which occur within a single population must be evaluated carefully or the statistical results will be overbalanced in the direction of undue complexity. Therefore, the number of specific separations will be increased, as the division is artificial rather than natural.

Moreover, even after a statistical analysis is made, the results should be combined in a key of the type suggested here inasmuch as paleontology is a practical as well as a theoretical science. The industrial paleontologist does not have the time, equipment, or often a sufficient number of specimens for a statistical evaluation. He must, therefore, either not identify his specimens, or have at hand a readily usable system for their identification.

There follows a listing of all the specific names used for American miogypsinids arranged under the five species recognized in this article. Certain specimens have been inadequately described and were placed with difficulty. Reexamination of the actual specimens in such cases may prove that they were not assigned correctly in the listing given, but it is the best that can be done under the present circumstances.

SYSTEMATIC DESCRIPTIONS

Family **MIOGYPSINIDAE**

Genus **MIOGYPSINOIDES** Yabe and Hanzawa, 1928

Miogypsinoides complanatus (Schlumberger) Pl. 25, figs. 1, 2

1933. *Miogypsina complanata* Schlumberger, Nuttall, Jour. Paleont., v. 7, No. 2, p. 176, 177, pl. 24, figs. 9, 13, 14 [not figs. 7, 11 which are *M. (Miolepidocyclina) panamensis* (Cushman)].

1937. *Miogypsina (Miogypsinoides) complanata* Schlumberger, Barker and Grimsdale, Ann. Mag. Nat. Hist., ser. 10, v. 14, p. 162, 163, pl. 5, fig. 6; pl. 6, figs. 1-6, 8; pl. 7, fig. 1; pl. 8, fig. 6.

1938. *Miogypsina (Miogypsinoides) complanata* Schlumberger, Cole, Florida Geol. Surv., Bull. 16, pl. 8, fig. 10.

1940. *Miogypsinella sanjosensis* Hanzawa, Jubilee Publ. in Commemoration of Prof. H. Yabe's 60th birthday, p. 766, 767, text fig. 3.

1941. *Miogypsinoides complanata* (Schlumberger), Galloway and Heminway, New York Acad. Sci., Scientific Surv. Porto Rico and the Virgin Islands, v. 3, pt. 4, p. 444, 445, pl. 36, figs. 6-9 [not fig. 10 which is probably *M. (Miolepidocyclina) panamensis* (Cushman)].

1951. *Miogypsina (Miogypsinella) bermudezi* Drooger, Konin. Nederl. Akad. Amsterdam Proc., ser. B, v. 54, No. 4, p. 357, 359, figs. 1-6.

1951. *Miogypsina (Miogypsinella) complanata* Schlumberger, Drooger, *idem*, p. 360-365, fig. 7.

Remarks.—This genus is easily recognized by the vertical section as lateral chambers are not developed. Excellent illustrations of vertical sections were given by Barker and Grimsdale (1937, pl. 8, fig. 6) and Drooger (1951, figs. 5-7). Drooger separated Cuban specimens, named *M. bermudezi* by him, from other American specimens which are referred to *M. complanatus* by the thinness of the walls covering the equatorial layer and the lack of surface ornamentation in *M. bermudezi.* However, these structures are individual ones rather than specific, therefore, the two species are combined.

Hanzawa (1940, p. 768) erected the generic name *Miogypsinella* and assigned among other species the Mexican species *Miogypsinoides complanatus* to this genus. Cole (in Cushman, 1948, p. 376) suggested that "There is complete gradation from this type to typical *Miogypsinoides*, and it is doubtful if these forms should be generically or even subgenerically designated."

Drooger (1951, p. 364) without mention of Cole's opinion reduced *Miogypsinella* to subgeneric rank under the genus *Miogypsina.* Later, he (1953, p. 120) recommended that "the separation of the Miogypsinae without lateral chambers in two subgenera on these grounds is not recommendable. It is therefore proposed to reunite them. . . ." Thus, Drooger eventually reached the same conclusion that Cole had in 1948.

Occurrence in Panama.—Not reported.

Occurrence elsewhere.—Mexico with *Lepidocyclina (Lepidocyclina) waylandvaughani* Cole and *Heterostegina israelskyi* Gravell and Hanna; Cuba (as *M. complanatus* (Schlumberger) and *M. bermudezi* Drooger); Porto Rico.

Genus **MIOGYPSINA** Sacco, 1893

Subgenus **MIOGYPSINA** Sacco, 1893

Miogypsina (Miogypsina) antillea (Cushman)

Pl. 26, figs. 6, 7; Pl. 28, figs. 1-9; Pl. 29, figs. 1-9

1919. *Heterosteginoides antillea* Cushman, Carnegie Inst. Washington, Publ. 291, p. 50, pl. 5, figs. 5, 6.
1924. *Miogypsina cushmani* Vaughan, Geol. Soc. Amer., Bull., v. 35, p. 813, pl. 36, figs. 4-6.
1926. *Miogypsina hawkinsi* Hodson, Bull. Amer. Paleont., v. 12, No. 47, p. 28, 29, pl. 7, fig. 9; pl. 8, figs. 1, 2.
1928. *Miogypsina bracuensis* Vaughan, Jour. Paleont., v. 1, No. 4, p. 283, 284, pl. 45, figs. 1-3.
1933. *Miogypsina bramlettei* Gravell, Smithsonian Miscell. Coll., v. 89, No. 11, p. 32-34, pl. 6, figs. 5-10.
1933. *Miogypsina hawkinsi* Hodson, Gravell, *idem*, p. 34, pl. 6, figs.11-14.
1941. *Miogypsina (Miogypsina) antillea* (Cushman), Vaughan and Cole, Geol. Soc. Amer., Sp. Paper 30, p. 79, pl. 45, figs. 5-7.
1941. *Miogypsina (Miogypsina) hawkinsi* Hodson, Vaughan and Cole, *idem*, p. 79, 80, pl. 45, fig. 9.
1941. *Miogypsina (Miogypsina) cushmani* Vaughan, Cole, Florida Geol. Surv., Bull. 19, p. 47, 48, pl. 17, figs. 3-5.
1951. *Miogypsina ? M. antillea* (Cushman), Drooger, Konin. Nederl. Akad. Amsterdam Proc., ser. B, v. 54, No. 1, p. 63, 64, text fig. 4.
1951. *Miogypsina ? M. hawkinsi* Hodson, Drooger, *idem*, p. 64, 65.
1952. *Miogypsina (Miogypsina) tani* Drooger, Doctor's Diss. Utrecht, p. 26, 27, pl. 2, figs. 20-24; pl. 3, figs. 2a, b.
1952. *Miogypsina irregularis* (Michelotti), Drooger, *idem*, p. 33, 34, pl. 2, figs. 25-29.
1952. *Miogypsina (Miogypsina) intermedia* Drooger, *idem*, p. 35, 36, pl. 2, figs. 30-34; pl. 3, figs. 4a, b.
1952. *Miogypsina antillea* (Cushman), Drooger, *idem*, p. 42, pl. 2, figs. 45-49.
1952. *Miogypsina cushmani* Vaughan, Drooger, *idem*, p. 37-39, pl. 2, figs. 40-44.
1952. *Miogypsina* ex. interc. *gunteri-tani* Drooger, *idem*, p. 23-25, pl. 2, figs. 16-19.
1952. *Miogypsina* ex. interc. *intermedia-cushmani* Drooger, *idem*, p. 37, pl. 2, figs. 35-39.
1953. *Miogypsina (Miogypsina) antillea* (Cushman), Cole, U. S. Geol. Surv., Prof. Paper 244, p. 35, 36, pl. 24, fig. 17; pl. 25, figs. 13-15.

Remarks.—The coil of periembryonic chambers never completely encircles the embryonic chambers, and the embryonic chambers always have a short area of contact with the peripheral zone of the test. The peripheral zone is composed of a series of radiating canals which form a fringelike border (fig. 9, Pl. 28) which shows clearly in specimens which have not been abraided.

Topotypes of *M. (M.) antillea* (fig. 1, Pl. 29) and *M. (M.) cushmani* (figs. 8, 9, Pl. 29) are identical. Moreover, these specimens have one or more (usually two) periembryonic chambers developed on the proximal margin of the initial periembryonic chamber. (Note: in fig. 8, Pl. 29 the initial periembryonic chamber is on the right side of the embryonic chambers, and its walls are in contact with the initial and second embryonic chambers. The main periembryonic coil revolves counter-clockwise from the distal wall of initial periembryonic chamber.) At first it was believed that the presence of these one or more smaller chambers might be a specific feature inasmuch as many specimens (for example, figs. 5, 7-9, Pl. 28) possess only the counter-clockwise coil from the initial periembryonic chamber.

However, there is complete gradation from specimens without these secondary periembryonic chambers (Cole, 1953, fig. 15, pl. 25) to those which are identical (fig. 7, Pl. 29) with the topotypes of *M. (M.) antillea* and *M. (M.) cushmani* in specimens from the same locality.

Occurrence in Panama.—USGS loc. 6012*d* (as *M. cushmani* Vaughan) with *Lepidocyclina (Lepidocyclina) yurnagunensis* Cushman (Culebra formation); loc. 37, 53 (Cole, 1953, p. 7) (Caimito formation); Barro Colorado Island: 42*d*, 42*h* (Bohio formation); 54*f*, 54*l* (Caimito formation).

Occurrence elsewhere.—Anguilla [as *M. antillea* (Cushman)]; Jamaica, B. W. I., (as *M. bracuensis* Vaughan) with *Lepidocyclina (Lepidocyclina) canellei* Lem. and R. Douvillé; Trinidad (as *M. hawkinsi* Hodson) with *Heterostegina antillea* Cushman, *Lepidocyclina (Lepidocyclina) canellei* Lem. and R. Douvillé, *L. (L.) parvula* Cushman and other species; Venezuela (as *M. hawkinsi* Hodson and *M. bramlettei* Gravell) with *Lepidocyclina (Lepidocyclina) canellei* Lem. and R. Douvillé, *L. (L.) sanluisensis* Gravell which is a synonym of *L. (L.) yurnagunensis morganopsis* Vaughan and other species; Florida (as *M. cushmani* Vaughan); Costa Rico (as *M. tani* Drooger); Cuba (as *M. intermedia* Drooger).

Miogypsina (Miogypsina) gunteri Cole Pl. 26, figs. 1-4, 8, 9; Pl. 27, fig. 1

1937. *Miogypsina (Miogypsina)* cf. *M. irregularis* (Michelotti), Barker and Grimsdale, Ann. Mag. Nat. Hist., ser. 10, v. 14, p. 163-166, pl. 5, figs. 4, 5, 7-10; pl. 7, figs. 2, 3.

1938. *Miogypsina (Miogypsina) gunteri* Cole, Florida Geol. Surv. Bull. 16, p. 42, 43, pl. 6, figs. 10-12, 14; pl. 8, figs. 1, 2, 4-9 [not fig. 3 which is *M. (Miolepidocyclina) panamensis* (Cushman)].

1941. *Miogypsina (Miogypsina) gunteri* Cole, Vaughan and Cole, Geol. Soc. Amer., Sp. Paper 30, p. 79, pl. 45, fig. 8.

1952. *Miogypsina (Miogypsina) thalmanni* Drooger, Doctor's Diss. Utrecht, p. 15, pl. 1, figs. 1-5; pl. 2, figs. 1-5; pl. 3, figs. 1a, b.

1952. *Miogypsina basraensis* Bronnimann, Drooger, *idem*, p. 30, pl. 2, figs. 6-10; text fig. 12.

1952. *Miogypsina gunteri* Cole, Drooger, *idem*, p. 23, pl. 2, figs. 11-15.

1952. *Miogypsina* ex. interc. *thalmanni-panamensis* Drooger, *idem*, p. 17, pl. 1, figs. 6, 9 [not figs. 7, 8, 10 which are *M. (Miolepidocyclina) panamensis* (Cushman), 1919].

Remarks.—The embryonic apparatus is peripheral. The periembryonic chambers are arranged in a regular coil, and the embryonic chambers are separated from the peripheral zone of the test only by the periembryonic coil.

Miogypsinopsis (Hanzawa, 1940, p. 773), of which the type is this species, does not differ significantly from other species referred to *Miogypsina* except that the periembryonic coil completely surrounds the embryonic chambers. This is a specific, not a generic, character.

Occurrence in Panama.—Barro Colorado Island: 42*h* (Bohio formation).

Occurrence elsewhere.—Florida; Mexico [as *M.* cf. *M. irregularis* (Michelotti)]; Dominican Republic (as *M. thalmanni* Drooger).

Subgenus **MIOLEPIDOCYCLINA** A. Silvestri, 1907

Miogypsina (Miolepidocyclina) panamensis (Cushman)

Pl. 26, fig. 5; Pl. 27, figs. 2-8

1918. *Heterosteginoides panamensis* Cushman, U. S. Nat. Mus., Bull. 103, p. 97, pl. 43, figs. 3-8, not figs. 1,2 which are *M. (Miogypsina) antillea* (Cushman), 1919.

1924. *Miogypsina panamensis* (Cushman), Vaughan, Geol. Soc. Amer., Bull., v. 35, p. 802, pl. 36, fig. 7.

1932. *Miogypsina* aff. *M. panamensis* (Cushman), Barker, Geol. Mag., v. 69, p. 280, 281, pl. 16, fig. 7; text fig. 1.

1936. *Miolepidocyclina ecuadorensis* Tan, De Ing. in Ned.-Indië. 4. Mijnb. en Geol. 3 Jaarg., p. 58.

1947. *Heterosteginoides panamensis* Cushman, Hanzawa, Jour. Paleont., v. 21, No. 3, p. 260-263, pl. 41, figs. 1-13.

1952. *Miogypsina panamensis* (Cushman), Drooger, Doctor's Diss. Utrecht, p. 17-19, pl. 1, figs. 11-15.

1952. *Miogypsina ecuadorensis* Tan, Drooger, *idem*, p. 25, pl. 1, figs. 16-28, text fig. 11.

1952. *Miogypsina (Miolepidocyclina) ecuadorensis* Tan, Graham and Drooger, Contrib. Cushman Fd. Foram. Res., v. 3, pt. 1, p. 21, 22, text fig. 2.

1953. *Miogypsina (Miolepidocyclina) panamensis* (Cushman), Cole, U. S. Geol. Surv., Prof. Paper 244, p. 36, 37, pl. 25, figs. 1-8.

Remarks.—The embryonic apparatus is subapical, and there are one or more rows of equatorial chambers between it and the peripheral fringe.

There is either a primary periembryonic spire alone (fig. 8, Pl. 27) or a primary spire and several secondary spires (fig. 7, Pl. 27). Additional illustrations which show the total variation have been published (Cole, 1953, pl. 25).

Drooger (1952, p. 20) separated *M. (M.) panamensis* from *M. (M.) ecuadorensis* on the greater number of intercalary chambers developed between the coils of the primary spire. This is an individual character and varies from specimen to specimen in the same population. Therefore, only one species can be recognized.

Occurrence in Panama.—USGS loc. 6025 with *Lepidocyclina (Lepidocyclina) canellei* Lem. and R. Douvillé and *Heterostegina panamensis* Gravell; loc. 55 (Cole, 1953, p. 7); Barro Colorado Island: 54*f* (Caimito formation).

Occurrence elsewhere.—Florida; Ecuador (as *M. ecuadorensis* Tan); California (as *M. ecuadorensis* Tan).

Miogypsina (Miolepidocyclina) staufferi Koch Pl. 30

1926. *Miogypsina staufferi* Koch, Eclogae geol. Helvetiae, v. 19, No. 3, p. 751-753, pl. 28, figs. 1-3.
1926. *Miogypsina venezuelana* Hodson, Bull. Amer. Paleont., v. 12, No. 47, p. 29, 30, pl. 8, figs. 3-6.
1933. *Miogypsina mexicana* Nuttall, Jour. Paleont., v. 7, No. 2, p. 175, 176, pl. 24, figs. 1-6, 8, 10, 12.
1937. *Miogypsina (Miolepidocyclina) mexicana* Nuttall, Barker and Grimsdale, Ann. Mag. Nat. Hist., ser. 10, v. 14, p. 166, pl. 7, fig. 4; pl. 9, fig. 6.
1938. *Miogypsina (Miogypsina) hawkinsi* Cole, not Hodson, 1926, Florida Geol. Surv., Bull. 16, p. 43, 44, pl. 7, figs. 5-7.
1938. *Miogypsina (Miogypsina) venezuelana* Hodson, Cole, *idem*, p. 44, 45, pl. 6, figs. 9, 13; pl. 7, figs. 1-4; pl. 11, fig. 8.
1941. *Miogypsina (Miogypsina) hawkinsi* Cole, not Hodson, 1926, *idem*, Bull. 19, p. 47, 48, pl. 17, figs. 1, 2.
1952. *Miogypsina (Miogypsinita) bronnimanni* Drooger, Doctor's Diss. Utrecht, p. 28-30, pl. 1, figs. 35-39; pl. 3, figs. 3a, c, not fig. 3b which is a vertical section of *Lepidocyclina (Eulepidina) undosa* Cushman.
1952. *Miogypsina ecuadorensis* Drooger, not Tan, 1936, *idem*, pl. 1, fig. 29, not figs. 25-28 which are *M. (Miolepidocyclina) panamensis* (Cushman).
1952. *Miogypsina mexicana* Nuttall, Drooger, *idem*, p. 39, pl. 1, figs. 40-42.
1953. *Miogypsina (Miolepidocyclina) mexicana* Nuttall, Cole, U. S. Geol. Surv., Prof. Paper 244, p. 36, 37, pl. 25, figs. 9-12.
1953. (?) *Miogypsina (Miolepidocyclina) panamensis* Cole, not Cushman, Jour. Paleont., v. 27, No. 3, p. 336, 337, pl. 44, figs. 1-5.
1956. *Miogypsina (Miolepidocyclina) panamensis* Cole, not Cushman, 1918, Bull. Amer. Paleont., v. 36, No. 158, p. 214, pl. 30, fig. 10.

Remarks.—The embryonic chambers are always subapical and completely surrounded by a ring of periembryonic chambers which are larger on one side of the embryonic chambers than on the other side. There is always at least one row and often several rows of equatorial chambers between the embryonic apparatus and the peripheral zone.

If the equatorial section is ground slightly tangential to the equatorial zone, a part of the periembryonic ring may be destroyed (fig. 3, Pl. 30). However, even in such specimens it is possible to recognize this fact because such specimens do not have the fringelike peripheral zone extending inward to the embryonic chambers as *M. (M.) antillea* does.

The subgenus *Miogypsinita* erected by Drooger (1952, p. 61) was defined to include species which have "a position of the embryonic-nepionic stage up to half way between the periphery and the center of the test in the macrospheric generation. . . ." The type species was designated as *Miogypsina mexicana* Nuttall *(=M. staufferi)*. As specimens of this species from a single population have a variable position of the embryonic apparatus from subapical (fig. 4, Pl. 30; Cole, 1953, fig. 9, pl. 25) to subcentral (Cole, 1953, fig. 11, pl. 25) this subgenus is invalid.

Occurence in Panama.—Not reported to date, except possibly as *M. (M.) panamensis* from the La Boca marine member of the Panama formation.

Occurrence elsewhere.—Venezuela (as *M. staufferi* Koch with small *Lepidocyclina; M. venezuelana* Hodson); Mexico (as *M. mexicana* Nuttall); Florida (as *M. hawkinsi* Cole, not Hodson; *M. venezuelana* Hodson) with *Operculinoides forresti* Vaughan and Cole; Trinidad with *Lepidocyclina (Lepidocyclina) supera* (Conrad) and *Amphistegina bullbrooki* (Vaughan and Cole) (as *M. bronnimanni* Drooger); Jamaica, B. W. I., (as *M. panamensis* Cole, not Cushman) with *Lepidocyclina (Lepidocyclina) canellei* Lem. and R. Douvillé.

AGE AND OCCURRENCE OF THE MIOGYPSINIDS

In the Port St. Joe test well 3 in Gulf County, Florida, *Miogypsina (Miogypsina) staufferi* was found at 700-721 feet, and *Miogypsina (Miogypsina) gunteri* was encountered at a depth of 890-911 feet (Cole, 1938, p. 19). At 996-1017 feet in this same well *Miogypsina (Miolepidocyclina) panamensis* occurs.

In Panama *M. (Miogypsina) antillea* and *M. (M.) gunteri* occur together (locality 42*h*) at one locality in the Bohio formation and *M. (M.) antillea* and *M. (Miolepidocyclina) panamensis* occur together (locality 54*f*) at another locality in the Caimito formation. Previously, Cole (1953, p. 7) found *M. (M.) antillea* in samples from two localities in the Caimito formation, one (locality 53) of which was from the middle member of this formation in the Gatun Lake area and the other (locality 37) was from an undifferentiated member of this same formation in the Pacific coastal area. In samples from another locality (locality 55), also in the middle member of the Caimito formation of the Gatun Lake area, he found *M. (Miolepidocyclina) panamensis.*

Thus, these three species appear to occur at nearly the same stratigraphic level in Panama, whereas *M. (M.) staufferi* would seem to occur at a slightly higher stratigraphic level in Florida and probably elsewhere in the Caribbean area.

Miogypsinoides complanatus was reported by Nuttall (1933, p. 177) to occur in the Meson formation of Mexico in association with *Lepidocyclina undosa* Cushman. In a sample in the writer's possession from the Meson formation *M. complanatus* occurs with *Heterostegina israelskyi* Gravell and Hanna and *Lepidocyclina waylandvaughani* Cole. This species, therefore, has apparently the same stratigraphic range as do the species of *Miogypsina.*

The types of *M. (M.) cushmani* (= *M. (M.) antillea)* are from USGS locality 6012*d* which is in the Culebra formation to which Woodring and Thompson (1949, p. 239) assigned a "late Oligocene(?) and early Miocene age." Recently, Woodring (1955) definitely placed the Culebra formation in the lower Miocene.

In examining the topotypes of *M. cushmani* given me years ago by the late T. Wayland Vaughan one specimen of *Lepidocyclina (Lepidocyclina) yurnagunensis* Cushman was found. Previously, Cole (1953, p. 7) reported this species from the middle and upper members of the Caimito formation. Therefore, the data at hand suggest that *M. (M.) gunteri* and *M. (M.) panamensis* occur in the middle member of the Caimito formation, whereas *M. (M.) antillea* and *L. (L.) yurnagunensis* occur in the middle and upper members of the Caimito formation and in a part of the Culebra formation.

Cole (1953, p. 336) identified *M. (M.) panamensis* from the La Boca marine member of the Panama formation. However, these specimens could represent *M. (M.) staufferi* as the embryonic apparatus is not well exposed in the available preparations. These specimens occurred in the same sample with undoubted specimens of *L. (L.) parvula* Cushman. Thus, species of *Lepidocyclina (Lepidocyclina), Miogypsina (Miogypsina)* and *Miogypsina (Miolepidocyclina)* in Panama extend into the lower Miocene if Woodring's age assignment for the Culebra through the La Boca is accepted.

In Trinidad *M. (M.) staufferi* occurs with *Lepidocyclina parvula* and *L. supera* at Morne Diablo quarry (Kugler loc. 11398). In Florida Cole (1934, p. 23) found *L. supera* in the same sample with *L. yurnagunensis.* Therefore, on association of species it is probable that there is not a large stratigraphic difference in range between *M. (M.) antillea* and *M. (M.) staufferi.*

Finally, *M. (M.) antillea* and *M. (M.) panamensis* occur with *Lepidocyclina canellei* in Panama and *M. (M.) staufferi* occurs with this species of *Lepidocyclina* in Jamaica, inasmuch as reexamination of specimens from locality V170 previously identified (Cole, 1956, p. 214, pl. 30, fig. 10) as *M. (M.) panamensis* are not that species but do represent typical *M. (M.) staufferi.*

These stratigraphic conclusions may be checked against the distribution of miogypsinids in wells in southern Florida. Drooger (1952, p 39) reported specimens identified by him as *Miogypsina* ex interc. *cushmani-mexicana* at a depth of 520-540 feet in a well in Collier County, Florida. These specimens undoubtedly represent *M. (M.) staufferi.* In three other wells in Collier County he reported *M. cushmani* at depths from 760 to 800 feet. These specimens appear to be *M. (M.) antillea.* In samples from this same county the writer found specimens of *M. (M.) panamensis* and *M. (M.) gunteri* at depths from 960 to 1100 feet.

AMERICAN EOCENE AND OLIGOCENE HETEROSTEGINIDS

Four species of heterosteginids are recognized at present, one from the Eocene and three from the upper Oligocene. The Eocene species *H. ocalana* has been discussed and illustrated in detail recently (Cole, 1953, p. 13). The Oligocene species recognized in Panama are illustrated (figs. 3-9, Pl. 25) and a key for identification of the species is given below.

KEY TO THE AMERICAN EOCENE AND OLIGOCENE SPECIES OF *HETEROSTEGINA*

A. Test involute, evenly biconvex with pronounced axial plug.
   1. With one to four operculine chambers ....*H. panamensis* Gravell.

B. Test evolute, more or less compressed.
   1. Test thin throughout without a distinctly inflated umbonal area *H. israelskyi* Gravell and Hanna.

2. Test with a distinctly inflated umbonal area bordered by a thin flange.
   a. With two to fourteen operculine chambers .... *H. ocalana* Cushman.[1]
   b. With one operculine chamber ....*H. antillea* Cushman.[2]

1. *H. cubana* de Cizancourt is a synonym of *H. ocalana.*
2. *H. texana* Gravell and Hanna is a synonym of *H. antillea.*

SYSTEMATIC DESCRIPTIONS

Family CAMERINIDAE

Genus **Heterostegina** d'Orbigny, 1826

Heterostegina antillea Cushman — Pl. 25, figs. 3-5

1919. *Heterostegina antillea* Cushman, Carnegie Inst. Washington, Publ. 291, p. 49, 50, pl. 2, fig. 1b; pl. 5, figs. 1, 2.
1937. *Heterostegina texana* Gravell and Hanna, Jour. Paleont., v. 11, No. 6, p. 525, 526, pl. 63, figs. 1-4.
1938. *Heterostegina texana* Gravell and Hanna, Cole, Florida Geol. Surv., Bull. 16, p. 40, 41, pl. 5, figs. 18-21; pl. 6, figs. 1, 2.
1941. *Heterostegina antillea* Cushman, Vaughan and Cole, Geol. Soc. Amer., Sp. Paper 30, p. 54, pl. 15, figs. 10-12; pl. 16.
1941. *Heterostegina texana* Gravell and Hanna, Cole, Florida Geol. Surv., Bull. 19, p. 33, pl. 11, figs. 1, 2, not pl. 10, figs. 1, 2 which are *Heterostegina panamensis.*
1944. *Heterostegina texana* Gravell and Hanna, Cole, *idem,* Bull. 26, p. 52, pl. 6, figs. 7-9.
1953. *Heterostegina antillea* Cushman, Cole, U. S. Geol. Surv., Prof. Paper 244, p. 11, 12, pl. 5, figs. 1-11.

Occurrence in Panama.—Barro Colorado Island: *42b* (Bohio formation), *54f* (Caimito formation); loc. 38, 39 (Bohio formation), 11a, 37, 43, 45 (Caimito formation) (Cole, 1953, p. 6, 7).

Occurrence elsewhere.—Long Island, Antigua; Trinidad; Venezuela; Mexico; Florida; Texas.

Heterostegina israelskyi Gravell and Hanna — Pl. 25, figs. 8, 9

1937. *Heterostegina israelskyi* Gravell and Hanna, Jour. Paleont., v. 11, p. 524, 525, pl. 62, figs. 1-4.
1953. *Heterostegina israelskyi* Gravell and Hanna, Cole, U. S. Geol. Surv., Prof. Paper 244, p. 12, pl. 1, fig. 22; pl. 4, fig. 1; pl. 5, figs. 12-14; pl. 6, figs. 17, 18.

Occurrence in Panama.—Barro Colorado Island: 54*f*, 54*l*; loc. 55, 110 (Caimito formation) (Cole, 1953, p. 7).

Occurrence elsewhere.—Texas; Cuba (specimens through the courtesy of Pedro J. Bermudez) with *Lepidocyclina (Lepidocyclina) asterodisca* Nuttall.

Heterostegina panamensis Gravell — Pl. 25, figs. 6, 7

1932. *Heterostegina panamensis* Gravell, Smithsonian Miscell. Coll., v. 89, No. 11, p. 17, 18, pl. 1, figs. 10, 11.

1941. *Heterostegina texana* Cole, not Gravell and Hanna, Florida Geol. Surv., Bull. 19, p. 33, pl. 10, figs. 8, 9, not pl. 11, figs. 1, 2 which are *Heterostegina antillea*.

1945. *Heterostegina texana* Cole, not Gravell and Hanna, *idem*, Bull. 28, p. 110, 111, pl. 15, figs. 9, 10.

1953. *Heterostegina panamensis* Gravell, Cole, U. S. Geol. Surv., Prof. Paper 244, p. 14, pl. 5, figs. 15-19.

Occurrence in Panama.—USGS loc. 6025; loc. 55 (Caimito formation) (Cole, 1953, p. 7).

Occurrence elsewhere.—Venezuela; Florida.

Genus **OPERCULINOIDES** Hanzawa, 1935

Operculinoides panamensis (Cushman)

1953. *Operculinoides panamensis* (Cushman), Cole, U. S. Geol. Surv., Prof. Paper 244, p. 10, 11, pl. 2, figs. 1-4.

Occurrence on Barro Colorado Island.—Loc. 54*l* (Caimito formation).

Family **PENEROPLIDAE**

Genus **ARCHAIAS Montfort,** 1808

Archaias compressus (d'Orbigny) — Pl. 24, figs. 1-9

1919. *Orbiculina compressa* d'Orbigny, Cushman, Carnegie Inst. Washington, Publ. 291, p. 70, pl. 7, fig. 6.

1930. *Archaias compressus* (d'Orbigny), Cushman, U. S. Nat. Mus., Bull. 104, p. 48, pl. 17, figs. 1, 2.

1941. *Archaias compressus* (d'Orbigny), Galloway and Heminway, New York Acad. Sci., Scientific Surv. Porto Rico and Virgin Islands, v. 3, pt. 4, p. 318, pl. 5, figs. 10 *a*, *b*.

The specimens from the Oligocene of Panama are identical with Recent specimens from Barbados from which an equatorial section (fig. 9, Pl. 24) and a vertical section (fig. 4, Pl. 24) were made for comparison.

Occurrence on Barro Colorado Island.—Loc. 42*d* (Bohio formation); loc. 54*h* (Caimito formation).

Family **ORBITOIDIDAE** Schubert

Genus **LEPIDOCYCLINA** Gümbel, 1870

Subgenus **LEPIDOCYCLINA** Gümbel, 1870

Lepidocyclina (Lepidocyclina) canellei Lemoine and R. Douvillé

1953. *Lepidocyclina (Lepidocyclina) canellei* Lem. and R. Douvillé, Cole, U. S. Geol. Surv., Prof. Paper 244, p. 18-20, pl. 16, figs. 1-22; pl. 17, figs. 1-3.

Occurrence on Barro Colorado Island.—Locs. 42*d*, 42*h* (Bohio formation); locs. 54*f-l* (Caimito formation).

Lepidocyclina (Lepidocyclina) parvula Cushman

1953. *Lepidocyclina (Lepidocyclina) parvula* Cushman, Cole, U. S. Geol. Surv., Prof. Paper 244, p. 20, pl. 15, figs. 6-10.

Occurrence on Barro Colorado Island.—Loc. 42*d* (Bohio formation); loc. 54*l* (Caimito formation).

Lepidocyclina (Lepidocyclina) waylandvaughani Cole

1953. *Lepidocyclina (Lepidocyclina) waylandvaughani* Cole, Cole, U. S. Geol. Surv., Prof. Paper 244, p. 20-22, pl. 18, figs. 1-10, 16, 17.

Occurrence on Barro Colorado Island.—Loc. 42*d* (Bohio formation).

Subgenus **NEPHROLEPIDINA** H. Douvillé, 1911

Lepidocyclina (Nephrolepidina) vaughani Cushman

1953. *Lepidocyclina (Nephrolepidina) vaughani* Cushman, Cole, U. S. Geol. Surv., Prof. Paper 244, p. 29, 30, pl. 18, figs. 14, 15; pl. 20, figs. 1-6; pl. 21, figs. 1-15.

Occurrence on Barro Colorado Island.—Loc. 42*d* (Bohio formation).

LITERATURE CITED

Barker, R. Wright, and Grimsdale, Thomas F.

1937. *Studies of Mexican fossil Foraminifera.* Ann. Mag. Nat. Hist., ser. 10, v. 19, p. 161-178, pls. 5-9, 2 text figs.

Cole, W. Storrs

1934. *Oligocene orbitoids from near Duncan Church, Washington County, Florida.* Jour. Paleont., v. 8, No. 1, p. 21-28, pls. 3, 4.

1938. *Stratigraphy and micropaleontology of two deep wells in Florida.* Florida Geol. Surv., Bull. 16, p. 1-73, pls. 1-12, 3 text figs.

1948. Cole in Cushman's *Foraminifera, their classification and economic use.* Harvard University Press.

1952 (1953). *Eocene and Oligocene larger Foraminifera from the Panama Canal Zone and vicinity.* U. S. Geol. Surv., Prof. Paper 244, p. 1-41, pls. 1-28, 2 text figs.

Drooger, C. W.

1951. *Notes on some representatives of Miogypsinella.* Konin. Nederl. Akad. Wetensch. Amsterdam Proc., ser. B, v. 54, No. 4, p. 357-365, 7 figs.

1952. *Study of American Miogypsinidae.* Doctor's Diss. Utrecht, p. 1-80, 3 pls., 18 text figs.

1953. *Some Indonesian Miogypsinae.* Konin. Nederl. Akad. Wetensch. Amsterdam Proc., ser. B, v. 56, No. 1, p. 104-123, 2 pls.

Hanzawa, Shoshiro

1940. *Micropalaeontological studies of drill cores from a deep well in Kita-Daito-Zima (North Borodino Island).* Jubilee Publ. in Commemoration of Prof. Yabe's 60th Birthday, p. 755-802, pls. 39-42, 5 text figs.

Nuttall, W. L. F.

1933. *Two species of Miogypsina from the Oligocene of Mexico.* Jour. Paleont., v. 7, No. 2, p. 175-177, pl. 24.

Woodring, W. P.

1955. *Geologic map of Canal Zone and adjoining parts of Panama.* U. S. Geol. Surv., Miscell. Geol. Investigations, Map I-1.

Woodring, W. P., and Thompson, T. F.

1949. *Tertiary formations of Panama Canal Zone and adjoining parts of Panama.* Amer. Assoc. Petrol. Geol., Bull., v. 33, No. 2, p. 223-247, 2 text figs.

PLATES

*Explanation of Plate 24

Figure		Page
1-9.	**Archaias compressus** (d'Orbigny)	326

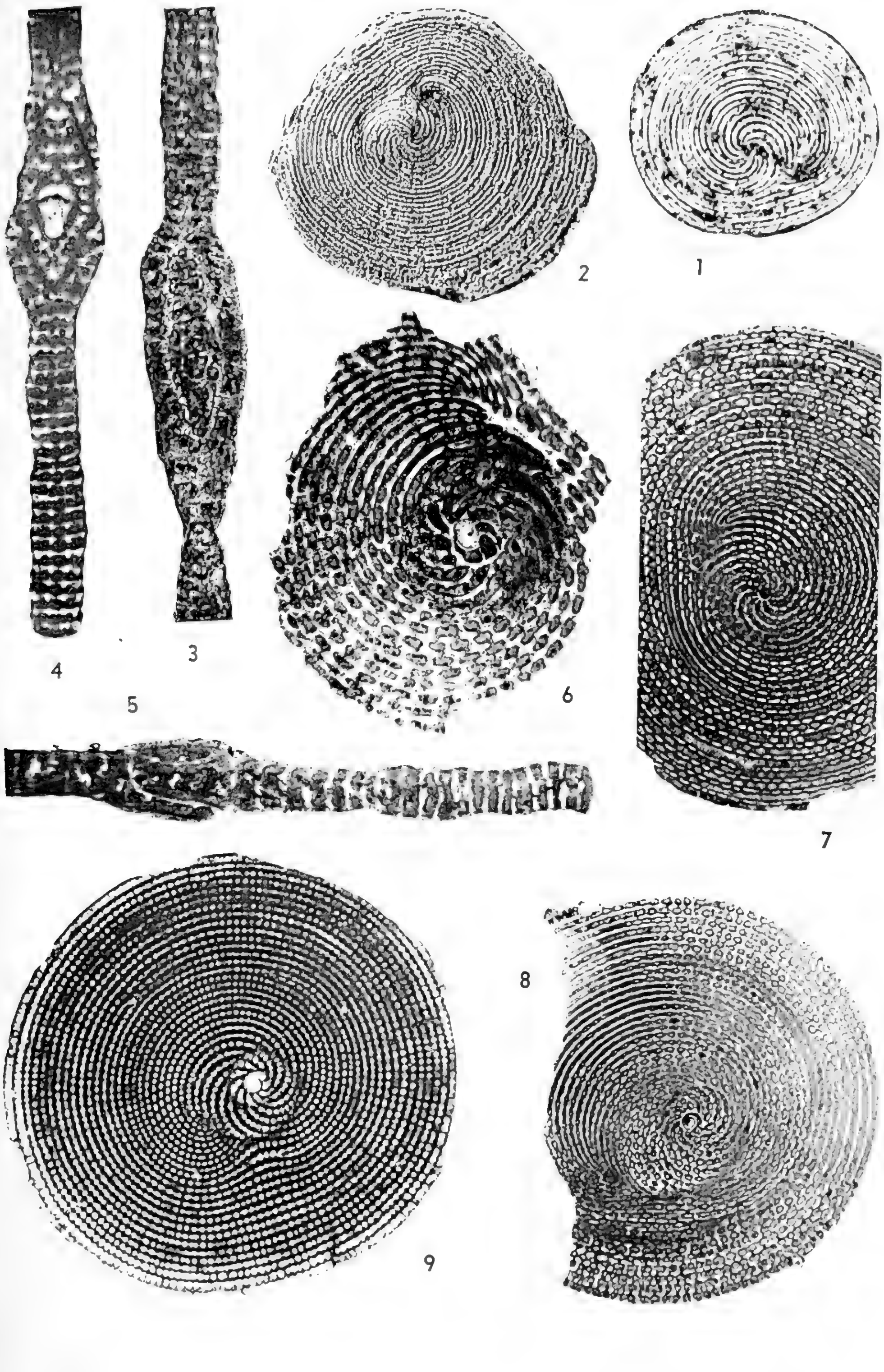
1,2. External views; 1, x 13; 2, x 14; locality *42d*.

3-5. Transverse sections, x 40; 3, 5, locality *42d*; 4, Barbados, introduced for comparison.

6-9. Median sections; 6, x 40; 7-9, x 20; 6-8, locality *42d*; 9, Barbados, introduced for comparison.

1-9, U.S.N.M. Nos. 562198-562206.

*Unless otherwise designated, the description of the localities is given in the text.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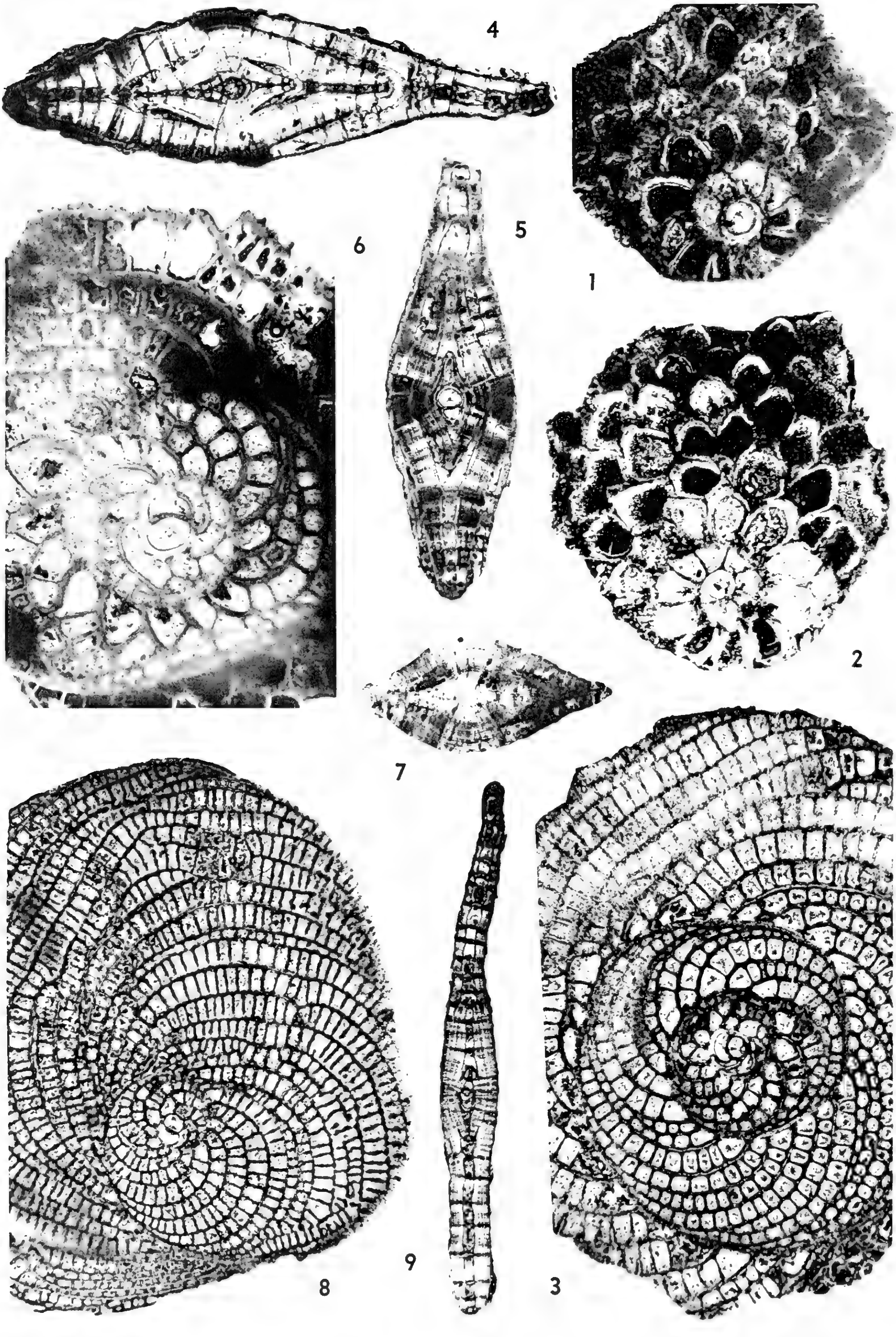
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Explanation of Plate 25

Figure | Page

1,2. **Miogypsinoides complanatus** (Schlumberger) 318

Equatorial sections; 1, x 40; 2, x 36.5, after Cole, Florida Geol. Surv., Bull. 16, fig. 10, pl. 8; 500 meters east of Rancho Abajo which is near kilometer 9 on the Huasteca Petroleum Company's narrow gauge railroad between San Geronimo and Cerro Azul, Mexico.

3-5. **Heterostegina antillea** Cushman 325

3. Median section, x 20, locality 42*b*; 4, 5, transverse sections, x 20; 4, locality 42*b*; 5, locality 54*f*.

6,7. **Heterostegina panamensis** Gravell 326

6. Median section, x 40; 7, transverse section, x 20; U. S. G. S. locality 6025, Bohio Ridge Switch, Panama Canal Zone.

8,9. **Heterostegina israelskyi** Gravell and Hanna 326

8. Median section, x 12.5; 9, transverse section, x 12.5; locality 54*f*.

2-9, U.S.N.M. Nos. 562207-562214.

Explanation of Plate 26

Figure Page

1-4, 8,9. **Miogypsina (Miogypsina) gunteri** Cole 320

1-4, 8, 9. Equatorial sections, 1, 3, 4, 8, 9, x 40; 2, x 36.5; 1-4, at a depth of 890-911 feet in the Port St. Joe Test well 3, Gulf County, Florida; 2, after Cole, Florida Geol. Surv., Bull. 16, fig. 1, pl. 8; 8, 9, locality *42h*.

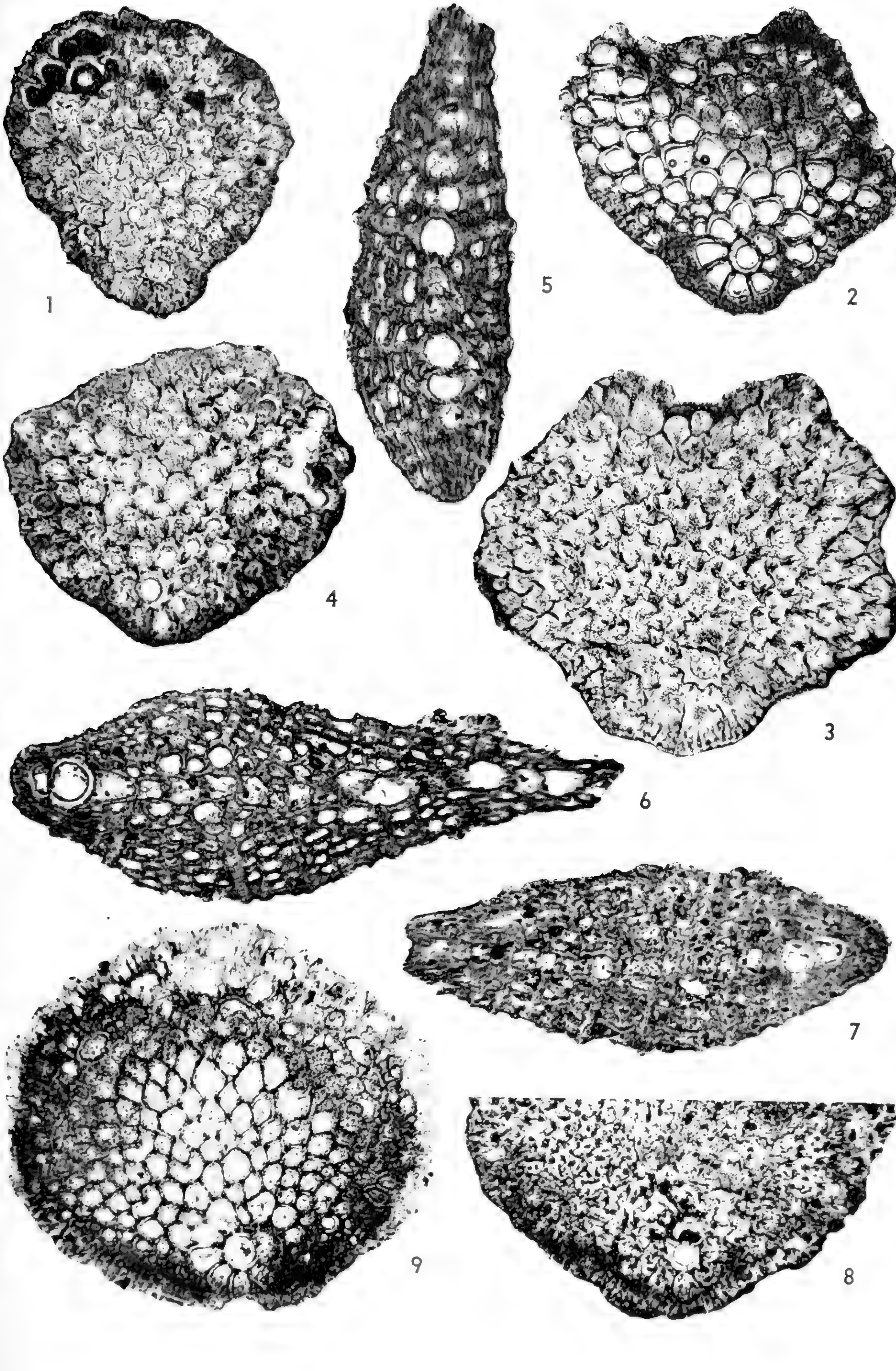
5. **Miogypsina (Miolepidocyclina) panamensis** (Cushman) 321

Vertical section, x 40, which shows the subapically situated embryonic apparatus with the equatorial layer developed on each side; at a depth of 1010-1020 feet from the Republic Oil Company's O. D. Robinson well No. 1 located in Card Sound, Monroe County, Florida.

6,7. **Miogypsina (Miogypsina) antillea** (Cushman) 319

Vertical sections, x 40, which show the apically situated embryonic apparatus with the equatorial layer developed only on the distal side; locality *54f*.

1, 3-9, U.S.N.M. Nos. 562215-562222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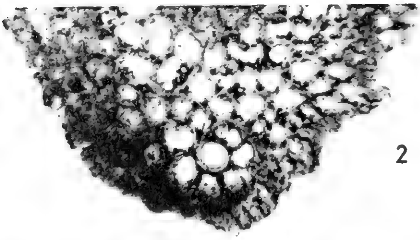

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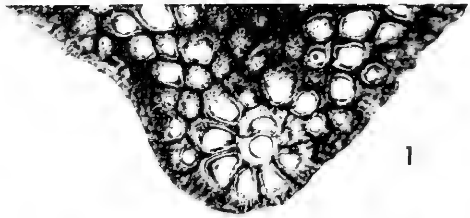

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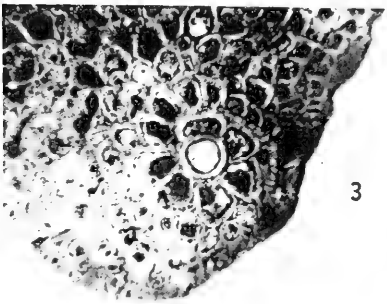

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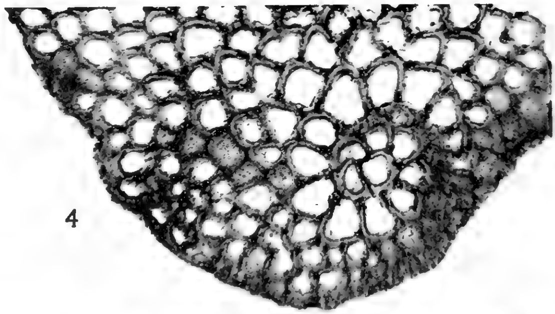

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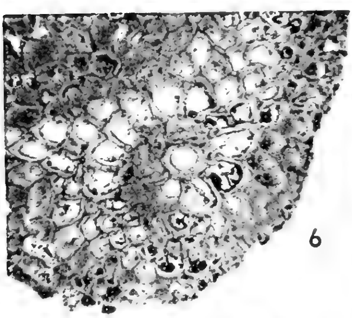

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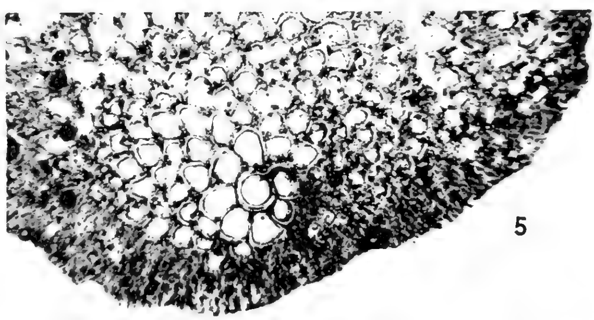

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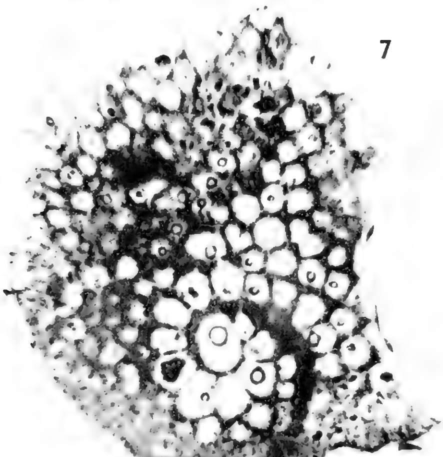

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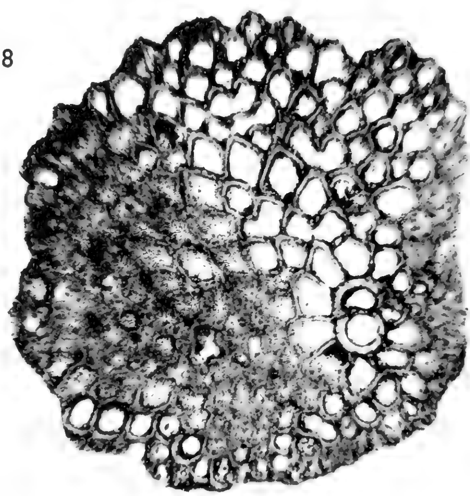

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Explanation of Plate 27

Figure Page

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Part of an equatorial section x 40, at a depth of 1090-1100 feet from the Republic Oil Company's O. D. Robinson well No. 1 located in Card Sound, Monroe County, Florida.

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1-8, U.S.N.M. Nos. 562223-562230.

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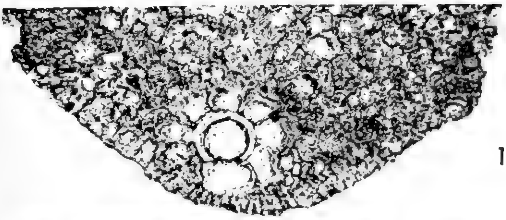
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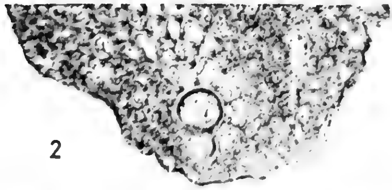
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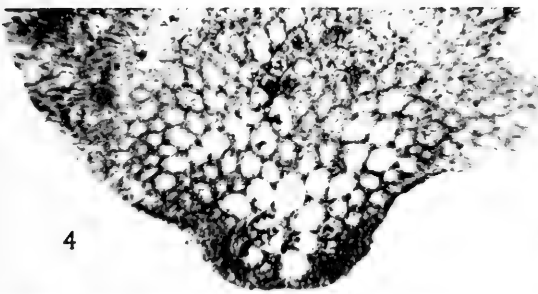
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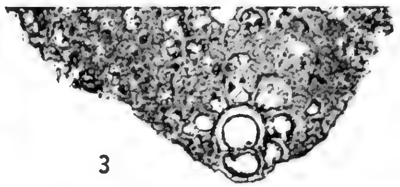
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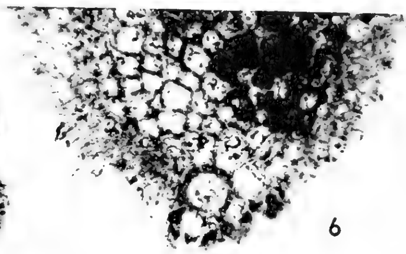
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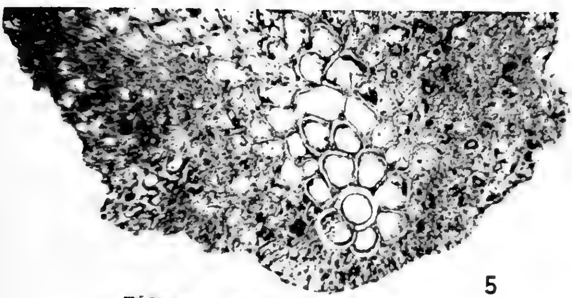
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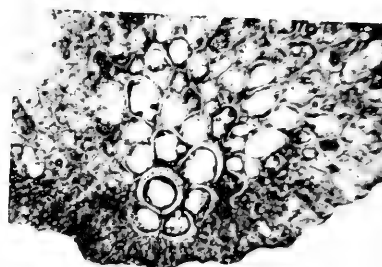
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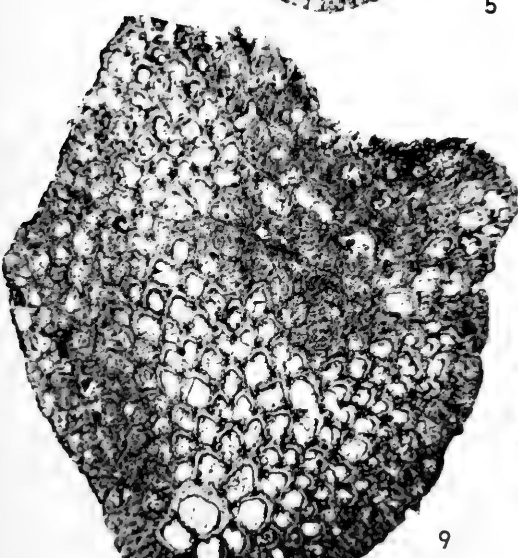
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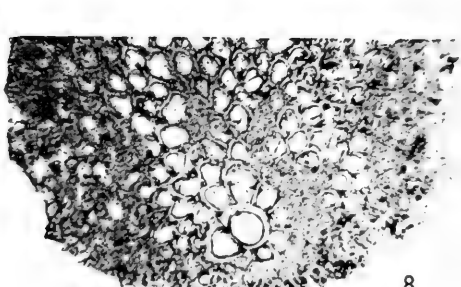
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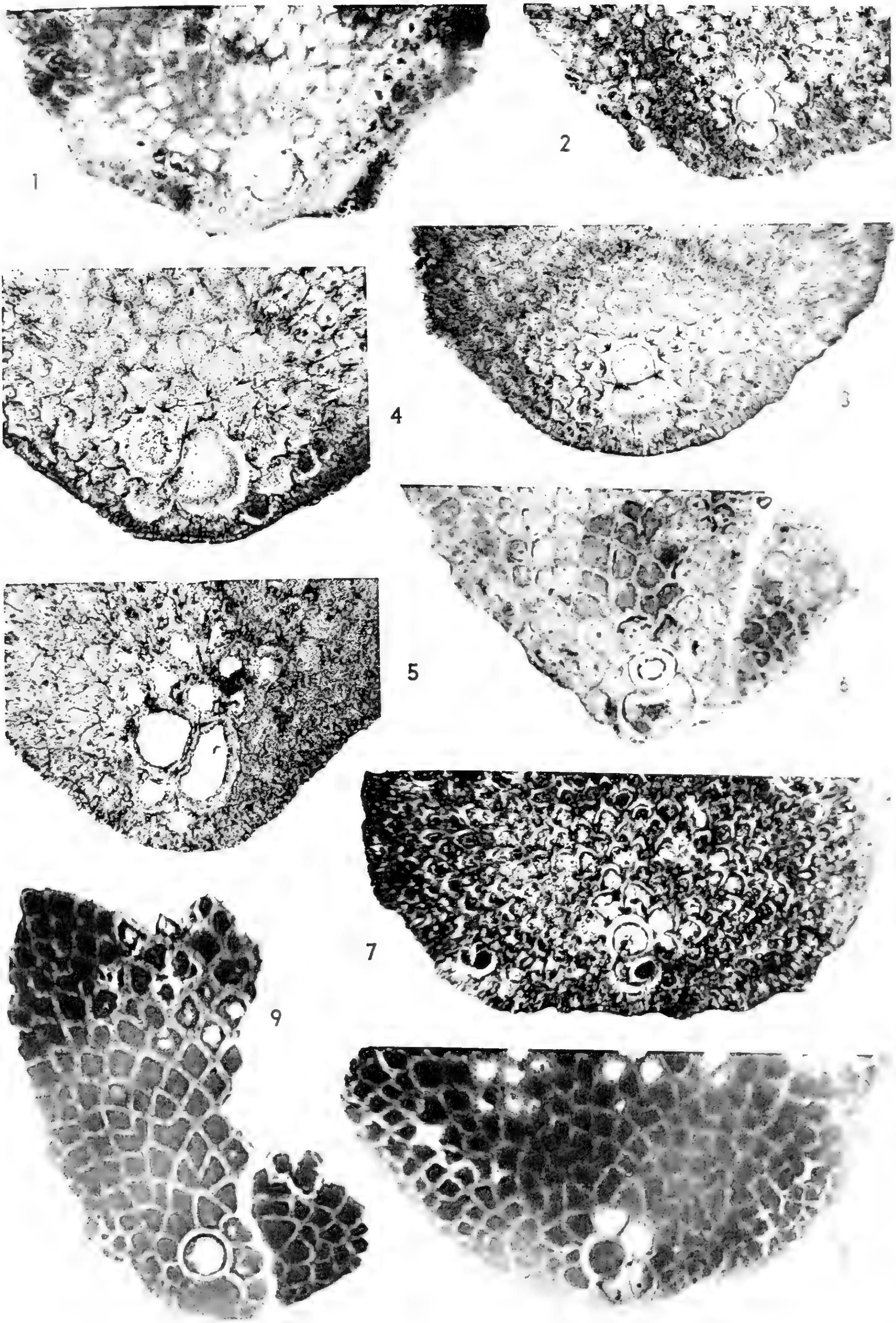
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1-9. Parts of equatorial sections, x 40; 1, topotype of *M.* (*M.*) *antillea* from U. S. G. S. locality 6965, Crocus Bay, Anguilla; 2, 7, locality 53 of U. S. Geol. Surv., Prof. Paper 244, low garden islet 400 meters N.E. of landing at Barro Colorado Island, Panama; 3-6, Peninsular Oil and Refining Company's J. W. Cory well No. 1, Monroe County, Florida, 3, at a depth of 940-950 feet, 4, 5, at a depth of 930-940 feet, 6, at a depth of 950-960 feet; 8, 9, topotypes of *M.* (*M.*) *cushmani* Vaughan, U. S. G. S. locality 6012*d*, west side of Gaillard Cut, Culebra, Panama Canal Zone.

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2. Equatorial section, x 36.5, at a depth of 700-721 feet in the Port St. Joe 16, fig. 7, pl. 7.

8. Vertical section, X20, Kugler locality K11398, Morne Diablo quarry, Trinidad.

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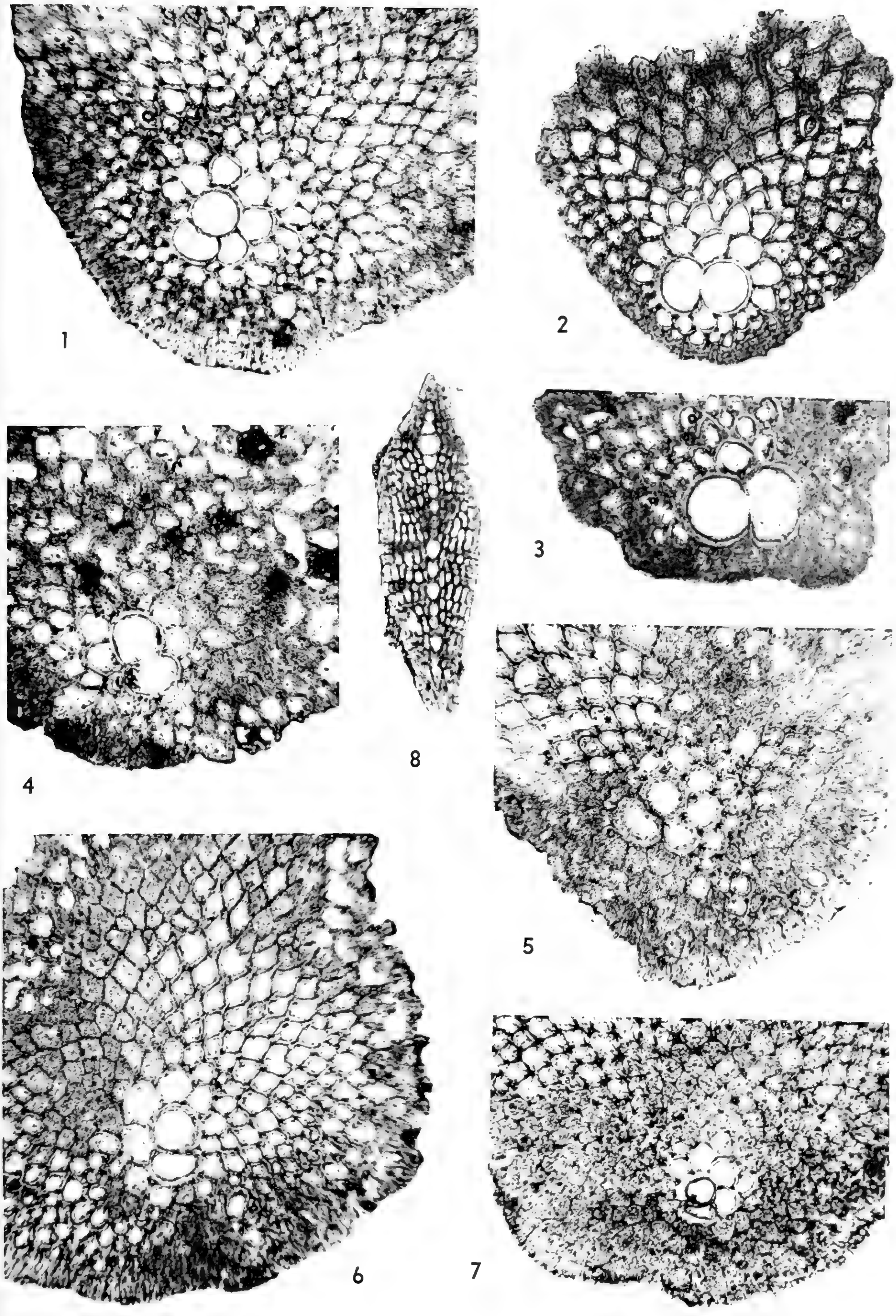
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STRUCTURE AND CLASSIFICATION OF THE STROMATOPOROIDEA

By

J. J. Galloway

Indiana University, Bloomington, Indiana

October 18, 1957

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STRUCTURE AND CLASSIFICATION OF THE STROMATOPOROIDEA

J. J. Galloway

Indiana University
Bloomington, Indiana

ABSTRACT

Stromatoporoidea are layered, calcareous, organic bodies composed of thin laminae, pillars, and curved plates, occurring in marine deposits of Ordovician, Silurian, and Devonian age. They frequently occur in large beds and make organic reefs or bioherms. They occur in profusion in North America, Europe, Asia, Australia, and Morocco, but are unreported from South America.

Stromatoporoidea are an extinct order of Hydrozoa, the ancestors of the upper Paleozoic and Mesozoic order Sphaeractinoidea, and in turn related to the modern order Hydroidea, especially to the hydractinoids.

The stromatoporoids consist either of cysts and pillars, or of laminae and pillars. They are here classified into five families, a modification of H. A. Nicholson's classification of 1886. The aim is to include every genus ever proposed for real Stromatoporoidea. Only 35 genera of the 69 which have been proposed, are recognized as valid, not including upper Paleozoic and Mesozoic genera.

In the first part, the structures, their systematic significance, the geographic and stratigraphic occurrence, the astogeny, ancestry and phylogeny, with phylogenetic diagram the ecology and fossilization, and the systematic position are discussed.

The second part of the work consists of a precise description of each valid genus, with type species, synonymy, occurrences and distinctions, key of the families and genera, with typical figures of the genera, and figures of all the types with supplementary figures. Two new genera are proposed. A selected bibliography is given.

The endeavor is to make the stromatoporoids recognizable to paleontologists, useful to stratigraphers in age determination of strata, and available to petroleum geologists who study the occurrence of petroleum in ancient organic reefs.

ACKNOWLEDGMENTS

The writer wishes to acknowledge obligations to many persons and institutions who have given important assistance in the preparation of the present study: Mr. R. S. Bowman, Ohio State University, for the loan of topotypes of *Clathrodictyon vesiculosum* and a fine specimen of *Stromatopora antiqua* N. & M.; Mrs. Ruth G. Browne, Louisville, Ky., for the gift of many specimens of *Aulacera;* Buffalo Society of Natural Sciences, for the loan of specimens; Mr. Guy Campbell, Corydon, Indiana, for the gift of many specimens of Ordovician and Devonian stromatoporoids; University of Cincinnati, for the loan of specimens; Dr. G. Arthur

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PART 1. CHARACTERISTICS OF THE STROMATOPOROIDEA

INTRODUCTION

Purpose of the study.—Stromatoporoids are abundant fossils in the lower and middle Paleozoic, yet they have been studied the least of any common fossils in America. The stromatoporoids are difficult to study, for the genera and species are recognizable only from thin sections. A vertical and a tangential section are needed for definite identification of every specimen, so that the labor of preparing specimens for identification is unusual for fossils. They are comparable to Paleozoic Bryozoa in methods used for identification.

The stromatoporoids are considered by most paleontologists to be obscure organisms and difficult to understand. For evaluation of structures, even with thin sections, the supposed obscurity of structures has been overemphasized; most specimens are well preserved and the structures can be seen and evaluated as readily as for other fossils which need to be studied with a microscope. The principal difficulty in studying and identifying stromatoporoids is the lack of literature with adequate descriptions and figures, notwithstanding nearly 600 papers on the group. It is a striking fact that there never has been a United States specialist on the group, and that the available literature is wholly inadequate for specific and even for generic identification. Although several people have published papers on North American stromatoporoids, the works of only two men are important; first are the famous works of the late Dr. H. A. Nicholson, of the University of Aberdeen, who was an early user of the method of studying corals, Bryozoa and Stromatoporoidea by means of thin sections, and of using internal structures instead of external structures for classification and identification. The other specialist was the late Dr. W. A. Parks, of the University of Toronto, who had made great progress in elucidating many of the stromatoporoids of Canada and the United States.

The identification of species is at present an entirely insuperable task for most paleontologists. It is, furthermore, scarcely possible to identify a genus, for no adequate description and figures have been published for many of the genera, *e.g., Aulacera, Cryptophragmus, Clathrodictyon, Stylodictyon, Clathrocoilona, Idiostroma* and others. Furthermore, where adequate descriptions and figures of the type species have been published, *e.g., Labechia, Syringostroma, Hermatostroma, Parallelopora, Stromatoporella,* and others, authors have departed widely from the type species, or have actually substituted a different meaning to a genus than that understood by the original author, as *Clathrodictyon* for *Anostylostroma.*

Stromatoporoids occur in the Midwestern States in great profusion. There are scores of stromatoporoid biostromes and bioherms in Indiana and Michigan, some in Kentucky, Ohio, Illinois, Wisconsin, Missouri, and in Ontario; and there are also great beds of biostromes and bioherms in the Upper Devonian strata of Iowa and the Rocky Mountain States.

The writer has been engaged in collecting and studying stromatoporoids for over twenty years, and has made extensive collections from Indiana, Kentucky, Ohio, Michigan, Iowa, and Ontario, and has borrowed types and has been given many specimens. He has paid especial attention to the stromatoporoids since 1933, when Parks (1934, p. 344) advocated their placement in the Foraminifera, a field familiar to the writer. Stromatoporoids require the same technique for study as do the larger Foraminifera and Bryozoa, algae and corals, so that despite their large size, they are properly a part of the subject of micropaleontology.

Nicholson in his great monograph (1886, pp. 1-27) reviewed the work of previous authors, and discussed the structure and classification of the Stromatoporoidea more thoroughly than had been done before or since. Other attempts at classifying the Stromatoporoidea have been made with varying success (Heinrich, 1914; Dehorne, 1920; Steiner, 1932); important studies on classification were made by Kühn (1927, 1939) and by Lecompte (1951, p. 44, and 1956, p. F107).

There are two recent papers on the structure and classification of the Stromatoporoidea: (1) Yavorsky, 1955, Stromatoporoidea Sovetskogo Soyuza, who has a brief discussion of the structure and a modification of Nicholson's classification into two families in the hydractinoid group, in which zooidal tubes (superposed galleries) are absent, and three families in the milleporoid group, in which zooidal tubes are present. He included six Mesozoic genera but discussed only those genera found in Russia. Many of Yavorsky's species in the "Milleporoid group" do not have vertical tubes, including his new genus *Ferestromatopora;* Yavorsky described and figured 195 Russian species. The figures are admirable. The work is in Russian, difficult to obtain and difficult to use even when translated, because different concepts are used in descriptions. (Review, Jour. Paleont., vol. 31, 1957, p. 834.)

(2) The second recent paper is that by Lecompte, 1956, in Part F of the Treatise on Invertebrate Paleontology. Lecompte, has a new classification of 62 genera, 36 lower Paleozoic genera and 26 late Paleozoic and Mesozoic genera, in 11 families, classified on the basis of general similarity, taking no account of geologic occurrence, interspersing the Mesozoic genera in Middle Paleozoic families. The discussions and descriptions are rather too brief to be readily understood, and the basis for the classification is obscure. (Review, Jour. Paleont., vol. 31, 1957, p. 836.)

It is not here proposed to revolutionize the classification of Stromatoporoidea, but rather to bring together the best thought and findings on the group, so as to make the genera and species understandable to others. It is hoped to make the stromatoporoids more useful to students of systematic paleontology, and to make it possible to use the stromatoporoids for age determination, and for more detailed stratigraphic correlation. Petroleum occurs in many stromatoporoid reefs or bioherms, and a knowledge of stromatoporoids should, therefore, be of considerable value in petroleum geology.

Galloway and St. Jean (1957) used a preliminary classification of the one developed here.

GLOSSARY OF STRUCTURAL TERMS APPLYING TO STROMATOPOROIDEA

Amalgamated. United without visible sutures; coalesced or fused. Used particularly for the condition of the union of the horizontal and vertical structures in the family Stromatoporidae (Pl. 31, figs. 14-16; Pl. 35, figs. 1-7). "Continuously reticulated skeleton," Nicholson (1886, pp. 34, 74). "Reticulate tissue," Lecompte (1956, p. F113).

Astogeny. Development of a colony from its beginning to the adult condition.

Astrorhizae. A group of radiating, branching grooves, generally centering at a mamelon and superposed in the axis of a mamelon, but not regularly superposed when there are no mamelons. In vertical sections appearing as large, round, horizontal pores, or as vertical or oblique, tabulate tubes. (Named by Carter, H. J., 1880, Ann. Mag. Nat. Hist., ser. 5, vol. 6, p. 341.) Commonly present in examples of the family Stromatoporidae, may occur in Actinostromatidae, Clathrodictyidae, and Labechiidae, not typically developed in the Idiostromatidae. Astrorhizae occur in many genera of the Hydrozoa and are not confined to the Stromatoporoidea.

Astrorhizal cylinders. Superposed mamelons and astrorhizae, 2 to 15 mm. in diameter, in which the laminae turn upward into the mamelons, giving the superficial appearance of a cylinder in vertical sections. (Nicholson, 1890, p. 165). Also called columns and astrorhizal systems. (Pl. 36, figs. 5, 6).

Axial column. The tabulate axis with arched tabulae, as in *Aulacera.* (Pl. 32, fig. 3)

Caespitose or *cespitose.* Bushy, fasciculate. *Idiostroma.*

Caunopore tubes. Conspicuous, vertical tubes, 0.5 to 1.5 mm. in diameter, having their own walls, generally with cystose or infundibular tabulae, (Pl. 35, fig. 2) and connected at their lower ends by stolons. They are most probably parasitic or commensal organisms, now generally agreed to be the coral *Syringopora. Caunopora* Phillips and *Diapora* Bargatzky are composite masses of stromatoporoids and tubular organisms and are not considered to be valid genera by systematists. Specimens with such tubes are often referred to as being in the "caunopore state." Caunopore tubes are common in *Stromatopora, Stromatoporella, Anostylostroma, Stictostroma, Actinostroma,* and *Gerronostroma* but are rare or absent in other genera of stromatoporoids.

Cells. Used by Yavorsky, 1955, for chambers and galleries.

Chamber. An enclosed space, as the space in a cyst, as of the Labechiidae (Pl. 31, figs. 1-3). Chamber is not a suitable term for the continuous interlaminar spaces traversed by pillars (used by Lecompte, 1951); galleries seem to be a more appropriate term for interlaminar spaces with pillars.

Coenosteum. The entire head or colony or skeleton of a milleporoid or a stromatoporoid. (Proposed by Moseley, 1881, p. 12, for the skeleton of the Hydrocorallina, and adopted by Nicholson, 1886, p. 28, for the skeleton of the Stromatoporoidea). (*Coeno,* common, *osteo,* bone or skeleton).

Columns. Vertical structures much larger than ordinary pillars, 1 to 10 mm. in diameter, making mamelons at the surface, composed primarily of upturned laminae, frequently with astrorhizae. *Anostylostroma columnare* (Pl. 33, fig. 7), *Parallelopora nodulata.* Also the cystose axial column of *Aulacera* and *Cryptophragmus* (Pl. 32, figs. 3, 8).

Compact. Homogeneous, not alveolar or porous or maculate, nor dense like a mineral crystal or glass, but made of calcareous tissue closely appressed, as in the Labechiidae and *Actinostroma* (Pl. 31, figs. 3, 9). A better term than "dense."

Cyst plates. Curved or lenticular plates composing the skeleton of the Labechiidae (Pl. 31, figs. 1-3; Pl. 32, figs. 1-4). Also the less regular, occasional curved plates crossing galleries, generally more or less horizontally or diagonally (Pl. 33, figs. 6, 8, 10). Also commonly called interlaminar septa and dissepiments. Common in *Actinodictyon* (Pl. 35, fig. 10), *Anostylostroma* (Pl. 31, figs. 5), *Stromatoporella* (Pl. 33, fig. 10), and in many other genera where there has been resumption in growth, as at the base of latilaminae and repair of injury. (Pl. 36, fig. 8). The generic and specific value of cyst plates varies. There is no indication that cyst plates are threads, fibers, or trabeculae; the cut plates are always curved lines, not fine, round dots or ellipses, as cut threads would be.

Cysts or *cytose vesicles.* Vesicles formed by outwardly convex plates. Labechiidae (Pl. 31, figs. 1-3); *Actinodictyon* (Pl. 35, fig. 10); *Clathrodictyon* (Pl. 33, fig. 5).

Dendritic. Repeatedly branching, as a tree. Idiostromatidae. Also the branching canals of astrorhizae.

Dense tissue. Apparently solid, compact, and homogeneous, excepting for small variations in texture. Not dense like glass. Not maculate, as in the Stromatoporidae, nor with transverse pores, as in *Stromatoporella*. *Actinostroma* has typically "dense" tissue (Pl. 31, fig. 9). *Trupetostroma* has dense tissue with small, ovoid, vacuoles (Pl. 34, fig. 4). Compact is a better term. Massive is not a precise term for compact or homogeneous.

Denticles. Short spines on the upper cyst plates of *Rosenella* and *Sinodictyon* (Pl. 32, figs. 4, 7).

Dissepiments. Thin, upward or obliquely curved plates, composing the coenostea of the Labechiidae and occurring in galleries of many genera. Also called interlaminar septa, curved plates or tabulae, cyst plates, partitions. *Cystostroma* (Pl. 31, fig. 1). *Actinodictyon* (Pl. 35, fig. 10), *Anostylostroma* (Pl. 33, fig 6).

Epitheca. A thin, wrinkled, basal layer, of finer and different structure than superjacent, normal structures. Occurs at the base of many coenostea. More properly called peritheca; also called holotheca.

"Fiber", "fibre." Microscopic structure of the skeletal tissue; literally, strands or threads; in general a misnomer since the term does not refer to genuine fibers. Also "skeletal fiber." Tissue is a better term.

Fibers. Fine, short, strands transverse to the laminae (Pl. 31, fig. 13).

Fibrous. Composed of short strands transverse to the laminae, as in *Amphipora* and *Anostylostroma* (Pl. 31, fig. 5). Care must be used to distinguish between fibrous and porous.

Flocculent. In loose groups, or not compact, as in the secondary layers of the cyst plates of the Labechiidae (Pl. 32, figs. 1, 2).

Foramen, -ina. A large or principal opening between two chambers, cells or superposed galleries (Pl. 31, fig. 11).

Fused. Same as amalgamated.

Galleries. Interlaminar spaces, traversed by pillars, not by vertical walls, in life occupied by part of the soft body of the animal or abandoned after a new lamina was laid down. Sometimes less aptly called chambers and cells. Superposed galleries, especially where the laminae (tabulae) between are missing, possibly resorbed, referred to by Nicholson and others as "zooidal tubes" (Pl. 35, figs. 1, 2).

Granules. Small elevations at the surface; a fraction of a mm. in diameter, usually the ends of pillars, or papillae.

Horizontal section. A section parallel to the laminae or latilaminae, when the laminae curve little, as in lenticular specimens. When the laminae curve much, the section is tangential. Usually referred to as the "tangential section."

Hydractinoid. Having pillars distinct from the laminae or horizontal processes, much as in the hydroid genus *Hydractinia,* and the tissue of neither the pillars nor laminae is maculate. Used by Nicholson (1886, p. 40, 74; Yavorsky, 1955, p. 7), and sometimes by others, to refer to the families Labechiidae and Actinostromatidae.

Infiltrated. Filled in solid by calcite from solution, after burial, preserving the hard parts nearly perfectly. The usual method of fossilization of colonial organisms, such as stromatoporoids, corals, and bryozoans. A better term than permineralized.

Interlaminar septa. Thin, outwardly or upward curved or oblique plates or tabulae in the galleries. Also called dissepiments, cyst plates and partitions. *Anostylostroma, Stromatoporella, Actinodictyon* (Pl. 31, fig. 5; Pl. 33, fig. 10; Pl. 35, fig. 10).

Interlaminar spaces. The galleries, cavities, spaces or chambers between the laminae. The spaces are more aptly designated as galleries, since they consist of connected rooms. The spaces are high in genera with thin walls, as *Actinostroma* and *Anostylostroma;* the spaces are narrow or more or less completely filled with porous and maculate tissue in the Stromatoporidae, and by fibrous or compact tissue in the Idiostromatidae. Interlaminar spaces are partly filled by pillars, partly by secondary tissue and partly by dissepiments.

Knobs. Large subconical or subhemispherical surface prominences, irregular in size, 10 to 50 mm. in diameter and height.

Lamella, -ae. Same as lamina.

Lamina, -ae. The thin parallel or concentric layers making up most of the coenostea. They are the fundamental structures of most stromatoporoids, modified from cyst plates of the Labechiidae. The primary or original laminae are thin and are called microlaminae. In most genera the laminae have been thickened by secondary layers deposited above and below the primary laminae. Also called lamellae.

Laminar. In layers, whether thin or thick, as seen with the unaided eye or with a low-power hand lens, and in most slightly weathered stromatoporoids. Some coenostea are thin and broad, *i. e.,* laminar, as *Stromatoporella granulata.*

Latilamina, -ae. Thick layers or strata, 1 to 20 mm. in thickness, in turn composed of many laminae or cysts; seen in most weathered specimens of stromatoporoids. (Proposed by Nicholson, 1886, p. 40). They may or may not be in specimens of the same species; they seem to be due to annual pauses in growth, and are without taxonomic significance, but do have ecological significance. The curved latilaminae make the stromatoporoid distinguishable in the field from mere pieces of rock but do not distinguish stromatoporoids from stromatolites. Latilaminae are not merely thick laminae (Pl. 36, figs. 1, 8; Pl. 37, fig. 1b).

Lumen, lumina. Vertical, round, lighter or darker colored centers of pillars. They were probably originally not open tubes, but the primary pillars around which the secondary material, of different color, was laid down. The luminalike portions of the pillars were considered by authors to be characteristic of *Hermatostroma* and *Labechia,* and occur in some species of *Labechia* (Pl. 32, fig. 9), *Actinostroma* (Pl. 34, fig. 2), *Atelodictyon* (Pl. 33, fig. 8), and even of *Taleastroma* (Pl. 35, fig. 4). The lumina of the hollow pillars of *Stromatoporella* are due to upturns of the laminae and were, therefore, originally hollow (Pl. 34, fig. 1).

Maculae, maculate. Dark or light spots or dots in a gray groundmass. The dots are 0.01 to 0.06 mm. in diameter, typically with clear centers, and occur in the laminae, pillars, and secondary tissue, typically seen in *Stromatopora* (Pl. 31, fig. 14), *Syringostroma* (Pl. 31, fig. 15), and *Parallelopora* (Pl. 31, fig. 16). The maculate structure is characteristic of the family Stromatoporidae, contrasting with the compact and fibrous, porous, flocculent or homogeneous tissue structure of the other four families. "Minutely porous or tubulated," (Nicholson, 1886, p. 74); "minutely porous" (Parks, 1907, p. 29); "finely reticulate or spongy" (Parks, 1936, p. 99); "feinporous oder von feinen Kanalen" (Kühn, 1939, p. A44); "microstructure poreuse ou vesiculaire" (Le Maître, 1949, p. 517); "microstructure est du type reticulé" (Le Maître, 1949, p. 523); "Fibre sequelettique alveolaire," (Lecompte, 1951, p. 195); "Fibre poreuse ou réticulée", "Fibre squelettique cellulaire" (Lecompte, 1952, p. 263); "cellular type" (Lecompte, 1956, p. F118). The appearance of the microstructure depends somewhat upon the character of fossilization.

Mamelons. Round, regular, or irregular elevations on the surface, as in *Parallelopora nodulata* (Nicholson) and *Labechia huronensis* (Billings). They vary from 2 to 15 mm. in diameter and 1 to 8 mm. high. They may be solid or occupied by a tube, frequently have astrorhizae at the summits and throughout the columns which make the mamelons. Surface elevations in order of size; granules, papillae, ring-pillars, monticules, mamillae, mamelons, knobs, or nodes, and undulations.

Mamillae. Small mamelons, 1 to 2 mm. in diameter, some with a nipplelike point. *Lophiostroma magnum* (Parks).

Mamillate. Having small mamelons or mamillae, generally less than 2 mm. in diameter.

Marginal vacuoles. Light-colored areas around pillars and on both sides of the laminae, as in typical species of *Hermatostroma* (Pl. 31, fig. 17).

Microlamina, -ae. Thin laminae which may be thickened on one or both sides, as in *Stromatopora* (Pl. 35, fig. 3) and *Trupetostroma* (Pl. 31, fig. 11). Also used to distinguish thin laminae from latilaminae.

Milleporoid. Having the laminae and pillars completely amalgamated and hardly recognizable as distinct structures and having vertical tubes, much as in the hydroid genus *Millepora;* the tissue is mostly secondary and maculate. Used by Nicholson (1886, pp. 40, 74) and by Yavorsky (1955, p. 7) for the families Stromatoporidae and Idiostromatidae.

Monticules. Small mamelons, 1 to 2 mm. in diameter.

Nodes. Large knobs on the surface, generally irregular in size and height.

Nodules. Irregular mamelons.

Ontogeny. The development of a single individual, not that of a colony.

Papillae. Small knobs at the surface, generally much less than 1 mm. in diameter, the upper ends of pillars. *Actinostroma, Labechia.*

Peritheca. The basal layer of many coenostea; less aptly called epitheca and holotheca.

Pila, -ae. Same as pillar. Little used.

Pillars. Small, vertical structures between laminae (short), or passing through many laminae, (long, continuous), 0.05 to 0.06 mm. in diameter, not to be confused with the larger columns. Pillars are substantially solid or compact, as in *Actinostroma,* maculate, as in *Syringostroma,* maculate, making parallel tubules, as in *Parallelopora,* or short and hollow (ring-pillars), made of upturned laminae, as in *Stromatoporella* (Pl. 34, fig. 1). Pillars are smaller than columns. They may be round, irregular, branched, and frequently divide and expand in the laminae, making vermicular, areolate and odd patterns, as seen in tangential sections. Pillars are mostly built on the primary lamellae, and are frequently superposed, as in *Gerronostroma* and *Trupetostroma* (Pl. 31, figs. 10, 11). Some pass through the laminae, as in *Actinostroma* (Pl. 34, fig. 2) and some clearly pierce the cyst plates, as in the Labechiidae (Pl. 31, fig. 2). Pillars are mostly primary structures, as in the Labechiidae and Actinostromatidae; some are secondary, as the short pillars of *Stromatopora* (Pl. 35, fig. 3) and *Synthetostroma* (Pl. 35, fig. 9). Also called radial pillars (Nicholson and Murie, 1878, p. 196), applicable to globular specimens.

Pits. Small round depressions at the surface.

Pores. Small, transverse tubes through the laminae, as in *Stromatoporella* (Pl. 31, fig. 8) and *Stictostroma* (Pl. 31, fig. 6). Not well used for pseudozooidal tubes or horizontal cavities or pits. Pores occur in ring-pillars at the surface, and at the summits of monticules, as in *Stromatoporella granulata.*

Porous. Having minute pores through the tissue. *Stictostroma, Stromatoporella.*

Primary plate. The thin, compact, homogeneous, median layer of the cyst plates, especially of the Labechiidae (Pl. 31, fig. 3).

Primary tissue. The material of the laminae and dissepiments as first constructed.

Protocoenosteum. The earliest astogenetic stage of stromatoporoids (Pl. 36, fig. 3).

Pseudopillars. Vertical, thin bands of darker flocculent material in the flocculent, lower layer of the cyst plates in the Labechiidae (Pl. 31, fig. 2; Pl. 32, fig. 1).

Pseudozooidal tubes. Vertical tubes or superposed and restricted galleries, irregular in cross section, only incidentally round, generally crossed by thin tabulae, the remnants of laminae; characteristic of the Stromatoporidae (Pl. 35, figs. 1, 2) but not present in all species. They have been called "zooidal tubes," but there is little or no evidence that they were occupied by zooids.

Radial processes. Arms in whorls extended from pillars. *Actinostroma* (Pl. 34, fig. 2).

Ramose. Round, erect and branching. *Idiostroma, Amphipora.*

Reticulate. Like a net, referring to the network of laminae and pillars. "Continuously reticulated" of Nicholson (1886, pp. 34, 74) refers to the network of laminae and pillars which are united so that the laminae and pillars are not discernible, but amalgamated, in the Stromatoporidae. Reticulate is not synonymous with maculate or porous structure of the finer tissue, although some authors so used the word.

Ribs. Longitudinal ridges, as in *Aulacera plummeri* (Pl. 37, fig. la.).

Ring-pillars. Short, hollow, thick-walled pillars, made by sharp upturns of the laminae; "hollow inflected points" of Parks, (1936, p. 94); characteristic of *Stromatoporella* (Pl. 33, fig. 1). Rings made by mere upward inflections of laminae (*Pseudostylodictyon,* Pl. 32, fig. 6), or by splitting of pillars (*Anostylostroma,* Pl. 33, fig. 6), or by tubes in mamelons, or by spherical cysts (*Actinostroma,* Pl. 35, fig. 10), are not ring-pillars.

Rods. Thin, dark, vertical, parallel rods in the pillars of *Parallelopora* (Pl. 35, fig. 6).

Sarcodeme. Obsolete term for coenosteum. (Nicholson, Ann. Mag. Nat. Hist., 1874, p. 5).

Secondary tissue. Tissue laid on the primary plates or laminae and pillars, in many genera and constituting the bulk of the tissue in some genera (Pl. 31, figs. 11, 12, 14-18).

Skeleton. All the hard parts of a stromatoporoid, usually implying the totality of internal structures.

Spines. Short, conical pillars, as in *Rosenella* and *Sinodictyon.* Denticles.

Spongy. Filled with irregular, minute vesicles or pores, as the finer skeletal tissue of the family Stromatoporidae. Sometimes used for larger structures, as the columns of some species of *Anostylostroma,* which are filled with irregular pillars and vacuities, and the structure of *Amphipora.* The term has no implication of relationship with sponges, nor of having spicules; a term to be avoided.

Tabulae. Thin, flat, or curved structures in vertical tubes or between superposed galleries, either distinct structures or the remnants of laminae. *Stromatopora* (Pl. 35, fig. 2).

Tangential. Refers to a section nearly parallel with the laminae especially as applying to small, globular or ramose forms, and in descriptions called the "tangential section."

Tissue. The microscopic structure or histology of the laminae, the pillars, the cysts, or other finer structures. Sometimes called "ultimate fibre" (Parks, 1936, p. 8), but not actually the finest calcite granules which compose the skeleton. The word "fibre" is not appropriate, since the substance is not composed of threadlike bodies.

Trabeculae. Rods, frequently anastomosing, as in *Millepora, Hydractinia,* the family Disjectoporidae, and the order Sphaeractinoidea. Trabeculae do not make up the skeleton of the Stromatoporoidea.

Tubercles. Small, unequal prominences at the surface. *Stromatoporella granulata.*

Tubes. Round, elongate openings, as in the axis of the Idiostromatidae, and in the axes of some mamelon columns. The "axial tube" of *Aulacera* and *Cryptophragmus* is better called an axial column.

Tubulate. Having very small tubes or pores (not referring to pseudozooidal or caunopore tubes) in the laminae, as of *Stromatoporella* and *Stachyodes.* Superposed maculae simulate small tubules in the pillars of *Parallelopora* (Pl. 31, fig. 16).

Tubules. Minute parallel tubes, as in the pillars of *Parallelopora,* and through the laminae of *Stictostroma* and *Stromatoporella* (Pl. 31, figs. 6-8).

Vacuole. A small cavity or space in the tissue of an organism, as in *Trupetostroma* (Pl. 31, fig. 11). A vacuity.

Vertical tubes. Remnants of superposed galleries, pseudozooidal tubes, often called "zooidal tubes" (Pl. 35, figs. 1, 2).

Vesicle. Small vacuities, as in the tissue of *Trupetostroma*; also the cavities made by cysts.

Vesicular. Full of irregular vacuities, or spongy in appearance, as the skeleton of *Dermatostroma* and *Hydractinia.*

Villi. Small, finger-like projections from the upper layer of the wall, as in *Cystostroma* (Pl. 32, fig. 2) and *Cryptophragmus.*

Walls. The substance surrounding tubes, chambers, or vesicles.

Rarely used because the structures are not in general camerate or tubular; chambers occur in the Labechiidae. Caunopore tubes have walls.

"*Zooidal tubes*." Vertical tubes, small and generally irregular and not round in cross section, usually tabulate, characteristic of forms with maculate tissue, as *Stromatopora* (Pl. 35, figs. 1, 2), *Syringostroma*, and *Parallelopora*. They are restricted galleries which are superposed. Better called pseudozooidal or vertical tubes. Superposed galleries are common in forms with long pillars and thick lamanae, as *Actinostroma* and *Trupetostroma* (Pl. 34, figs. 2-4); they are rare in forms with thin laminae and short pilars, as *Clathrodictyon* and *Anostylostroma*, and are absent in forms composed of cysts, the Labechiidae. Parks and Lecompte did not recognize the existence of zooidal tubes, but considered them to be, as the writer does, merely superposed interlaminar spaces or galleries, and the tabulae as remnants of laminae (Parks, 1936, p. 10). Yavorsky (1931, pp. 1405-1412) mistakenly used "zooidal tubes" for simple galleries, and in his latest work (1955, p. 7) attempted to maintain the division of all genera of stromatoporoids into two groups, those without zooidal tubes and those with zooidal tubes. His new genus *Ferestromatopora*, however, a member of the Stromatoporidae, lacks zooidal tubes.

STRUCTURES OF STROMATOPOROIDEA AND THEIR TAXONOMIC VALUE

FAMILY AND GENERIC CHARACTERS

1. *Characters of the tissue*.—The skeletons or hard parts of the stromatoporoids were originally composed, and mostly are now composed, of nearly pure calcium carbonate in the form of calcite. There is no indication, such as distortion or pseudomorphs, that the original calcium carbonate was aragonite. The skeleton of the hydrocorallines is called the coenosteum.

The smaller structures of cyst plates, laminae, and pillars, which are visible with the microscope at ordinary powers, 16 mm. objective and 7.5× eyepiece (65×), are referred to as the tissue. About 30 magnification is ordinarily better for preliminary examinations and to see the variation of structures in the section. Also 48, 35, and 32 mm. objectives and 7.5×, 10×, and 15× eyepieces are used, depending upon the amount of field it is desirable to see at once and the detail desired. A field of 4 mm. diameter (using 32 mm. objective) is satisfactory. With higher magnification, 4 mm. objective and 10× eyepiece (430×), the structures are resolved into granules and crystals of calcite of variable size and shape, so that the real significance of the character of the tissue has been obliterated in the magnification. The size of the maculae and tubules can be measured with a camera lucida and 16 mm. objective and 10× eyepiece, giving a magnification, on the paper, of 132×.

As noted by Nicholson (1886, p. 36), under higher magnification, the tissue contains innumerable, tiny black specks, irregular in size and shape, giving a dusty appearance to the tissue. Most, but not all tissue, contains the black specks, and there are some black specks in the calcite filling of the chambers and galleries. The black specks are well developed in *Labechia conferta* (Pl. 31, fig. 3) and are profuse in *Parallelopora nodulata* (Pl. 31, fig. 16). The black specks are nothing like maculae. They seem to be secondary and to have been deposited by infiltrating water. Their composition is not known; they may be iron sulphide or iron oxide, or even organic carbon. The specks seem to be of no taxonomic value.

The tissue is either, (1) primary, where it is the thin, median layer of cyst plates or the laminae (Pl. 31, figs. 1-8), or (2) secondary, where the tissue is thickening tissue or different kind of tissue laid down either below or above the primary tissues (Pl. 31, figs. 11, 12, 14-18).

The tissue of the stromatoporoids is fundamentally of three kinds: first, the compact and homogeneous and flocculent (Pl. 31, figs. 1-3), family Labechiidae; secondly, the compact and vacuolate, transversely fibrous or tubulate structure (Pl. 31, figs. 4-13), families Clathrodictyidae, Actinostromatidae, and Idiostromatidae; and thirdly, the tissue which is maculate, *i.e.*, full of dark or light round spots (Pl. 31, figs. 14-18), the family Stromatoporidae. The tissue of the first and last families are more consistent than they are in the other three families. The tissue structure was first pointed out by Nicholson (1886, p. 35, 73). He referred to the forms with compact, or apparently solid tissue, to the "Hydractinoid" Group and the forms which had "dotted or porous" tissue, *i.e.* maculate, he referred to the "Milleporoid" Group. There is no essential similarity between the kinds of tissue and the two Recent hydrozoan groups which Nicholson designated. It is, however, a tribute to Nicholson's perspicacity that the most satisfactory classification is based upon the kinds of tissue, as well as the skeletal structure, and the geologic occurrence.

Although the preservation of most stromatoporoids appears to be that of the original constitution they had in life, merely impregnated with calcite, there is some recrystallization, involving the enlargement of the original, minute crystals of calcite. The distortion of structure involved in leaching, silicification, and dolomitization must be distinguished from the original structure. Specimens distorted internally should be avoided for the purpose of studying the tissue, although the laminae and pillars may have their original size and arrangement.

The skeleton of the oldest stromatoporoids, the family Labechiidae, consists of convex plates, the primary tissue of which is compact and nearly homogeneous (*Cystostroma, Aulacera,* Pl. 31, figs. 1-3). There are secondary layers inside or both inside and outside of the compact, curved plate, in which the tissue has a flocculent appearance (*Cystostroma, Aulacera*). The secondary tissue is neither fibrous nor tubulose but may have lighter areas between the loosely aggregated and irregular tissue. The laminae of the Clathrodictyidae (*Clathrodictyon, Anostylostroma*), some of the Actinostromatidae (*Gerronostroma*) and some of the Idiostromatidae (*Amphipora*) are minutely fibrous transversely, as seen under moderate powers of the microscope. The tissue of *Stictostroma* and *Stromatoporella* is transversely fibrous and tubulate, rarely with anastomosing tubules (Pl. 31, fig. 7). Lecompte (1956, p. F118) denied the existence of such tubules. In some species of *Stromatoporella,* as *S. eriensis* (Parks), the transverse fibers and pores may be seen only in the best preserved specimens.

The tissue is compact in *Actinostroma, Trupetostroma,* and *Idiostroma.* Even though the laminar tissue appears compact and homogeneous, in many cases the pillars are transversely fibrous in appearance, as in the genera of the Clathrodictyidae (Pl. 31, figs. 4-8). The tissue may be compact, excepting for conspicuous vacuities of many sizes in the pillars and secondary laminae, as in the genera *Trupetostroma* and *Idiostroma* (Pl. 31, figs. 11, 12). There are other slight variations in the structure which is known as compact, or fibrous, and porous, but such variations do not include the maculate structure. Some specimens of *Stictostroma* and of *Stromatoporella* are so coarsely porous that the pores may be mistaken for maculae (Lecompte, 1956, fig. 102, 3, maculae, 102, 4, pores).

The third fundamental kind of wall structure is designated as maculate, which is a better designation than "minutely porous or tabulated" (Nicholson, 1886, p. 90), or "fibre squelettique cellulaire" as used by Lecompte, (1952, p. 263), or "cellular type" (Lecompte, 1956, p. F118). Nicholson (1886, p. 36) correctly appreciated the "characteristic dotted or porous structure." In the genera belonging to the family Stromatoporidae, the tissue contains spherical, light spots which are surrounded by darker tissue, so that in whatever direction the tissue is cut the same spotted or maculate appearance prevails. In some cases the dots do not show the white center but appear only as dark spots with lighter, gray tissue surrounding them. The maculae are fine in most of the genera, 0.2 to 0.3 mm. in diameter, as may be seen typically in *Stromatopora, Ferestromatopora,* and *Syringostroma* (Pl. 31, figs. 14, 15); in some cases the dots are coarse, 0.03 to 0.06 mm. in diameter, and have a thin, dark wall, and light center, as in most species of *Parallelopora* (Pl. 31, fig. 16). The maculae are not pores (Kühn, 1939, p. A37, fig. 51 right) but dots, either light or dark.

The tissue may be minutely but uniformly maculate, as in *Stromatopora concentrica* (Pl. 35, fig. 1). The maculae may be arranged in horizontal lines in and between microlaminae as in *Stromatopora laminosa* (Pl. 35, fig. 3); they may be large and irregularly arranged, as in *Hermatostroma logansportense* (Pl. 31, fig. 17); and the maculae may be very large and arranged in vertical lines, appearing as tabulate tubules in the pillars, as in all species of *Parallelopora* (Pl. 31, fig. 16).

Although Nicholson pointed out in 1886 (p. 35) the fundamental differences in structure between the forms with compact tissue and those with maculate tissue, few later authors, excepting W. A. Parks, have paid special attention to the tissue structure, and he did not live to publish his studies on the maculate group. Workers in more recent years, Yavorsky, Riabinin, and Lecompte, have tended to minimize the finer tissue structure and have stressed the more obvious features, such as laminae, pillars, dissepiments, pseudozooidal tubes, and astrorhizae.

2. *Horizontal structures.*—The most primitive and fundamental structures of stromatoporoids are thin, curved plates or dissepiments, which are short and highly arched as in *Cystostroma, Aulacera,* and *Labechia* (Pl. 32, figs. 1-3, 9), or broad and low, as in *Rosenella* (Pl. 32, fig. 4) and *Stromatocerium* (Pl. 33, figs. 3, 4). The plates are variable in size and usually without visible pores or foramina connecting the chambers thus formed. The plates are imbricated or overlapping, so that they do not form laminae, but may occur in layers. The earliest plates are simple arcs, as in *Cystostroma* followed in the phylogeny by broad, low arcs and short pillars on the tops of the plates, as in *Rosenella* and *Sinodictyon* (Pl. 32, figs. 4, 7), and later by long pillars, as in *Labechia* and *Stromatocerium.* In *Labechiella* (Pl. 32, fig. 10) the cysts in the neanic stage pass into laminae in the ephebic stage of the astogeny.

Shorter and more arcuate plates are more primitive than the broad, low ones, and they also are much more regular in size, as in *Cystostroma, Aulacera* and *Labechia.* Large, hemispherical plates occur in a single, superposed series, as in *Cryptophragmus* and in the axis of *Aulacera.* Such large, hemispherical plates seem to be so different from the short, arcuate plates occurring around the axis of *Aulacera* that they have sometimes been considered to belong to a separate organism (Shideler, 1946). When it is considered, however, that the larger axial plates may grade imperceptibly into the smaller, lateral plates, as seen in *Sinodictyon* (Yabe and Sugiyama, 1930, pl. 19, figs. 3, 4), and in *"Ludictyon" vesiculatum* Ozaki (1938, pl. 33, figs. 3b, 3c; pl. 34, fig. 3), as well as in *Aulacera nodulifera intermedia* (Foerste), it is apparent that the actual column of cystose plates is part of the same organism that built the outside (but not the sheaths of *Cryptophragmus,* a foreign organism).

The coenosteum of *Cryptophragmus* (and synonyms) is usually complete without any outer sheath. In the case of *Cryptophragmus antiquatus* from Carden, Ontario, the type locality, the central column, in some specimens, is enclosed by unattached sheaths of entirely distinct and foreign organisms, probably an alga, and in one case by a bryozoan.

The curved plates occur side by side in typical members of the genus *Clathrodictyon*. The vertical and lateral appression of the cysts compel them to become flat on the tops and vertical on the sides, thus producing laminae and pillars, as in later species of *Clathrodictyon,* passing into typical laminae and pillars of *Anostylostroma*. The wide cysts of *Rosenella* seem to have become broad plates or laminae in *Labechiella,* and to have become regular laminae in the family Actinostromatidae. In addition to the primary curved plates, there is usually a layer of secondary, flocculent tissue deposited either inside, or both inside and outside, of the primary plates, as seen in *Cystostroma, Aulacera,* and *Rosenella*. Cystoid plates also occur as repair tissue, and at the lower sides of latilaminae in many genera (Pl. 36, fig. 8).

The fundamental structures of most stromatoporoids are the laminae, which are flat, eccentric or concentric plates. They may be thin or thick, and are usually continuous, but may be discontinuous, as in *Anostylostroma microtuberculatum* (Riabinin), or the laminae may converge into one; they may be regular and nearly straight as in *Anostylostroma laxum* (Parks), or finely undulating, as in *Anostylostroma insulare* (Parks) and variable in thickness. In *Stromatopora concentrica* (Pl. 35, fig. 1) and other typical species of *Stromatopora,* the laminae can scarcely be distinguished, but have been broken into curved tabulae, or have been resorbed by the secondary tissue, or may not have been formed between latilaminar boundaries.

In all the families and most of the genera the cyst plates and laminae have an upper or a median, thin dark- or light-colored primary lamina. The primary laminae are compact and mostly imperforate in the families Labechiidae, Clathrodictyidae, Actinostromatidae, and Idiostromatidae and porous and maculate in the Stromatoporidae. There is also considerable, but thin, secondary thickening on the two sides of the laminae in the families Clathrodictyidae and Actinostromatidae. Such secondary tissue is coarser in texture than is the primary layer, but the secondary tissue in those two families is not maculate.

In the family Stromatoporidae the thickening tissue becomes so great that it ordinarily fills from 50 to 90 percent of the original interlaminar spaces. Such secondary tissue is typically maculate or made up of minute, hollow spots surrounded by gray tissue, and such secondary tissue is also so conspicuous that the primary, thin laminae may be overlooked. In many specimens the thin, primary laminae may have been resorbed by the secondary tissue, or largely destroyed in the fossilization. Some specimens of *Stromatopora*, and other genera with maculate tissue, seem to show no primary laminae at all (Nicholson, 1886-92, pl. 5, figs. 15; pl. 9, fig. 11; p. 10, figs. 2, 7, 9, 12; pl. 11, fig. 18, etc.; Lecompte, 1952, pl. 50, fig. 4a; pl. 52, fig. 2a; pl. 53, figs. 2a, 2b; pl. 54, figs. 1-3 and others.) The fine laminae in *Stromatopora* can usually be seen when looked for especially. In the tangential sections the fine laminae of *Stromatopora, Syringostroma* and *Parallelopora* and other genera, do not show at all, giving the "continuously reticulated", fused appearance, noted by Nicholson (1886, p. 74). The secondary, maculate tissue shows the same kind of structure in both vertical and horizontal sections and has been referred to, especially by Nicholson, as reticulate or fused tissue. When the secondary maculate tissue is large in amount, it obscures the primary pillars, as in *Stromatopora* or forms entirely new pillars, as in *Syringostroma* and *Parallelopora*.

Whenever the laminae are thicker than the exceedingly thin primary laminae, the laminae may be double, with a secondary lower layer, as seen in *Anostylostroma* (Pl. 33, fig. 6). Mostly the thick walls are triple, consisting of the thin, median, primary lamina and lower and an upper layer of different structure (Pl. 31, fig. 6). The outer and inner layers of *Cystostroma, Aulacera,* and other genera of the Labechiidae, is flocculent and loose in appearance. In the Clathrodictyidae and Actinostromatidae the two secondary layers are compact and darker than the median lamina (Pl. 31, fig. 11). In *Dendrostroma* (Pl. 34, fig. 8), the secondary layers are transversely fibrous. In the Stromatoporidae in general, the secondary layers are finely or coarsely maculate. The laminae are composed of microlaminae in *Synthetostroma* (Lecompte says, 1956, p. F131, "intertwined fibrils").

A remarkable kind of horizontal structure is the development of radial arms on the pillars in the genus *Actinostroma*, which radial arms occur at concordant levels, making what appear to be laminae, as seen in vertical section. They may be horizontal or bend downwards. The radial arms may be accompanied by a lamina just above the arms. In some genera, as in *Anostylostroma, Atelodictyon*, and *Trupetostroma*, there are secondary thickenings particularly on the under sides of the laminae which produce curved lines and a complicated network of lines, as seen in tangential sections. The particular pattern formed at the upper ends of pillars, whether curved, radial, or a complicated network (Galloway and St. Jean, 1957, pl. 2, fig. 3b), cannot be determined from the vertical section. Even the coalescence of the pillars, as seen in *Anostylostroma, Labechiella, Hermatostroma*, and *Atelodictyon*, cannot be determined from the vertical section alone.

Cyst plates are of family importance when regular and imbricated, as in the family Labechiidae. The writer does not consider the Labechiidae an order, for cyst plates occur in all families. Cyst plates are of generic importance in *Clathrodictyon*, where they occur mostly side by side, and in *Actinodictyon*, where they are irregularly arranged. Most other genera of stromatoporoids have definite laminae, although the laminae may not be well marked in the Idiostromatidae.

The average size of cyst plates and their variation in size in the same specimen are specific characters. The number of laminae in the convenient distance of 2 mm. is usually considered to be a specific character; there are six laminae in 2 mm. in *Actinostroma verrucosum* and 12 in 2 mm. in *A. tyrrelli*. The variation of number of laminae in 2 mm. may be due to pauses in growth, as between latilamina, or to cool seasons of growth, and in that case the number is without systematic value. The thickness of the laminae is a specific character when it is constant. In most species of *Clathrodictyon* the cysts are in fairly smooth layers; in *C. fastigiatum* the layers of cysts zigzag up and down.

The cyst plates and the laminae are two of the most fundamental structures of the skeletons of stromatoporoids. Without them the object could scarcely be a member of the Stromatoporoidea, although *Stromatopora* itself, may have neither laminae, pillars, nor dissepiments but do have other stromatoporoid structures, such as astrorhizae, pseudozooidal tubes, tabulae, and maculate tissue.

3. *Vertical structures.*—Vertical structures, now called pillars and in the case of globular specimens called radial pillars, rarely called pilae, served the obvious purpose of holding the laminae apart, although they may have served some additional function. Pillars at the surface appear as papillae, and specimens with conspicuous papillae, as in *Stromatoporella, Labechia* and *Actinostroma,* were ready for the next lamina to be laid down. Pillars vary greatly in length, thickness, origin, and systematic value.

The simplest pillars are short, conical spines or denticles on the upper cyst plate, as in *Rosenella* and *Sinodictyon* (Pl. 32, figs. 4-7). Such short pillars or denticles obviously did not hold the long cysts apart, but the cysts touched other cysts at their ends.

Most of the pillars are short, that is, they extend through only one interlaminar space. They were derived from upward growth of denticles in the Labechiidae, were formed by down-turns of the cyst plates in *Clathrodictyon,* formed by the addition of structures separate from the laminae in *Anostylostroma* and were constructed of secondary tissue in *Syringostroma.*

There are both primary pillars and secondary pillars. The pillars of *Actinostroma* are long and may be called primary pillars, for they are part of the primary skeleton, and continue through the laminae. The long pillars of part of the Labechiidae and of the Actinostromatidae are frequently spoken of as continuous because they seem to pierce the laminae; but, it seems, the laminae were built around the pillars when the objects were alive. The continuous pillars pass from latilamina to latilamina, as long as the growing surface stays alive. Where the pillars diverge the increase is mostly by implantation, in some cases by bifurcation. In some genera, such as *Trupetostroma* and *Gerronostroma* (Pl. 31, figs. 10, 11), the pillars are really superposed but appear continuous at first glance; close inspection shows the fine laminae to pass through the pillars, and the pillars are therefore secondary to the laminae. Obviously the pillars were built on the laminae but continued to be built over the previous pillars, indicating some kind of connection in life between successive interlaminar spaces.

Frequently, the pillars appear to be hollow, as in *Labechia, Actinostroma, Atelodictyon, Hermatostroma,* and *Taleastroma.* The writer cannot agree with Nicholson that the pillars ever were hollow. In well-preserved examples the pillars do have axes of lighter color, but the conical sheaths of which the pillars are made may frequently be seen as, indeed, they were figured by Nicholson (1886, p. 46, fig. 4). In the case of *Hermatostroma,* the writer cannot agree with Nicholson (1886, pl. 3, fig. 2) that the pillars and laminae had a canal system, which was injected with some opaque material. Obviously there was some character in the composition or structure of the pillars of *Hermatostroma schlüteri* (Pl. 35, fig. 7), and the laminae as well, which allowed them to be infiltrated with some darker material rather than to have been injected into hollow cavities. The "lumina" of a pillar was not a real, original canal in a tube, but was merely lighter material, or it appears lighter because of the transverse structure of the axes of the pillars. In the Labechiidae (Pl. 31, figs. 2, 3) the pillars are composed of less dense material than are the primary walls of the cysts, but still are not made of the same material as that of the secondary or flocculent layers of the walls. The pillars have been infiltrated with calcite, and the original calcite recrystallized, so that the pillars appear structureless, or have only a definite outer boundary.

Pillars are spool-shaped in several genera, as in *Anostylostroma, Trupetostroma,* and *Gerronostroma* (Pl. 31, figs. 10, 11), because they are composed of secondary tissue, and constructed at the same time the secondary thickening was laid down on the laminae, and are continuous with the secondary laminae.

Pillars rarely occur in groups, but they do in the genus *Pseudolabechia* (Pl. 33, fig. 1). In some cases the pillars divide upward into many small pillars, as in *Anostylostroma* (Pl. 31, fig. 5; Pl. 33, fig. 6), or they may divide in a dendritic manner, as they do in *Stromatocerium* (Pl. 33, fig. 4). The pillars may be normally in groups, and some are plumose or like water-jets, as in *Pseudolabechia* (*Stylostroma* Gorsky). There are adventitious groups of plumose pillars in some places in otherwise typical *Labechia huronensis* (Billings) (Pl. 36, fig. 9); the irregularity of occurrence and form of the pillars suggests that in this case they may have been due to some pathological condition.

A secondary deposit on both laminae and pillars, as in *Hermatostroma,* may be light in color. Short pillars may be intercalated between normal pillars as in *Atelodictyon* and *Anostylostroma* (Pl. 31, fig. 5).

The pillars were made by down-turnings of the cysts in *Clathrodictyon* and the structure of the pillars in that case is the same as that of the laminae (Pl. 31, fig. 5). In most of the Clathrodictyidae and Actinostromatidae the structure of the laminae appears to be distinct from that of the pillars. The laminae may be transversely fibrous and of light color; and the pillars also may be transversely fibrous and of darker color, as in *Anostylostroma* (Pl. 31, fig. 5).

Some pillars are made by up-turns of the laminae, making ring-pillars, as in *Stromatoporella* in which the tissue is fibrous and tubulose (Pl. 31, figs. 7, 8). The dividing pillars of *Anostylostroma* may also produce rings (Pl. 33, fig. 6) as seen in tangential section; in this case both laminae and pillars are transversely fibrous, and care must be used to distinguish such fibers from maculate tissue.

In the Stromatoporidae the pillars are dominantly composed of secondary maculate tissue. In *Taleastroma* there are primary pillars which are light in color and compact in appearance, as in *T. cumingsi* (Pl. 35, fig. 4). In *Stromatopora* (Pl. 35, figs. 1, 2) and *Ferestromatopora* (Pl. 31, fig. 14) there are no separate pillars, but only the filling of the interlaminar spaces, leaving galleries and superposed galleries or pseudozooidal tubes. In *Syringostroma* and *Parallelopora* (Pl. 31, figs. 15, 16) the pillars are large and long and are composed entirely of secondary, maculate tissue. In the case of *Parallelopora* the maculae are coarse and are arranged in vertical files in the pillars.

The length of pillars is considered to be of family importance in the families Clathrodictyidae and Actinostromatidae; of only generic importance in the Labechiidae, the Idiostromatidae, and the Stromatoporidae. The absence of pillars in *Cystostroma* and in young stages of *Aulacera* distinguish those genera from *Labechia,* in which pillars occur from base to top of the coenosteum.

In most genera, the pillars in all astogenetic stages of the coenostea appear to be the same in length, width, and numbers. In the genus *Aulacera* pillars may be absent (*A. undulata, A. nodulifera*) or absent in neanic parts of specimens and long and narrow in the adult stage (*A. plummeri, A. nodulosa*).

It will thus be seen that the pillars of the stromatoporoids vary much in character, in origin, possibly in function, and also in systematic importance.

4. *Chambers and galleries.*—The space inside the curved plates of the Labechiidae may be referred to as chambers, since they are inclosed spaces. There are no foramina between adjacent or superposed cysts, but there are pores in places, and living material may have penetrated the median, compact plate.

When there are laminae, the spaces between are sometimes referred to as interlaminar spaces (Nicholson, 1886, p. 47) or as cells (Yavorsky, 1955, p. 10), sometimes as chambers, at other times not designated by a name by students of stromatoporoids, or not even mentioned (Lecompte, 1951, 1956). In general the interlaminar spaces may be considered to be large, horizontal spaces, with real pillars set at more or less regular distances throughout the spaces; such spaces here are referred to as galleries, having in mind a coal mine, which has large galleries between which there are pillars. A gallery also refers to a structure with many connected rooms which are all used for the same purpose, as an art gallery. The shapes and sizes of the galleries are important characteristics of the coenosteum and should be described for both vertical and tangential sections. The interlaminar spaces are in part occupied by primary pillars, partly by secondary tissue, and partly by open spaces, the galleries. Galleries mostly are much higher than the laminae are thick. Their shape and size depends upon the closeness of laminae and pillars and the amount of secondary tissue on the laminae and pillars. The galleries of the Clathrodictyidae and the Actinostromatidae are mostly large, open, more or less rectangular areas as seen in vertical sections. When the tissue has been thickened, as in *Trupetostroma, Gerronostroma, Synthetostroma, Stictostroma,* and the Stromatoporidae and Idiostromatidae, the galleries are oval or round and the space is much restricted by secondary tissue.

The galleries are further modified by the presence of upward convex, interlaminar septa or cyst plates or dissepiments. Such partitions are mostly curved upward and outward, although they may be also oblique. The galleries are nearly closed by secondary tissue in most of the Stromatoporidae and in *Stachyodes.*

The galleries are superposed in forms with continuous pillars, in which case they may be connected by foramina, as in *Trupetostroma* (Pl. 31, fig. 11) and *Actinostroma* (Pl. 31, fig. 9), and other genera. The size and shape of the galleries are always matters of specific importance and should always be described. The galleries are of odd shapes much modified from a rectangular form, as in *Stromatoporella* and *Actinodictyon.* In the case of *Stachyodes,* the interlaminar spaces have been for the most part completely filled with secondary tissue leaving small remnants of chambers.

5. *Pseudozooidal tubes.*—In the families Stromatoporidae and Idiostromatidae where secondary tissue fills a moderate or great part of the interlaminar spaces, there are normally small, superposed galleries which make structures simulating tubes. They were referred to by Nicholson (1886, p. 49) as zooidal tubes. There is no evidence that such tubes were once occupied by zooids, and they are here referred to as pseudozooidal tubes. Such tubes are nothing more than remnants of galleries. Such remnants of galleries are of necessity superposed in genera which have long, continuous pillars, either primary, as in some species of *Actinostroma, Trupetostroma,* and *Taleastroma,* or secondary, as in *Stromatopora, Syringostroma, Parallelopora,* and genera of the Idiostromatidae. The pseudozooidal tubes in secondary tissue are characteristic of *Stromatopora* and closely allied genera. Such superposed galleries are not ordinarily round in tangential section, but vermicular, or irregular in shape. Many of the pseudozooidal tubes are round in

the genera *Syringostroma* and *Parallelopora* which genera have large, long, secondary pillars which affect the shapes of the galleries. Nicholson (1886, p. 49) saw a considerable and fundamental similarity between such tubes and tubes in Recent genus *Hydractinia.* He saw a great similarity between the supposed "zooidal tubes" of *Stromatopora,* and the tubes which housed dimorphic individuals, gastropores, and dactylopores, in the Recent *Millepora.* The writer does not see any genetic similarity between the remnants of superposed galleries in the stromatoporoids and the zooidal tubes of Recent hydrozoans; and, therefore, does not call the remnants of superposed galleries "zooidal tubes" but "pseudozooidal tubes." The Recent *Hydractinia echinata* (Fleming), as identified and figured by Lecompte (1956, fig. 101), shows tabulate zooidal tubes.

Nevertheless, the writer agrees with Nicholson and others, that the stromatoporoids are Hydrozoa, as will be discussed below under the heading "Systematic Position of Stromatoporoidea." Parks (1936, p. 10) denied hydrozoan affinities of the stromatoporoids, and he said that "zooidal pores" become simply "vertical pores." Lecompte, in his great monograph (1951-52), seemed not to have mentioned zooidal tubes nor even superposed chambers and considered them merely "tabulate, vertical chambers" (personal communication). The size and configuration of such superposed galleries, or "vertical chambers," are of specific importance in some cases, but the writer does not attach any such importance to them as was done by Nicholson. Yavorsky (1955, p. 10) laid great stress upon the taxonomic importance of "zooidal" tubes and the concomitant maculate tissue. The maculate tissue is a more reliable character for recognition of the family Stromatoporidae than are the presence of pseudozooidal tubes, for many nonmaculate forms have superposed galleries forming typical pseudozooidal tubes, as *Gerronostroma, Trupetostroma, Idiostroma, Stachyodes,* and *Amphipora.* Yavorsky's *Ferestromatopora* (1955, p. 109) does not have pseudozooidal tubes, although it is closely allied to *Stromatopora* which does have such tubes.

The superposed galleries are usually crossed by straight or curved tabulae. Such "tabulae" are probably not new structures but are merely the thin laminae. In some cases the laminae are missing between superposed galleries, giving the effect of a short tube, but being no more than foramina in the laminae, as discussed in Section 15 below.

6. *Coenosteum, shape.*—The coenostea of each species have a characteristic shape and size. Most coenostea tend to be hemispherical, varying to discoidal or laminar specimens on the one hand, and to bulbous, nodular, or ramose specimens on the other. Twenty-six genera have laminar or massive coenostea and nine are ramose or cylindrical. Some genera have a characteristic shape, as the vertical column of *Cryptophragmus* and *Aulacera,* and the ramose form of the Idiostromatidae. A branching form otherwise like *Cryptophragmus* is not a valid generic character, as considered by Raymond (1931, p. 180), but it may be a specific difference. The most modified form of coenosteum is short bush-shaped or cespitose, as in the Idiostromatidae. *Amphipora* and *Paramphipora* may be recognized by the long thin, cylindrical stems, which must have grown upright and close together, for they are normally found intertwined. The two genera are distinguished only by thin sections. There are no typically dentritic or treelike coenostea, the nearest approach, perhaps, being *Sinodictyon* and *Idiostroma.* While a genus can sometimes be identified from the shape of the coenosteum, a species can rarely be identified without thin sections within the massive and ramose groups, the particular shape of the coenosteum is not considered to be a generic character. In the case of *Aulacera* and *Sinodictyon,* the cylindrical or club-shape form of the coenosteum, with a coarsely vesicular axis, has been considered characteristic of the genera. Massive forms which have simple cysts, as in the early stage of *Aulacera,* are placed in the older genus, *Cystostroma.* Parks (1936, p. 113) did not consider the size or shape of the coenosteum to be of much systematic importance; he may have had in mind only the massive or laminar forms.

The axial tube is considered to be a family characteristic in the genera of the Idiostromatidae, although *Clavidictyon* has no axial tube. *Ludictyon* and *Sinodictyon* were erected of the basis of the character of the axial cystose zone. Those genera are much like *Rosenella,* excepting for the upright growth. There are specimens of *Labechia huronensis* which grow in the form of a tall cone with large open convex spaces in the axis, somewhat resembling *Aulacera*; but that character alone is not considered to be either of generic or specific importance.

The shape and form of the coenosteum, therefore, must be considered, but in identification the external characters of the coenosteum are outranked by the internal characters.

7. *Coenosteum, size.*—The size of the coenosteum, for the common massive shape, varies with ontogenetic age of the specimen, the habitat and the species. Massive specimens vary from 1 cm. to 2 cm. in diameter, as in *Stromatopora nux* Winchell, to the usual size from 10 cm. to 20 cm. in diameter, to 1 meter in diameter, as in *Stromatopora monticulifera* Winchell. Specimens of *Stromatoporella* which lived on a muddy bottom, as *S. granulata,* are thin crusts usually less than 5 mm. in thickness.

Cylindrical forms, as *Aulacera* are usually from 3 to 6 cm. in diameter, and in pieces less than 20 cm. long. Plummer (1843, p. 293) gave the size of *Aulacera* as up to three feet in length, and Billings stated that "*Beatricea*" *nodulosa* from Anticosti Island are up to a foot in diameter and 15 feet in length (1865, p. 406). *Amphipora* has the least diameter of any stromatoporoid 2 to 4 mm., and the length is a few cm. *Idiostroma* has a normal diameter of 5 to 10 mms., and *Cryptophragmus* consists of cylinders or branches from 5 to 15 mm. in diameter.

8. *Axial columns.*—Several genera of the Labechiidae have an axial column, composed of large, superposed cyst plates or dissepiments. The typical axial column occurs in *Aulacera,* where the column is overlain by smaller, imbricating, convex plates, oriented perpendicularly to the plates of the column. The structure of the outer plates, outside of the size, is the same as those of the axis. In the genus *Cryptophragmus* from the type region, Carden, Ontario, there may be an outer zone of sheaths which is a separate organism, but the zone of sheaths is not necessary for the identification of the genus, for the genus occurs in many localities, at the same horizon, without the sheaths, as well as at Carden, Ontario (Raymond, 1914, pl. 1, fig. 2; pl. 4, fig. 5).

The axial column of cyst plates is sometimes referred to as "a large axial tube, crossed by strongly curved calcareous partitions, or tabulae" (Nicholson, 1886, p. 86) or a "camerate tube"

(Shideler, 1946, p. 1230). The column of cysts is not in reality a tube, for the cysts are bound laterally by the lower ends of the overlapping cysts, rather than by a separate, continuous wall of a tube. In *Aulacera nodulifera intermedia* the axial zone of cysts is irregular in width and the large cysts grade imperceptable out into the cysts which are at right angles to the axial columns. Furthermore, the genera *Sinodictyon* Yabe and Sugiyama (1920, p. 52), and "*Ludictyon*" Ozaki (1938, p. 33, fig. 3) have large and small cysts in an ill-defined axial zone, which in no sense makes a tube, but in which the axial cysts grade in size and position out into the lateral zone of cysts. The facts that the axial zone of cysts have the same wall structure as the cysts of the lateral zone, and the axial cysts grade in size out into the cysts of the lateral zones, seem definite evidence that the axial zone in *Aulacera* and *Sinodictyon* is part of the organism and not a separate organism. The axial column may be covered by algae, other stromatoporoids, corals and bryozoans, but that fact is not of systematic significance, not being a case of symbiosis.

There are forms of stromatoporoids whose growth is hemispherical and in which the skeleton is composed of overlapping, convex cysts without pillars, as in *Cystostroma* and *Pseudostylodictyon.* The forms with the axial column are readily distinguished from the flat or hemispherical bodies, and are considered to be separate genera. The oldest known stromatoporoids (not admitting that Yavorsky's supposed Cambrian forms are really of Cambrian age, 1932, p. 613) are the hemispherical forms first described by Seely from the Chazy limestones of Isle La Motte (Seely, 1904, p. 148, pl. 72; pl. 74, fig. 1). Many specimens from the Chazy of Isle La Motte have arcuate cysts and some have wide cysts, but there are no known specimens with an axial column. Forms with the axial column begin with the Lebanon limestone of Tennessee and the Lowville limestone of Ontario, both of Black River age, and extend to the top of the Ordovician, Ellis Bay formation of Anticosti, and late Richmond of Indiana.

SPECIFIC CHARACTERS

In addition to the primary characters, those distinguishing families and genera, there are many other characters which are present or absent in the same genus, and they are usually of specific importance.

9. *Surface.*—Many species of stromatoporoids have essentially smooth surfaces. Much more commonly the surfaces have some kind of prominence, either small or large, regular or irregular. Most forms with pillars have papillae, which are the ends of pillars which extend through the last lamina or are new pillars built on the last lamina, as in forms with short pillars. The surface of *Stromatoporella granulata, Anostylostroma retiforme,* and many other species, is covered with sharp conical points.

Anostylostroma hamiltonense has no mamelons, but an associated form, *A. hamiltonense papillatum,* has small mamelons about 2 mm. in diameter and half that in height; it was considered by Parks (1936, p. 50) to be only a variation or subspecies of that species, but the writer considers it to be a distinct species.

Several species have been recognized in the genus *Aulacera* (*Beatricea*) solely on the basis of the surface characters; *A. undulata* has sharp, vertical ridges at the surface; the type species of *Aulacera, A. plummeri,* from Indiana, has wide and low surface ridges. *A. nodulosa* and *A. nodulifera* have surface knobs of different size, and other species have other surface characters which are probably of specific or subspecific value. The cyst plates of the Labechiidae appear at the surface as small blisters. In *Aulacera undulata* the cyst plates are highly arched, and look like large papillae at the surface.

The particular kind of surface characters, and their dimensions, can be determined from the surface and from sections. There may be knobs or undulations on parts of a specimen or in different astogenetic stages of a specimen, which characters fade out before the surface is reached, or they may be missing on some parts of the surface and apparent on others, as in *Anostylostroma laxum* (Nicholson). Regular surface characters are usually of specific importance. Irregular knobs are generally of no systematic value. A genus may have different surface characters in the different species.

The presence or absence of mamelons, their size, distance apart, shape and regularity or irregularity, seem to be consistent for each species, and of importance in distinguishing species, and constitute a convenient basis on which to differentiate species in keys.

10. *Astrorhizae.*—The surfaces of many stromatoporoids are marked by depressions with branching, rootlike groups extending radially outward. The depressions or canals do not have any proper walls and merge with the galleries of the specimen. They were named astrorhizae by H. J. Carter (1880, p. 341), which name is apt, and it has been accepted by all subsequent authorities. The nature of the astrorhizae have been extensively discussed not only by Carter, but by Nicholson (1886, p. 53) and others, and recently by Lecompte (1951, p. 19; 1956 p. F114), and by Yavorsky (1955, p. 11). The presence or absence of astrohizae seem to be of no more than specific importance, although their presence in the Stromatoporidae is one of the strong points which ally the Stromatoporidae with the Hydrozoa, as maintained by Carter, and accepted by Nicholson, Kühn, Lecompte, Yavorsky, and others.

Astrorhizae vary greatly in size and development. The earliest astrorhizae, which are small, about 2 mm. in diameter, and imperfectly developed, occur in *Stromatocerium rugosum,* where the radiating canals are short and only feebly branched (Galloway and St. Jean, 1955, p. 8, 10, figs. 5-7). Those in *Syringostroma subfuscum* Galloway and St. Jean (1957, pl. 18, fig. 13) are 2 mm. in diameter; in *Clathrodictyon linnarsoni* (299-51) about 3 mm. in diameter; in *Stromatopora typica* the astrorhizae are about 5 mm. in diameter (Nicholson, 1891, pl. 21, figs. 4, 7); in *Actinostroma astroites* astrorhizae are 10 to 12 mm. in diameter (Nicholson, 1889, pl. 17, fig. 1); in *Ferestromatopora larocquei* (Galloway and St. Jean) they are 15 mm. in diameter and well formed (Pl. 36, fig. 4). The largest ones seem to occur in *Stromatoporella eifeliensis,* which are 25-30 mm. in diameter (Nicholson, 1886, pl. 4, fig. 2), and in a species of *Syringostroma* from the Meshberger quarry, Bartholomew County, Indiana. The astrorhizal canals may not form definite, radiating clusters but appear as sporadic canals (*Parallelopora typicalis* Galloway and St. Jean, 1957, pl. 19, fig. 4).

Some astrorhizae are superposed and occupy the centers of columns and may produce a tabulate axial column, and appear at the surface in the centers of mamelons, as in *Stromatopora diver-*

gens Galloway and St. Jean (Pl. 36, fig. 5), and in *Hermatostroma perseptatum* Lecompte (1952, pl. 45, fig. 2). In other cases the astrorhizae occur scattered throughout the skeleton and appear in vertical section as unusually large and oval galleries, as in *Syringostroma radicosum* Galloway and St. Jean (Pl. 36, fig. 7). When the astrorhizae are well formed the branching canals of one astrorhiza merge with those of neighboring astrorhizae, in capillary fashion, as in *Ferestromatopora larocquei* (Galloway & St. Jean) (Pl. 36, fig. 4).

Syringostroma densum Nicholson (1875, p. 251, pl. 24, fig. 2) (*syrinx,* tube) was at first distinguished from *Stromatopora* on the basis of horizontal (astrorhizal) canals one-fifth to one-fourth of a line (one-twelfth inch) in diameter, and the astrohizae were well described from the surface as, "starlike, not elevated, impressions, formed of vermicular bifurcating horizontal canals, which radiate from a central point." Later Nicholson, (1886, p. 97, pl. 11, figs. 13, 14) distinguished *Syringostroma* from *Stromatopora* on the more important "large-sized radial pillars." In some cases the astrorhizae are scattered at the surface without regard to the presence of regular mamelons, as in, *Syringostroma tuberosum* Galloway and St. Jean (1957, pl. 17, fig. 4).

The branches of the astrorhizae may also be tabulate, the tabulae being oblique both to the laminae and to the astrorhizal branches. Both the axial tube and the branches of the astrorhizae may be crossed by curved or cystose plates. There is no necessary connection between astrorhizae and pseudozooidal tubes, since specimens may have astrorhizae but no pseudozooidal tubes, as *Clathrodictyon vesiculosum* N. and M. *Hermatostroma schlüteri* has no astrorhizae, but most maculate species have both astrorhizae and pseudozooidal tubes. In the Idiostromatidae there is a tabulate tube, similar to an astrorhizal tube, from which branch smaller tubes similar to pseudozooidal tubes.

In the Idiostromatidae, the axial tube with lateral branches suggest a similarity to an astrorhizal column in the other genera. Under the discussion of astrorhizae, Lecompte (1951, p. 19) observed that the axial tube of *Idiostroma roemeri* branches into the normal network of the skeleton, implying that the axial tube and branches from it are real astrorhizae, an observation made more definite recently (Lecompte, 1956, p. F115). Numerous specimens of *Idiostroma* and *Dendrostroma* do not show any astrorhizae at the terminal ends of the branches, although there is the axial tube with a few branches. It is a rather intriguing idea that the Idiostromatidae may be made up of largely isolated astrorhizal cylinders. The axial tubes of *Amphipora* (Pl. 34, fig. 7) and *Paramphipora* (Yavorsky, 1955, pl. 84, fig. 3) (Pl. 37, fig. 3) may have curved and irregular tubes resembling those of some mamelon and astrorhizal cylinders.

One gets the impression from surface examination that astrorhizae occur in scarcely one specimen in 10, although the fact that the surface of the stromatoporoids is not always well preserved may add to that impression; at any rate, astrorhizae are not so common as the discussion of their importance would seem to indicate. Small astrorhizae have small, sparsely branching canals. Some astrorhizal canals are large but not arranged in starlike manner, and the canals may not at first study be recognized as astrorhizae (Pl. 35, fig. 8). Astrorhizae and astrorhizal canals are often visible in thin sections when they are not detectable at the surface, as in *Stromatopora laminosa* (Pl. 35, fig. 3). In the fauna of 85 species described by Galloway and St. Jean (1957), 55 species had astrorhizae and 30 species did not have them. Only 3 species of 17 species of *Anostylostroma* had astrorhizae; about half of the species of *Stromatoporella* had astrorhizae, and all described species of *Stromatopora* and *Syringostroma* had astrorhizae.

The function of the astrorhizae is as yet unknown, although it is obvious that they were occupied by some kind of important soft structure. They may have been reproductive zooids, or ampullae for the production of medusae, or they may even have been female polyps, or coenostea with astrorhizae may have been female individuals, whereas similar specimens without astrorhizae may have been male or asexual. Steiner (1932) and Yavorsky (1955, p. 13) favored the hypothesis that astrorhizae were organs where zooidal budding took place. Whatever they are, they must have been important in the life of the specimens which had them. Inasmuch as alternation of generation, with vegetative and sexual stages of different characters, occur in Hydrozoa, the possibility that stromatoporoids with astrorhizae may represent the sexed stages in the life cycle, and specimens without astrorhizae the asexual stage, must not be overlooked. But conspicuous and important as they seem to be, astrorhizae cannot be more than of specific importance, as they are understood at the present time, in which the writer agrees with Nicholson (1886, p. 11, 56). Sugiyama (1939, p. 443; 1940, p. 111) distinguished the genus *Labechiella* from *Labechia*, solely on the basis of the presence of astrorhizae, not a generic difference. Winchell (1867, p. 99) proposed the new genus *Coenostroma* on the presence of astrorhizae and mamelons. Nicholson showed (1886, pp. 11, 56) that astrorhizae do not constitute a generic character; so *Coenostroma* has been placed in synonymy with *Stromatopora* by most authors since that time. The writer has studied the type specimen of *Coenostroma*, *C. monticuliferum* Winchell, and it is a typical *Stromatopora* with maculate tissue and pseudozooidal tubes.

The presence or absence of astrorhizae is always noted in specific descriptions, but pairs of species, those with and those without astrorhizae, are not definitely known, as are pairs of species, those with mamelons and those without mamelons.

11. *Mamelon columns and astrorhizal columns.*—Mamelon columns are produced where mamelons are consistently superposed, as in *Anostylostroma columnare*, *Actinostroma stellatum*, *Parallelopora nodulata*, *Anostylostroma papillatum*, *Pseudostylodictyon poshanensis*, and *Taleastroma magnimamillatum*. There are corresponding species in all those genera without either mamelons or mamelon columns, *e.g.*, *Anostylostroma laxum*, *Actinostroma expansum*, *Parallelopora typicalis*, *Anostylostroma hamiltonense*, *Pseudostylodictyon woyuensis*, and *Taleastroma cumingsi*. Mamelon columns are a rather uncommon feature of coenostea; the novelty of mamelon columns inspired Nicholson and Murie to erect the genus *Stylodictyon* on that basis alone, and Ozaki erected the genus *Pseudostylodictyon* on the presence of columns alone. On the basis of the columns, each of those genera consisted of a single species, which would indicate that the character is only a specific one.

One to eight vertical, tabulate tubes may occur in each mamelon column, as in *Anostylostroma columnare* (Parks) (Pl. 33, fig. 7), *Stromatoporella huronensis* (Parks) (Pl. 36, fig. 6), *Gerronostroma plectile* Galloway and St. Jean, and *G. excellens* Galloway and St. Jean, but in those species there are no astrorhizal canals transverse to the axial canals, and no astrorhizae are apparent at the surface nor in tangential sections. The tabulate mamelon tubes, without transverse astrorhizal canals, resemble astrorhizal tubes and also the axial tubes in the Idiostromatidae. It cannot be stated, however, at this time that mamelon columns without lateral branches are really astrorhizal columns but without lateral canals.

Mamelon columns do not in general constitute a generic character, but they do constitute a specific character. The genus *Lophiostroma,* as yet little known, was characterized by the mamelon columns.

In some specimens with mamelons, whether regular in size or irregular in size and shape, each mamelon is confined to one latilamina, and they are only incidentally superposed and do not make mamelon columns. Such mamelons constitute a specific character. A specimen of *Clathrodictyon variolare* was figured by Nicholson, showing strong mamelons, 5 to 10 mm. in diameter; he says (1888, pl. 17, fig. 14), "The laminae in this specimen exhibit rounded 'mamelons,' but these are by no means invariably present in this species." Even though Nicholson did not consider mamelons even of specific importance, yet he and Murie erected the genus *Stylodictyon* on the mere presence of mamelons and mamelon columns. Parks (1936, p. 16) erected, on the basis of the columns, a subspecies named *"Clathrodictyon" laxum columnare* which is a good species of *Anostylostroma.*

It will thus be appreciated, if not readily apparent, that mamelon columns have been considered to be of generic, of specific, and of subspecific importance. Where there are astrorhizae, they tend to be at the summits of mamelons, and mamelon columns may also be astrorhizal columns, as in *Parallelopora nodulata.* The presence or absence of astrorhizal columns is only a specific character, not a generic character.

12. *Dissepiments.*—In addition to the family Labechiidae, in which dissepiments or cyst plates are a dominant character, curved

plates occur in all other families and, indeed, in all of the genera excepting *Dermatostroma* and *Lophiostroma*. In families outside of the Labechiidae the curved plates are not regularly arcuate and imbricate, but occur in the galleries, and are of the same shape and structure as the primary plates of the Labechiidae. The genus *Clathrodictyon* (Pl. 33, fig. 5) is made up of highly arched plates which occur mostly side by side, and not typically imbricate, and do not form typical laminae. In the genus *Actinodictyon* the skeleton is largely made of cyst plates with pillars, and in *Synthetostroma* there are typical laminae, with numerous cyst plates in the galleries. Cyst plates are also of common occurrence in many other genera, as *Anostylostroma, Stictostroma, Stromatoporella,* and in the genera of the Idiostromatidae. Dissepiments are small and arcuate in most cases; they are large and broad in *Rosenella* and *Stromatocerium;* they are large and hemispherical in the axes of *Aulacera* and *Cryptophragmus;* they are irregular in size and shape in astrorhizal canals; they are oblique and curved upward in several species of *Anostylostroma*. In rare cases some curve downward as well as upward, as in *Clathrodictyon vesiculosum*, and sporadically as in some species of *Anostylostroma*.

The function of the curved dissepiments is unknown, but their frequent occurrence in all the families of the Stromatoporoidea is proof that they were of considerable structural, physiological, and perhaps phylogenetic importance. Two possible reasons for their presence may be offered: first, they may be vestigial structures inherited from the ancestral Labechiidae, in which the curved plates constitute the main skeletal structure; secondly, cyst plates of variable size occur where the organism has been injured and the injury repaired. A zone of overlapping, thin cysts occur where part of the coenosteum had died and was overlain by a new growth of the same species *Stictostroma mcgraini* Galloway & St. Jean (Pl. 36, fig. 8), and a zone of cysts may occur at the beginning of each latilamina.

The abundance and regularity of dissepiments is considered to be of family importance in the Labechiidae, of generic importance because of their abundance in the genera *Clathrodictyon, Actinodictyon,* and *Synthetostroma;* in other cases, the number of curved dissepiments, whether absent, scarce or common, are of specific significance. In most cases the occurrence of an occasional dissepiment appears always to be compact, as it is in the Labechiidae, even in *Stromatopora* and *Stromatoporella*. The order Labecheidea Kühn, 1927, based largely on the presence of cysts (but including the family Idiostromatidae with few cysts) is not a good order, but forms with imbricating cysts, characteristic of the Ordovician, make a natural family, closely allied to the other four families of the order Stromatoporoidea.

13. *Villi.*—Small, finger-like structures extend upward from the upper layer of the dissepiments in some Ordovician genera and species, as in *Cystostroma simplex* (Pl. 32, fig. 2), *Sinodictyon* (Pl. 32, fig. 7) and *Cryptophragmus antiquatus* (Pl. 32, fig. 8). They are biologic structures, not due to preservation, and have the same structure as the upper layer, a finely flocculent appearance. In tangential section the villi are consistent in size, abundant, and look like short pillars. They are not the same as denticles, for they are straight-sided, not conical, and not part of the median or primary layer, but are secondary structures. Their function is not apparent, but their presence or absence may be considered of specific value.

14. *Lighter centers in pillars.*—In several genera, as *Labechia, Actinostroma* (Pl. 34, fig. 2), *Hermatostroma,* and *Atelodictyon* (Pl. 33, fig. 8), the pillars have lighter colored tissue in the centers, in some cases giving the impression that the pillars had been hollow. The pillars of *Aulacera* (Pl. 31, fig. 2), *Taleastroma* (Pl. 35, fig. 4), and also various species of *Labechia* have light centers bounded by a dark border, which condition might be mistaken for hollow pillars; but in well-preserved specimens it is always seen that the pillars have tissue in the centers, not secondary calcite, are not and never were hollow. The writer cannot, therefore, agree with Nicholson, who stated (1889, p. 160) that in *Labechia conferta* "the radial pillars are hollow, each being transversed by a well-marked axial canal," and that in the case of *Hermatostroma* (1892, p. 219) there are "exceedingly well developed, 'continuous' radial pillars, which are transversed by axial canals." The light centers of pillars is of little systematic value, although the width of the light-colored zone,

as also the width of the pillar itself, may be a specific character. Since the original structure of the pillars was frequently different from that of the cysts or the laminae, they may be more altered by recrystallization, dolomitization, or silicification, than are the cysts or laminae of the same specimen; in *Labechia pustulosa* (Safford) the laminae appear to be perfectly preserved, but the pillars are nearly completely destroyed by infiltration of calcite and by recrystallization. Ring-pillars are hollow (Pl. 34, fig. 1) and occasional hollow rings (not ring-pillars) are seen in the tangential sections of several genera (Pl. 34, fig. 6; Pl. 33, figs. 2, 6; Pl. 35, fig. 10).

15. *Foramina in the laminae.*—In many genera of all of the families, there are occasional openings between superposed galleries (Pl. 31, figs. 10, 11). Such openings are far larger than are pores in the walls and are referred to as foramina. Such openings may have been incompletions of the new lamina when it was laid down. Openings occur through the thick laminae of some species of *Anostylostroma,* but rare in other species. In *Stromatoporella* it may be difficult to distinguish foramina from ring-pillars made by upturns and down-turns of the laminae (Pl. 31, fig. 8). In the genus *Actinostroma* the superposed galleries appear to have been connected normally by foramina in the laminae (Pl. 31, fig. 9), the foramina being merely openings left between the radiating arms of the pillars. In the case of *Actinostroma,* at least, all of the galleries between the many laminae may have been connected with the surface of the coenosteum, and living tissue may have occupied all of the galleries at the same time. Occasional foramina occur through the laminae in *Trupetostroma, Hermatostroma, Stromatopora, Stromatoporella, Stictostroma,* and also in all genera of the Idiostromatidae. The writer does not attach any systematic importance to the occurrence of occasional foramina through the laminae, although they do occur more abundantly in some genera and some species than in others. Such foramina are not "zooidal tubes", as used by Nicholson, which are superposed galleries, frequently separated by tabulae.

NEGLIGIBLE TAXONOMIC CHARACTERS

16. *Latilaminae.*—Many coenostea of stromatoporoids grew in concentric or eccentric annulations, ordinarily 3 to 5 mm. thickness but in some cases running as high as 20 mm. Latilaminae are

demarked by closer laminae, distorted laminae, by discontinuity of growth, and by thin layers of mud. The thick layers, or latilaminae (Nicholson, 1886, p. 40), constitute the structure most readily observed in hand specimens, and is the character by which stromatoporoids are detected in the field. It was the latilaminae which suggested to Goldfuss the name *Stromatopora* (*stroma,* layer), for the layers are the most apparent feature of *S. concentrica* as figured by Goldfuss. In the hand specimen, the latilaminae of stromatoporoids are not distinguishable from similar growth bands in *Cryptozoon* and other stromatolites, and in associated corals, as *Rhapidopora.* Latilaminae are more apparent on weathered specimens than in unweathered specimens taken from excavations. At a given locality the latilaminae have much the same thickness regardless of the genus or species, because of the common ecological conditions, although it is apparent that some specimens grew faster than others, because the laminae are farther apart and latilaminae are thicker. Ordinarily growth is continued from one latilamina to the next and pillars may be continuous from one latilamina to the next. Specimens are found in which the latilaminae are separated in much of the specimen by layers of mud, so that growth was stopped and a new latilamina was made by overgrowth from some other part of the specimen.

Latilaminae seem to be better marked in *Stromatopora, Syringostroma, Parallelopora,* and other species of Stromatoporidae; but latilaminae also occur in most of the genera of all of the families but are much less obvious in the Idiostromatidae. Specimens tend to separate between latilaminae. Where the specimens are solidly infiltrated, as at the Falls of the Ohio, latilaminae may not be apparent in a broken specimen. Lamination of limestone and of concretions and nodules simulate latilaminae, and thin sections may be necessary to show that such objects lack laminae, pillars, dissepiments, astrorhizae, and other structures characteristic of stromatoporoids.

It is most probable that latilaminae mark pauses in growth due to seasonal changes in temperature or other conditions of the water in which the organisms grew. At the junction of two latilaminae, the structure is usually finer than it is higher in the latilaminae, giving the analogy of annual rings of growth in wood. It is the presence of latilaminae which enables the collector to distinguish between stromatoporoids and mere pieces of rock in the field. Latilaminae should not be confused with thick laminae (Fritz and Waines, 1956, p. 116).

The presence of latilaminae or their thickness, are without generic or specific significance, but they have a physiological or ecological explanation, as annual changes of seasons. It might even be possible to match the latilaminae for annual growth, as has been done for wood. It may be noted that other reef-building organisms, as algae and corals, are composed of latilaminae. (Faul, H., Am. Jour. Sci., 1943, p. 579).

17. *Peritheca.*—When specimens grew on a sediment, as clay or lime mud, they produced a wrinkled, thin, compact, lower layer, referred to here as peritheca, but sometimes less aptly called epitheca and holotheca. The peritheca, when present, shows the lines of growth or latilaminae, as well figured by Nicholson (1886, pl. 3, fig. 7, 8) for *Labechia.* Such a wrinkled peritheca occurs at the base of stromatoporoids from the Middle Devonian Traverse shale at Rockport Quarry, Michigan, and at Thedford, Ontario. The peritheca is ordinarily thin, a millimeter or less in thickness, and of more dense structure than the overlying normal skeletal tissue. In some cases it consists of cystose vesicles. Specimens which are attached to limestones ordinarily are broken off above the peritheca, so that it does not show. Also, specimens which have been weathered out usually have the peritheca destroyed. The presence or absence or character of the peritheca seems to be entirely without systematic value. When studies of the early ontogeny of stromatoporoids are eventually made, it will be necessary to find specimens with the peritheca preserved in the beginning stage of the coenosteum. It should be noted that the corrugation on the peritheca are much wider than the latilaminae are in the same specimen, for the growth was greater laterally than it was vertically.

18. *Caunopore tubes.*—The conspicuous, vertical tubes in some coenostea, which are about one millimeter in diameter and which have their own thick, laminated, compact proper walls, have been known as "caunopore tubes", taking their name from the invalid generic name, *Caunopora* Phillips, 1841. Such tubes have

convex overlapping cyst plates on the inside of the tubes, and some are infundibular, as they are in the coral genera *Aulopora* and *Syringopora* (Roemer, 1844, p. 5; 1880, p. 343). New tubes arise from the older tubes by small, short, horizontal stolonal tubes. Bargatzky's *Diapora* (1881, p. 287) is an invalid name referring to a combination of *Syringopora* and different genera of stromatoporoids.

The caunopore tubes occur commonly in the genus *Stromatopora,* and several specimens of *Anostylostroma insulare* have abundant caunopore tubes. They also occur in the genus *Stromatoporella* (Nicholson, 1886, pl. 10, figs. 1-7; Lecompte, 1951, pl. 24), in *Actinostroma* (Nicholson, 1886, pl. 17, figs. 1-6), in *Stictostroma* (Parks, 1936, p. 89), *Gerronostroma* (Yavorsky, 1955, pl. 12), but as yet have not been reported in other genera. The caunopore tubes are most abundant in Devonian specimens and only rarely found in the Silurian (Boehnke, 1915, pp. 173-174). *Stromatopora* with caunopore tubes occur in the top of the Silurian of New York. Caunopore tubes have not been reported in Ordovician forms.

The writer agrees with Nicholson, Lecompte, Yavorsky, and most other students of stromatoporoids that the caunopore tubes are parasites of some different organism, probably the coral *Syringopora.* Kühn (1939, p. A40) thought that the stromatoporoid attached itself to the caunopore organism, and the stromatoporoid was, therefore, the parasite.

It may be insisted, agreeing with most students of stromatoporoids, that the caunopore tubes do not constitute a generic or specific feature. A species may or may not have been parasitized by the colonial coral.

GEOGRAPHIC OCCURRENCE OF STROMATOPOROIDEA

The true Stromatoporoidea, which are confined to the Ordovician, Silurian, and Devonian periods, occur in abundance in the United States, Canada, England, France, Belgium, the Carnic Alps, Gotland, Estonia, Rheinland and northern Germany, Austria, Holland, Poland, Bohemia, Asia Minor, Urals, and southern Russia, Novaya Zemlya, Morocco, northern China, Manchuria, Korea, Japan, and Australia. No stromatoporoid has been reported from South America (not including the order Sphaeractinoidea as Stromatoporoidea). The geographic range is nearly confined to the northern temperate zone and the southern temperate zone of Australia.

The main areas in North America where stromatoporoids occur are: *Ordovician* of Anticosti Island, Ottawa basin, Ontario, Baffin Land, Akpatok Island; Vermont, New York, Pennsylvania, Virginia, Alabama, Indiana, Ohio, Kentucky, Tennessee, New Mexico, Colorado, Wyoming, Nevada, and Alaska; *Silurian* of Quebec, Ontario, Hudson Bay, northern Canada, New York, Michigan, Ohio, Indiana, Kentucky, and Missouri; *Devonian* of Quebec, Ontario, Hudson Bay, Mackenzie Basin, northern Canada, New York, New Jersey, Maryland, Pennsylvania, West Virginia, Ohio, Michigan, Indiana, Illinois, Missouri, Iowa, the northern Rocky Mountains of the United States and Canada, and California. It is interesting that no Devonian stromatoporoid has been reported from Kentucky south of the Louisville areas, where Devonian limestones occur, and stromatoporoids may be expected; the writer has seen only one specimen, from the Princeton University Collections, from Moreland, Kentucky. A fuller discussion occurs in Galloway and St. Jean's paper (1957, p. 53).

STRATIGRAPHIC OCCURRENCE OF STROMATOPOROIDEA

Yavorsky (1932, Centralbl. Miner., Geol., Palaeont., Abt. B, p. 613) announced the discovery of two genera of stromatoporoids from the Cambrian of western Siberia. The first form he placed in the genus *Actinostroma.* He remarked that the structure of that form is similar to *Actinostroma* from the Jurassic. Indeed, it is more like the Jurassic form than it is like *Actinostroma,* for the pillars are not continuous, and there are no radial processes, both of which any form must have to be placed in *Actinostroma.* The writer feels that something is amiss, and the specimen may be Jurassic and not Cambrian; it seems identical with *Actinostromaria stellata* Haug (Kühn, 1939, p. A42, fig. 56).

The other species Yavorsky placed in the genus *Clathrodictyon.*

It has thin laminae with large pores through the laminae, the pillars are confined to one interlaminar space and they flare and divide upward. The structure is that of *Anostylostroma* from the Devonian. It cannot be admitted, without further checking, that such a form could possibly occur in the Cambrian, even if Archaeocyatha were reported from the same rock. Inasmuch as nearly all Ordovician stromatoporoids are composed of cysts, not of laminae as apply to post-Ordovician forms, one would expect Cambrian forms to be constructed of simple cysts, not of laminae and pillars. One should be skeptical if supposed Cambrian forms of any group of fossils have the structure of Mesozoic and Devonian forms.

Obrutschew (1926, p. 86 *et. seq.*) announced the occurrence of "*Stromatoporen*" in Cambrian rocks of Siberia. He gave neither description nor figures of the objects he noted, so we do not know whether they were stromatoporoids or only stromatolites, as *Cryptozoon* and other algal bodies, which occur abundantly in Cambrian strata.

The first undoubted stromatoporoids, the genera *Cystostroma* and *Pseudostylodictyon,* appear in the Middle Ordovician of Vermont, the Chazy limestone. It is probable that the horizon for stromatoporoids in Manchuria and northern China (Ozaki, 1938, p. 205) is also Middle Ordovician, about Black River in age. The Black River formations contain *Crytophragmus, Sinodictyon, Rosenella, Dermatostroma, Labechia, Labechiella, Pseudolabechia, Stromatocerium,* and *?Lophiostroma.* Stromatoporoids become more abundant in the Upper Ordovician with the continuation of the genera mentioned and the appearance of *Aulacera* (Ozaki's *Aulacera,* 1938, p. 217, seems to be *Sinodictyon*), and *Clathrodictyon* and doubtfully *Stromatopora.* Bioherms with stromatoporoids occur in both Middle and Upper Ordovician.

In the Silurian the number of genera, species, and specimens increases greatly, and bioherms of stromatoporoids become more common and larger. The following genera occur: *Rosenella, Pseudostylodictyon, Labechia, Pseudolabechia, Clathrodictyon, Anostylostroma, Stictostroma, Stromatoporella, Actinostroma, Lophiostroma, Clavidictyon, Paramphipora, Amphipora, Ferestromatopora, Stromatopora, Syringostroma, Parallelopora, Hermatostroma,* and *Actinodictyon*. Of these 20 genera it would seem that *Clathrodictyon* is most abundant and characteristic; most of them continue into the Devonian.

The following genera, so far as information shows at the present time, occur for the first time in the Devonian: *Atelodictyon, Gerronostroma, Trupetostroma, Dendrostroma, Idiostroma, Stachyodes, Taleastroma, Clathrocoilona,* and *Synthetostroma.* It would appear that the following genera are most abundant and most widespread and, therefore, most characteristic of the Devonian: *Anostylostroma, Gerronostroma, Amphipora, Dendrostroma, Idiostroma,* and *Taleastroma.* The last undoubted stromatoporoids occur as bioherms and biostromes in the Upper Devonian of Iowa, and the late Devonian of Etroeungt of France, Belgium, and Germany, after which time the real stromatoporoids appear to have become extinct.

It is a remarkable fact that no genuine stromatoporoid has been reported from the Mississippian from any place in world. The writer does not admit that *Aphralysia* is a stromatoporoid, but considers it to be an alga, similar to *Girvanella.* There have been few recorded occurrences of supposed stromatoporoids in post-Devonian. In America the only form from the Pennsylvanian which has been referred to a stromatoporoid is that reported by Newell (Jour. Paleont., vol. 9, p. 341), which form is surely a sponge, for it shows spicules which are recognizable as spicules by Newell. The forms found in the Permian by Waagen and Wentzel (1887, Mem. Geol. Surv. India, Pal. Indica, ser. 13, vol. 1, p. 942) and assigned by them to the Stromatoporoidea under the genera *Arduorhiza, Circopora, Disjectopora* and *Irregulatopora* have all the characters, including trabeculae, of the order Sphaeractinoidea. The writer does not consider them to belong to the Stromatoporoidea.

Many forms have been found in the Jurassic and Cretaceous of Europe and Asia, but they are constructed of anastomosing rods or trabeculae, and they are admitted by all students of those forms to be Hydrozoa, but they belong in the order Sphaeractinoidea and not in the order Stromatoporoidea. It is remarkable that only one species of Sphaeractinoidea (called a stromatoporoid) has been described from North America (Wells, 1934, Jour. Paleont., p. 169), from the Lower Cretaceous of Texas.

No forms has been referred to the Stromatoporoidea from the Cenozoic nor have the most closely related forms, the Sphaeractinoidea, been reported from rocks later than the Mesozoic. Typical Hydrozoa, including the Hydractiniidae and the Milleporidae, occur from the Cretaceous to the Recent.

In summary it may be stated that the typical Stromaoporoidea appeared in the Middle Ordovician, greatly increased in number of forms and specimens in the Silurian, and reached their acme in forms and numbers in the Devonian, at the end of which time they became extinct. It should not be surprising if the simplest forms, *Cystostroma, Rosenella,* and *Pseudostylodictyon* should occur in the Lower Ordovician. Some rare forms must have persisted during the Mississippian and Pennsylvanian and given rise to the Disjectoporidae of the Permian and the Stromatoporinidae.

A table showing the stratigraphic and geologic range of the Stromatoporoidea, and their occurrence in biostromes and bioherms, was given by Galloway and St. Jean (1957, p. 58).

ASTOGENY OF STROMATOPOROIDEA

Nothing seems to have been published on the early coenosteal development, or astogeny, of the stromatoporoids. It would be useful in determining the ancestry and phylogeny of the stromatoporoids and, therefore, the classification of the stromatoporoids, as has been done for some corals and Bryozoa.

It is nearly impossible to get the early stages of stromatoporoids, especially those which were embedded in limestone, for the early developmental stages of the colonies are nearly always lost in freeing the specimens from the matrix. Small specimens may be attached to corals and, in such cases, offer hope of finding the beginning stage. Specimens which were preserved in shale do show the beginning of the colony; but, in most cases, the early stage cannot be developed out by sawing or by other convenient means. Attempts have been made to cut specimens through the nepionastic stage of many specimens, but the early stage could not be recognized in specimens which were most favorable, as *Labechia huronensis,* from the late Ordovician, and species of *Stromatopora,* from the Middle Devonian of Michigan.

Occurring with *Cystostroma vermontense,* n. sp. are bodies composed of a spherical chamber, 0.2 to 0.5 mm. in diameter, with a neck of 0.5 mm. long extending from the substratum; on each side of the spherical chamber are three annular cysts, which look like pairs in vertical sections, the lower attached to the lower side of the chamber, extending to the substratum, the second attached to the middle of the chamber, extending to the substratum, and the upper cysts attached to the top of the spherical chamber and extending to the substratum. The most advanced specimen continues upward into normal cysts of *Cystostroma.* The whole structure is convex upward, 1 mm. high and 3 to 4 mm. in diameter (Pl. 36, fig. 3). The structure described is considered to be the beginning of the coenosteum and has been named the protocoenosteum (Galloway and St. Jean, 1957, p. 45). Four specimens in different stages of development occur in one section and are attached to and are covered by algal structures. No protocoenosteum of any other stromatoporoid is as yet known.

Small specimens of *Aulacera plummeri* and other closely allied species of that genus from the late Ordovician of Indiana and Kentucky, are in reality neanic, or half-grown, specimens. In that stage specimens of *Aulacera* up to 30 to 40 mm. in diameter do not have any pillars; whereas, in specimens 40 to 120 mm. in diameter, there are pillars in the outer zones. Young specimens of *Aulacera,* in the lateral zone, recapitulate the adult stage of its ancestor, *Cystostroma,* which is massive in form and occurs earlier in the Ordovician. *Aulacera* is one of the few stromatoporoids which shows an adult stage different from the young stage.

In parts of some specimens of *Labechia huronensis* there are groups of dividing and flaring pillars in the outer zones (Pl. 36, fig. 9). The meaning of such pillars is puzzling, whether specific or a phylogerontic or a pathologic character.

Ozaki's figure of *Labechiella mingshankouensis* (1938, pl. 23, fig. 1d) shows cysts in the submature stage and straight laminae in the mature stage, indicating that *Labechia,* made entirely of cysts and round pillars, was the ancestor of *Labechiella.*

Specimens of *Stromatocerium canadense,* which consists of wide cysts with short pillars in part of the coenosteum, a perfect *Rosenella* stage, is followed by broad cysts with long, irregular pillars in another part of the coenosteum, the *Stromatocerium* stage. One specimen shows the *Stromatocerium* stage followed by a *Rosenella* stage. Repetition of immature and mature zones is of common occurrence in colonial corals and in trepostomatous Bryozoa. The early, attached stages of *Aulacera,* and *Cryptophragmus* must have been explanate. Yavorsky (1955, p. 71, pl. 36, fig. 3) discussed the position of *Aulacera* in life, figured a specimen with an enlarged attachment at the small end, and favored the idea that in life they stood vertically with the small end downward.

Dermatostroma and *Labechia* occur together in the same beds of the Richmond group at Clarksville, Ohio (Foerste, 1916, pl. 1, fig. 1, 3), and they may be related, but the writer does consider that *Dermatostroma* is an early astogenetic stage of *Labechia* since it is not composed of cysts.

Three other facts would indicate that the early stages of many of the genera of stromatoporoids, particularly the Clathrodictyidae and the Actinostromatidae, had ancestors made of cysts rather than of laminae. *Clathrodictyon* was derived from a form composed of cysts, because it is also formed of cysts, albeit arranged side by side rather than in an imbricating matter. Secondly, the presence of cyst plates in most of the genera of all of the families of stromatoporoids, indicates that the cysts are of some fundamental importance. They may well be ancestral characters which are still retained in derived families. Another fact which indicates that cysts are primitive and fundamental structures in the stromatoporoids, is the presence of cystose repair tissue, where specimens were injured or rejuvenated; in such cases the beginning tissue, even in such advanced genera as *Stromatoporella,* is composed of cysts. Latilaminae, in genera with typical laminae and pillars, may start with cysts at the bases, then change to laminae and pillars (Pl. 36, fig. 8).

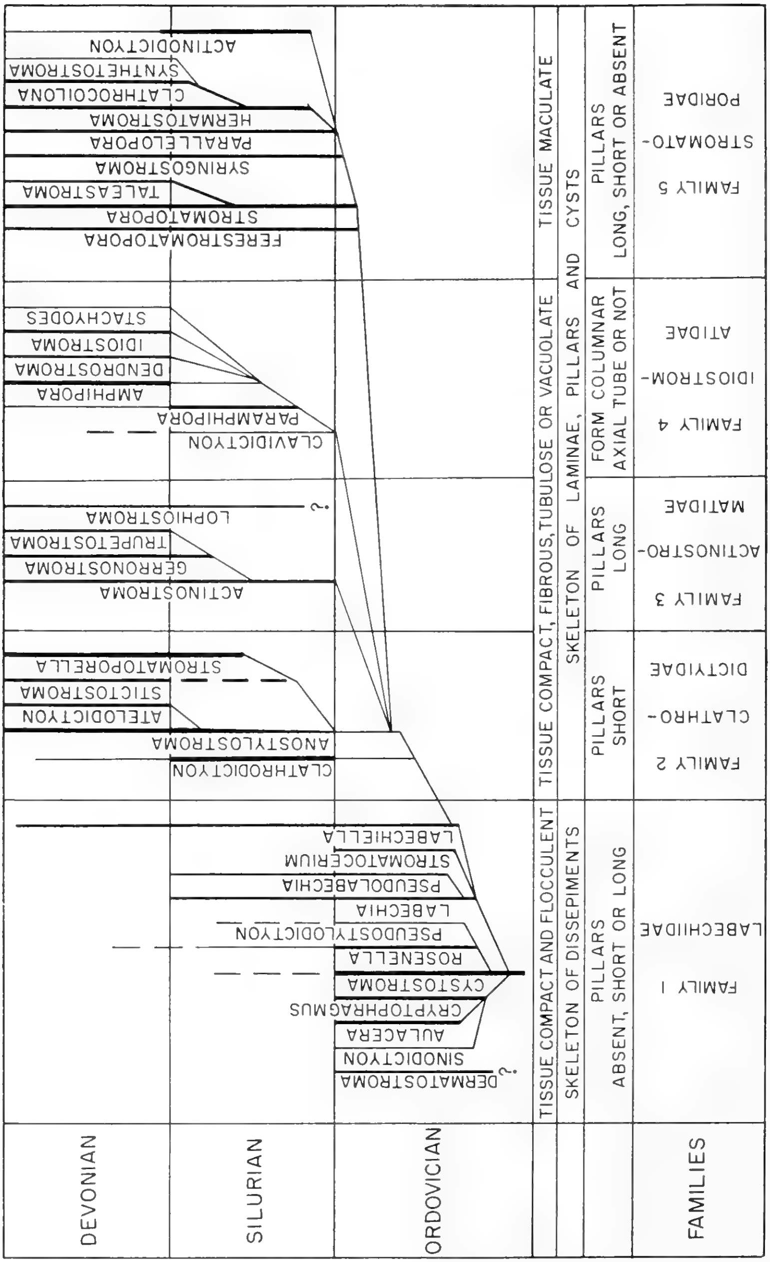
The coenosteum of stromatoporoids seems to have been a biologic colony, rather than an individual; hence, the use of astogeny, meaning colonial development, in preference to ontogeny, or individual development. There is little evidence, outside of the presence of astrorhizae in some species, that the coenosteum was a collection of individuals. Most coenostea are composed either of cysts, of cysts and pillars, or of laminae and pillars, all parts of the coenosteum having the same structure, except for variations due to pauses in growth or accidents. In the case of specimens with astrorhizae, there were two kinds of structure, that without and that with astrorhizae. It was suggested in Section 10 above that astrorhizae may have had something to do with the reproduction of the stromatoporoids, and that specimens with astrorhizae were dimorphic in structure and function. Inasmuch as each coenosteum was obviously produced by the proliferation of a single polyp, or early ontogenetic stage of some kind, one might think of the coenosteum as being one individual animal. The coenosteum is generally considered to be a colony.

ANCESTRY AND PHYLOGENY OF STROMATOPOROIDEA

It is necessary to know the phylogeny of a group of organisms before a natural classification can be made, and the species, genera and higher groups discussed in correct order. Ideally, a classification is built on the basis of comparative structure, and the application of the Law of Recapitulation, checked by the known geologic range of each taxonomic group used in the classification. The ancestor of a group of organisms should be older and simpler than the oldest member of the group.

The phylogeny of the Stromatoporoidea, as shown in the chart, p. 396, is constructed on the basis of similarity of structure of the families and genera, the simplest coming first in the arrangement, and on geologic occurrence, the oldest coming first. The Labechiidae must come first, because it is most primitive and the ancestor, directly or indirectly of all other families. The Clathrodictyidae and Actinostromatidae come next being moderately modified. The Idiostromatidae are highly evolved in the form of the coenosteum, and the Stromatoporidae are highly evolved in the great development of secondary tissue which is maculate.

The relationship of the genera within a family is determined by the degrees of similarities and the changes judged adequate to produce another genus.



GEOLOGIC RANGES AND RELATIONSHIPS OF THE FAMILIES AND GENERA OF STROMATOPOROIDEA

The oldest undoubted stromatoporoids occur in the Middle Ordovician. The simplest Ordovician forms consist of arched cysts, without pillars, and a laminar or massive coenosteum. Such a form is *Cystostroma.* The oldest known species of that genus is *Cystostroma vermontense,* n. sp., of the Middle Ordovician of Isle La Motte, Vermont (Pl. 31, fig. 1; Pl. 32, fig. 1). One would, therefore, expect a Cambrian stromatoporoid ancestral form to consist merely of small cyst plates, without pillars or columns, and without astrorhizae. The laminae should be thin and dense but perhaps with an inner layer of flocculent, thickening tissue. Stromatoporoidea may have evolved from the Archaeocyatha, from such a form as *Exocyathus* (Okulitch, 1943, Geol. Soc. Amer. Spec. Pap. 48, p. 83, pls. 16, 17).

Other simple and primitive genera of stromatoporoids are *Rosenella, Pseudostylodictyon,* and *Sinodictyon* (Ozaki, 1938, pp. 208, 216, 218). On the basis of the adult earliest stromatoporoids, and the probable protocoenosteum, any Cambrian or Lower Ordovician stromatoporoid should be composed of dissepiments, resembling *Cystostroma,* with a spherical chamber at the beginning of the coenosteum.

The method of determining the ancestry by means of the Law of Recapitulation, or Biogenetic Law, cannot as yet be fully applied to the stromatoporoids. We do not ordinarily have the beginning stage, for the specimens are attached to the rock, and in breaking them out the early stage is nearly always lost. In the case of weathered or silicified specimens, the early stage has been destroyed. *Cryptophragmus* of the Middle Ordovician may have been derived from the *Cystostroma* by the piling up of the cysts in a vertical column. *Labechia* may have been developed from *Cystostroma* by early appearance of the pillars. The significance of *Dermatostroma* is in doubt; it seems to show the development of pillars, monticules, and even incipient astrorhizae. The structural advance made in the stromatoporoids in Ordovician time was the development of long pillars, columns, and the coalescence of plates into laminae, and an upright coenosteum. Ordovician forms are characteristically composed of imbricating curved plates. The most significant paper on Ordovician Stromatoporoidea is that of Ozaki (1938, p. 205).

The small family Clathrodictyidae, characterized by cysts arranged side by side, and by laminae and short pillars with remnants of cysts, might well have been derived from one of the Labechiidae in the late Ordovician (Twenhofel, 1927, p. 107) by the side by side placing of the cysts, rather than being overlapped or imbricated, as in the Labechiidae.

The ancestor of the Actinostromatidae may have been *Anostylostroma*. Ozaki (1938, p. 207) calls attention to the resemblance of his Ordovician forms to *Actinostroma*. Great numbers of real cysts occur in the family Actinostromatidae, especially in some species of *Trupetostroma*. The Idiostromatidae show greatest similarity in tissue structure to *Trupetostroma*. There are specimens of *Idiostroma* in the late Devonian of Missouri (U. S. Nat. Mus., No. 39733) which have a massive coenosteum, like *Trupetostroma* or *Gerronostroma*, from which rise mamelon, astrorhizal columns 1 cm. or more high; the age is too young for it to have been ancestral to the family, but it seems to show the mode of derivation of the ramose coenostea. *Clavidictyon* has no axial, cystose column, which shows that a column could arise without the presence of astrorhizae.

The origin of the type family, the Stromatoporidae, is not clear. The family has laminae and some genera have primary pillars, and both long and short secondary pillars, and a considerable number of cyst plates, but it is characterized by the thickening tissue on the laminae and the pillars, which tissue is full of small, round spots giving a maculate appearance not seen in the previous families. Some of the genera of the Stromatoporidae, *Stromatopora, Syringostroma,* and *Parallelopora,* have pillars constructed of secondary tissue. The pillars of *Syringostroma* and *Parallelopora* are not well marked by an outer boundary, as is true of the pillars of the first three families, which have primary pillars. Several of the genera, *Taleastroma, Hermatostroma, Clathrocoilona, Synthetostroma,* and *Actinodictyon,* have pillars not composed entirely of secondary, maculate material. The development within the family Stromatoporidae is in modification of fundamental structures, enlargement of pillars in *Syringostroma,* and development of large superposed maculae in *Parallelopora*. In *Synthetostroma* and *Actino-*

dictyon the conspicuous development of cyst plates is the diagnostic feature, similar to *Anostylostroma,* and in *Clathrocoilona* and *Synthetostroma* the pillars are confined to one interlaminar space again resembling *Anostylostroma.*

The family Stromatoporidae must have been the ancestor of the order Sphaeractinoidea. The order Stromatoporoidea became suddenly extinct at the end of the Devonian, mostly by extermination, but in the case of a few genera, *Anostylostroma, Actinostroma, Hermatostroma,* and *Stromatopora,* the extinction may have been by evolution. Several Mesozoic Sphaeractinoidea resemble Stromatoporoidea: *Sphaeractinia* (Kühn, 1939, p. A55) resembles *Anostylostroma; Heptastylus* (Kühn, 1939, p. A60) resembles *Hermatostroma,* including astrorhizae, and *Stromatoporina* (Kühn, 1939, p. A47), *Parastromatopora,* and *Epistromatopora* Yabe and Sugiyama (1935, p. 176) vaguely resemble *Stromatopora,* including the presence of astrorhizae. The Mesozoic genera are composed of rod-like trabeculae, rather than of laminae and pillars, and dissepiments seem to be absent and the tissue structure differs from that of Stromatoporoidea, so they are typical members of the order Sphaeractinoidea. The tissue in *Parastromatopora* has large, oval "micropores" (Yabe and Sugiyama, 1935, pl. 41, fig. 2; pl. 44, fig. 3; pl. 45, fig. 1). The tissue of *Epistromatopora* is composed of expanding fibers (1935, Yabe and Sugiyama, pl. 71, fig. 1, 2). The Mesozoic family Stromatoporinidae and the Permian family Disjectoporidae are better placed in the order Sphaeractinoidea, since they are characterized by trabeculae. The finer structure of the tissue of most late Paleozoic and Mesozoic forms is not well known; it is usually shown as if it were dense or structureless, or with an expanding fibrous structure. The vague resemblance of Mesozoic sphaeractinoids to the middle Paleozoic stromatoporoids caused Lecompte (1956, p. F107) to intermingle Paleozoic and Mesozoic genera in the same families.

It is a most remarkable fact that no example of either the order Stromatoporoidea or the order Sphaeractinoidea has been discovered from the Mississippian (not admitting that *Aphralysia* is a genus of Stromatoporoidea). The reason for the extermination of the Stromatoporoidea with the beginning of the Mississippian is not apparent. There are few other orders of organisms which became extinct at that time, although there was a great decline in corals, trilobites, and graptolites. There seems to have been no great geologic, paleogeographic, or climatic change which took place with the close of the Devonian; and there is little evidence of the sudden development of new enemies of the stromatoporoids. If a Mississippian stromatoporoid were found it should look like either *Anostylostroma* or *Actinostroma,* or the tissue would be maculate, and the genus like some member of the family Stromatoporidae. *Aphralysia* could scarcely be the same as *Aulacera,* as stated by Ozaki (1938, p. 213), for they have little similarity.

ECOLOGY OF STROMATOPOROIDEA

Stromatoporoids are sessile, benthonic, marine organisms, most often associated with corals, and occur frequently in limestones, rarely in calcareous shales. They probably lived in a clear, shallow, moving water, of tropical to subtropical environment. Latilaminae indicate annual warm and cold seasons.

Stromatoporoids have been reported in large numbers in bioherms (organic reefs), in biostromes (organic limestones) or in "banks" (Riabinin, 1941, p. 49, 82). They may also occur as randomly scattered specimens in limestone, as in the late Ordovician of Indiana, Ohio, Kentucky, and in calcareous shales, as in the Middle Devonian Bell shale of Michigan.

Some of the reefs, especially in the Devonian Traverse group of Michigan (from which the writer has collected material) contain angular conglomeratic fragments of stromatoporoids (Fenton, M. A., 1931, p. 200, fig. 2)[1], suggesting a local, small scale, storm breccia. Such reefs must have been built near the surface of the sea, and have been subject to constant wave action, as are present reefs. Large specimens of stromatoporoids, over 30 cm. in diameter occur upside down in the great reef at the Falls of the Ohio.

As modern day coral reefs are not composed exclusively of coral, so the stromatoporoid reefs are most often not composed

[1] Complete references are given in Galloway and St. Jean, 1956, Jour. Paleont., vol. 30, p. 170.

entirely of stromatoporoids. The diversification of kinds of organisms is not so great, however, as in the case of the Recent coral reefs (Fenton, C. L., 1931, p. 204). The lack of variety of organisms in the reefs may be due to the encrusting nature of many of the stromatoporoids; they grew over each other or over other organisms, thereby completely engulfing the organisms over which they grew. More likely, the lack of variety of reef organisms is due to the relatively small number of organisms adapted or specialized for the rigors of a reef environment.

Stromatoporoids, together with colonial corals and calcareous algae, form typical bioherms in the Middle Ordovician, lower Chazyan, on Isle La Motte, Vermont (Raymond, 1924, p. 72) and in the lower and middle Chazyan of northeastern New York (Oxley, 1951, p. 92), and in the middle and upper Chazyan, and Black River of Isle La Motte (Seely, 1904, p. 144). The oldest, authentic stromatoporoid known, *Cystostroma vermontense,* occurs in a reef or large accumulation of stromatoporoids and calcareous algae, in the middle Chazyan, 1 mile southeast of Isle La Motte village, Vermont, collected by Dr. Marshall Kay, 1954.

Great number of *Aulacera* occur two miles southwest of Deatsville, Nelson County, Kentucky, in the basal Liberty formation; the occurrence has been referred to as the "Bardstown Reef."

A bed of limestone three feet thick, three miles west of Madison, Indiana, in the late Richmond, Whitewater formation, is made up almost entirely of *Labechia huronensis;* a bioherm of the same species, at the same horizon, occurs at the dam site of the Mascatatuck State Farm, Butlerville, Indiana.

Stromatoporoids occur in large numbers with normal marine invertebrates, where reefs were not formed, and between reefs. For example, Bassler recorded (1932, p. 113) a large invertebrate fauna accompanying large and abundant "*Stromatocerium*" *(Labechia) pustulosum,* and Wilson (1948, p. 45) recorded a large fauna with stromatoporoids from the Middle Ordovician of Ottawa. *Clathrodictyon* occurs abundantly on Anticosti Island in the Upper Ordovician and Lower Silurian, with a large invertebrate fauna (Twenhofel, 1928, p. 107). Reefs of the Silurian of Indiana (Cumings and Shrock, 1928, p. 145) are highly dolomitized, so that most of the original fauna has been destroyed, but give some evidence of having been made of stromatoporoids and corals. Stromatoporoids only slightly altered occur in some of the reefs, as in the Silurian at Lapel, Indiana. Stromatoporoids and a few corals make up the Silurian reefs of the Chicago region (Fenton, 1931, p. 204). A large marine invertebrate fauna occurs with stromatoporoids in the limestone of Kitakami Mountainland of Japan, described by Sugiyama (1940, p. 99). Neither bioherms nor biostromes were mentioned by Sugiyama.

In the Devonian bioherms at Alpena, Michigan, stromatoporoids make the bulk of several reefs, and there are a few corals, *Hexagonaria* and *Emmonsia*. Between reefs, as at the Potter Farm, just west of Alpena, stromatoporoids occur with abundant brachiopods and corals. At Petoskey, Michigan, stromatoporoids make bioherms, with few other fossils, and the stromatoporoid heads and branches, have been broken and tumbled about, making a breccia (Fenton, 1931, p. 199). The breccia proves that the reefs were in shallow water and were hammered by the breakers. At Bay View, Michigan, two miles northeast of Petoskey, corals, and stromatoporoids occur in profusion in the interreef facies of thinbedded limestones.

Roemer (1880, p. 343) and Nicholson (1886, pp. 110-130) considered the caunopora tubes associated with stromatoporoids to be commensal tabulate corals, as *Aulopora* or *Syringopora*, but since in some cases the corallites are completely engulfed in the coenosteum, Kühn (1939, p. A40) considered it likely that the stromatoporoids parasitized the corals.

It is apparent that stromatoporoids could not compete with corals in a muddy habitat; for example, stromatoporoids are rare in the Devonian Hamilton shale of Thedford, Ontario, which is famous for its coral and invertebrate fauna, and the same is true for the Hamilton shale of western New York. The famous coral reef at the Falls of the Ohio at Jeffersonville, Indiana, consists mostly of both single and colonial corals, lying in position as left by wave action; perhaps ten percent of the organic material consists of stromatoporoid heads, from a few centimeters to nearly a meter in diameter, and specimens 35 cm. in diameter and weighing as much as 30 pounds are found upside down. The specimens have been completely infiltrated with calcite since burial and at time of deposition may have weighed only 10 pounds or less, since the skeleton of most stromatoporoids were frail before burial.

Lecompte (1951, p. 53) stated that corals and stromatoporoids do not normally occur together in the biostromes and bioherms in the Frasnian series of Belgium.

In the late Devonian of Iowa stromatoporoids make biostromes and so do corals, but they tend to occur separately. At Nora Springs, there are two beds of stromatoporoids separated by a 10-foot bed of shale. Just north of Floyd, Iowa, in the Cedar Valley formation, large round heads of stromatoporoids, no corals, occur tumbled in a limestone breccia, probably the flank of a bioherm.

Stromatoporoids are mentioned only in references in the Treatise on Marine Ecology and Paleoecology (Geol. Soc. Amer., Mem. 67, 1957, pp. 775, 777).

In summary, stromatoporoids are indicative of a clear, warm, shallow water, marine environment, with annual change of seasons, some stromatoporoid bioherms show that they could flourish in water only a few feet deep, and subject to the pounding of breakers, as in present organic reefs.

FOSSILIZATION OF STROMATOPOROIDEA

The skeletons of stromatoporoids were originally constructed of calcium carbonate, apparently in the form of calcite, rather than that of aragonite, for there is little indication of change in the form of crystallization since the skeletons were made. As stated by Nicholson (1886, p. 30), there is no possibility of the skeleton having been originally siliceous and having been replaced by calcite. Indeed, the writer knows of no genuine example of replacement of an originally siliceous skeleton of any organism by calcium carbonate, including sponges, notwithstanding statements to the contrary in text-books.

Stromatoporoids obtained from solid limestone or shaley limestone, and which are obtained from quarries, road cuts, and stream gorges, or other fresh exposures, are well preserved. They have been preserved by infiltration of calcium carbonate from solution in ground water, and the original structures of the laminae, pillars, and cyst plates are usually preserved in their original condition. Even finer structures are well preserved, such as the dark spots in the laminae and pillars, of forms in which the tissue is maculate, or has pores through the laminae, and the lighter centers of pillars, and even the exceedingly fine laminae of which pillars may be constructed are also well preserved. The tissue of both laminae and pillars shows more or less leaching and recrystallization in specimens from porous limestone. The appearance of preservation of stromatoporoids is the equal of that of other forms which are studied by means of thin sections: Bryozoa, tabulate corals, the fusulinids, calcareous algae, and others. Stromatoporoids, which are suitable for study by means of thin sections, should be collected from rocks which have been little disturbed and little weathered.

Specimens of stromatoporoids from the Middle Devonian limestones of Indiana, as near Logansport, Charlestown, and the Falls of the Ohio, are so well preserved that there is little to be desired. Specimens from the Middle Devonian limestones of Ohio, Ontario, New York, northern Michigan, Illinois, and Missouri, are also perfectly preserved by infiltration of calcite, as also are specimens from the Upper Devonian limestones of Iowa.

Specimens from the Middle Devonian of the Meshberger Quarry, eight miles southeast of Columbus, Indiana, are white and chalky in appearance; they have not been solidly infiltrated with calcium carbonate, and they may be slightly leached. There has been a slight amount of recrystallization of the tissue, yet most structures may be satisfactorily studied and photographed.

Specimens of stromatoporoids which occur at or near the surface of limestones are weathered considerably and the original calcareous structures have been modified by recrystallization, so that laminae and pillars may be destroyed, and all finer structures have been destroyed in the recrystallization of the calcite which made up the skeleton. The specimens of stromatoporoids which occur in Ordovician limestone of the Mohawk Valley have been considerably altered by weathering and recrystallization, and the tissue may be colorless, whereas the matrix is gray or dark. It seems most improbable that the original calcite of the skeleton has been removed by solution and then replaced by calcite, as considered by Nicholson, (1886, p. 32).

Usually specimens were infiltrated before any considerable pressure of overlying rocks developed on them. In some cases the originally frail skeleton has been crushed before infiltration, producing a false condition of close laminae and irregular pillars. Crushed specimens of *Anostylostroma columnare* (Parks) occur at Marblehead, Ohio, and crushed specimens of *Stromatoporella* occur in southern Indiana. *"Clathrodictyon" townsendi* Parks (1936, pl. 4, 1-3) seems to be a crushed specimen of *"C." insulare* Parks. *"C." ohioense* Parks may be the same species, only slightly crushed; they are all from the same horizon and locality, Kelleys Island, Ohio.

Stromatoporoids which occur in dolomitic limestone, such as the Middle Ordovician of Nashville, Tennessee, the Middle Silurian of northern Indiana, and the Middle Devonian of Petoskey, Michigan, exhibit latilaminae, but most of the finer structure has been destroyed by dolomitization. Such specimens are unsatisfactory for study, for the histological structures are largely or totally destroyed. Dolomitized specimens also exhibit a secondary porosity of the tissue which came about when the fossils were dolomitized. In the Silurian bioherm at Wabash, Indiana, infiltration, dolomitization, and recrystallization have destroyed all traces of fossils throughout the greater part of the bioherm, which is 900 feet long and 25 to 40 feet thick, although traces of stromatoporoids and Bryozoa occur in places. Cumings and Shrock (1928, p. 145) consider the reef rock to have been "extensively diagenized," especially in the core of the bioherm. The Geneva limestone, Middle Devonian, just below the Jeffersonville limestone of Shelby, Bartholomew, Jennings, and Jefferson counties, Indiana, is brown, porous dolomite, in which the fossils have been almost completely destroyed. No stromatoporoids have been recognized excepting *Amphipora*, which occurs in abundance in the form of molds and vague coenostea showing the axial tube. Specimens of *Labechia pustulosa* (Safford), from the type locality, the upper Trenton limestone of Nashville, Tennesee, are so badly dolomitized that the structure can be determined only in an occasional specimen, but the surface mamelons are preserved.

Specimens found at the surface of a limestone frequently are in part or wholly silicified, in which case the structures finer than latilaminae are largely or totally destroyed. It is not widely understood that calcareous fossils are silicified during the last stages of weathering and destruction of the limestone containing them. At the Falls of the Ohio the upper sides of corals and stromatoporoids frequently have a thin crust of silica, produced by the running water, whereas the rest of the fossils are in their original calcareous condition. When a specimen is partly weathered, the outside may be silicified all the way round and the inside of the specimen be still more or less in its original condition, as for example, a specimen of *Cystostroma* from the Middle Ordovician of Frankfort, Kentucky, (299- 68, 69). It has been the plaint of Nicholson (1886, p. 31, pl. 2, figs. 1-5) and also that of Parks (1910, p. 8) that many of the specimens were so poorly preserved that the internal structures could not be made out with any satisfaction. The main reason for the poor preservation is that the fossils came from weathered rocks. In some places weathered specimens are all that are available. Black River stromatoporoids from the Mohawk Valley of New York have been in part recrystallized and in part silicified in the same specimen. In the buhrstone or silicified bed of the basal Jeffersonville limestone of Jennings County, Indiana, the calcareous matrix and galleries are replaced by silica, the fossils have been dissolved, and only the hollow molds of *Amphipora* and corals remain. In cases of incipient silicification there are small spheres of silica within the coenosteum, as well as at the surface, in which case the tissue may be destroyed at those places. Specimens with beekite or chalcedony rings at the surface show no original structure. In rare cases, as specimens from the Middle Devonian, one mile northwest of Hanover, Indiana, and from the Middle Devonian of Moreland, Kentucky, the specimens and infiltrated calcite have been totally silicified, but still the structure can be fairly well made out. Silicified specimens are mostly worthless for identification. Specimens in cores from oil wells are as well preserved as are corals, bryozoans, or any other fossil.

Specimens may have been replaced or "injected" by iron oxide, as some of those mentioned by Nicholson (1886, p. 217, pl. 3, figs. 1, 2). In the case of infiltrated and perfectly preserved specimens, the skeletal structures in thin section have a gray appearance; whereas the infiltrated calcite in the galleries and pores is nearly perfectly transparent. Specimens preserved in black limestone, such as the Black River limestone of New York, show dark material in the galleries, which dark appearance is due to carbonaceous material or hydrocarbons in the limestone and also in the galleries of the fossils. The material may have the appearance of clay or carbonaceous clay, but since clay is not soluble in water it could not have been infiltrated into the specimen and clay could get in only through fractures. In such cases the usual appearance is reversed, the galleries are dark and the laminae and pillars are light (Nicholson, 1886, pl. 2, figs. 4, 5).

In orogenic areas, such as the Appalachians, the Ardennes of Belgium, and the Kitakami Mountainland of Honshu, Japan, specimens have been infiltrated by calcium carbonate and later broken in the folding of the rocks, so that the specimens have veins filled with calcite, but on the whole the structure of the fossil can still be made out satisfactorily.

The general impression that the structures of the skeletons of stromatoporoids are obscure and difficult to decipher comes from studying specimens which were picked up from the soil or the weathered surface and are badly weathered, dolomitized, or silicified. It is notable that specimens obtained from glacial drift at Ann Arbor, Michigan (Parks, 1910, p. 10), may be well preserved. Even Devonian pebbles in Triassic conglomerate (Nicholson, 1892, p. 219, pl. 28, figs. 4-6) may contain well-preserved stromatoporoids.

In times past it was possible to collect stromatoporoids only from scattered exposures, or from stream valleys, as south of Richmond, Indiana, or from sea cliffs, as on Anticosti Island. At present it is possible to collect fresh specimens from the hundreds of quarries, railroad cuts, and road cuts now available and made accessible by good roads and automobiles. There is, therefore, little excuse for describing new species from silicified or otherwise badly preserved specimens.

SYSTEMATIC POSITION OF STROMATOPOROIDEA

The biologic relationships of the Stromatoporoidea have been discussed by many authors, and they have been placed in many different groups. A good summary of the facts and arguments offered by proponents of the various theories has recently been given by Lecompte (1951, p. 27; 1956, p. F121). It is not intended in the present work to present an extensive discussion of the systematic position of the Stromatoporoidea, but a brief summary of ideas is in order.

There is considerable resemblance between the large, hemispherical, laminated masess of Paleozoic rocks, termed stromatolites (Cloud, 1942, p. 363), or calcareous algae, especially *Cryptozoon,* and the stromatoporoids. But the presence of definite laminae, pillars, galleries, cyst plates, or dissepiments, tabulae, mamelons, astrorhizae, and of fibrous, porous or dotted structures of the laminae, and the obviously more complex and more highly advanced structure of the stromatoporoids, is convincing evidence that the stromatoporoids are not algae, and the two are not in the same kingdom. The stromatoporoids do not have cellular structure as do *Solenopora, Girvanella, Lithothamnium,* and other calcareous algae.

An attempt was made by Hickson (1934, p. 433) to show that the Stromatoporoidea are Foraminifera, by comparing the stromatoporoid structure with that of the Recent "*Gypsina*" *plana* (Carter). In the first place, "*G.*" *plana,* which is an encrustation on corals, is not a *Gypsina,* whose type species is a small, globular form, *Gypsina vesicularis* (Parker and Jones), but is either a degenerate Foraminifera similar to *Acervulina,* or more probably, is a hydroid similar to *Hydractinia.* "*G.*" *plana,* if it is a foraminifer, is a degenerate form similar to *Acervulina* and *Carpenteria,* and derived from coarsely perforate Rotaliidae. One should scarcely expect degenerate, Recent organisms to have more than an accidental similarity with the large, but not degenerate, organisms from the lower Paleozoic. Secondly, there is no similarity between "*G.*" *plana* and any stromatoporoid, and a comparison of Hickson's own figures of "*G.*" *plana* with the best examples of real stromatoporoids that Hickson could choose, shows their entire dissimilarity. Thirdly, there is no similarity between either "*G.*" *plana* or the stromatoporoids to the minute Foraminifera in arrangement of chambers or in wall structure, either the hyaline, porcellaneous, or arenaceous groups. Fourthly, there are no intermediate or connecting forms between the lower Paleozoic Stromatoporoidea and any Foraminifera of the Paleozic, Mesozoic, or the Cenozoic. Fifthly, surely no one would try to show a relationship between the Stromatoporoidea of the lower Paleozoic and the characteristic Foraminifera of the upper Paleozoic, the Fusulinidae, nor with the Mesozoic and lower Cenozoic Nummulitidae and Orbitoididae. There is a similarity in the growth layers between *Pseudogypsina* Trauth, 1918 (Denkschr. k. Ak. Wiss. Wien, Math.-Naturw. cl., vol. 95, p. 244) from the Eocene of Austria and *Stromatopora*. *Pseudogypsina* is most likely a hydroid, and related to *Hydractinia,* and would lend itself as a small item of proof that stromatoporoids are hydroids.

Parks, (1935, p. 18) also made an unconvincing attempt to show that stromatoporoids are similar in tissue structure ("fiber") and vertical tabulate tubes "like those of the milleporoid Stromatoporoidea," to the Foraminifera. His arguments were based on hypotheses rather than on facts. A cursory comparison of the figures of both Hickson and Parks of "*G.*" *plana* and the supposedly similar stromatoporoids should be sufficient to demonstrate their dissimilarity. It surely cannot be admitted by anyone who is familiar with Foraminifera (Parks said, p. 19, "having little knowledge of Foraminifera") that there is any comparison between the minute, simple Foraminifera, known definitely only from the Silurian and later, and the massive, laminated bodies of the stromatoporoids of the Ordovician to the Devonian. Nor is the tissue structure of the Stromatoporoidea similar to the wall structure of the Foraminifera, either of the hyaline or porcellaneous or arenaceous or the alveolar (fusulinid), or siliceous (especially Silurian), walls of Foraminifera. The "basal chambers" of Parks (p. 28) are dissepiments, and are remnants of Ordovician ancestors, which were composed essentially of dissepiments. And it may be insisted that there is no essential structural similarity, either megascopic or microscopic, other than that both groups are animals, between the stromatoporoids and the groups of larger Foraminifera, the Fusulinidae, the Acervulinidae, the nummulites, or the orbitoids. Lecompte (1951, p. 31) has refuted Hickson's and Park's arguments and hypotheses effectively. The writer is familiar with Foraminifera, and sees no basis for confusing them with stromatoporoids.

The idea that stromatoporoids were sponges was entertained early in the study of the group (d'Orbigny, 1850; Rosen, 1869; Salter, 1873; Nicholson and Murie, 1878), but the thorough work of Carter (1877, 1878) in comparing stromatoporoids with calcareous Hydrozoa has convinced all workers excepting two (Parks and Twitchell), since that time that the Stromatoporoidea are Hydrozoa related to the Hydractiniidae and Milleporidae. Carter's statement (1877, p. 73), "All this chain of evidence seems to lead to the conclusion that the whole of these organisms, both recent and fossil, were species of Hydrozoa, and neither Foraminifera nor Sponges," is well stated. Carter was an important authority on Foraminifera, sponges and Hydrozoa, so that he could speak from personal knowledge of all three groups, and also of the Stromatoporoidea. Only Twitchell (1929, p. 270) made a serious effort to prove that the typical stromatoporoids are sponges. He insisted (p. 281) without sufficient knowledge that "sponges are the only modern forms of life that include foreign organisms in any way analogous to the inclusion of caunopore tubes in the stromatoporoids," admitting with nearly all students that the caunopore tubes were parasitic organisms. He found structures analogous to astrorhizae in the fresh-water sponge *Spongilla fragilis,* but as he admitted (p. 270) that analogy is not demonstration. Twitchell also considered many other analogies, also unconvincing. His identification of spicules in "*Stromatopora centrotum*" (pl. 25, figs. 1, 2) may be denied, as due to some accident of nature or of man. His specimen is probably not a stromatoporoid. The writer agrees with Lecompte (1951, p. 30) that he has seen no example of spicules in a stromatoporoid. The total absence of a spicular structure in the stromatoporoids, the absence of a vaselike shape, the absence of an osculum and canals through the body, and the presence of cystose and laminar structure, precludes them from being sponges. They may have evolved from the Cambrian aberrent sponges, the Archaeocyatha, as *e.g., Exocyathus* (Okulitch, 1943, p. 83, pls. 16, 17).

Many students of hydroids and of stromatoporoids have noted their essential similarity, particularly between the family Hydractiniidae and the family Actinostromatidae. The similarities between the lower and middle Paleozoic Stromatoporoidea and the Cenozoic and Recent Hydrozoa are not obvious, excepting in shape of coenostea, being constructed of layers, and lacking individual polyps or corallites. The similarities between the tissue of stromatoporoids and the hydroids is scarcely sufficient to divide the Stromatoporoidea into a "Hydractinoid" and a "Milleporoid" group (Nicholson, 1886, p. 74; Yavorsky, 1955, p. 7).

The writer agrees with Lindstrom, Carter, Zittel, Steinmann, Bargatzky, Nicholson, Waagen and Wentzel, Počta, Dehorne, Tripp, Kühn, Steiner, Ripper, Yabe and Sugiyama, Ozaki, Yavorsky, Le Maître, Lecompte, and most other students of stromatoporoids of the present century, that stromatoporoids are Hydrozoa.

The Paleozoic stromatoporoids are of the scale of organization of undoubted Hydrozoa, particularly the Hydractiniidae, the Milleporidae, the Milleporidiidae, and the Stromatoporinidae, the Disjectoporidae and the order Sphaeractinoidea (Kühn, 1939, Bd. 2A).

The Stromatoporidae evolved into the Disjectoporidae of the upper Paleozoic, which in turn became the Sphaeractinoidea of the Mesozoic. The Sphaeractinoidea evolved into the Hydrozoa of the Cenozoic and Recent.

It is noteworthy that the Stromatoporoidea do not form a coenosteum in which all the structures form a typical shape or individual or "person", as is true of most sponges, including the Archaeocyatha, and the hydroid families Stylasteridae and the suborder Thectata. The nearest approach to a form which might be called a "person" is represented by *Cryptophragmus, Aulacera,* and the genera of the Idiostromatidae, among the Stromatoporoidea. Nor can a coenosteum of a stromatoporoid be considered a colony of separate individuals, as is true of a coral corallum. The soft parts of the animals are of course unknown, but the soft structures must have been confluent, including the astrorhizae.

It would seem that the soft parts were largely undifferentiated soft tissue, which occupied the surface only of the coenosteum, built pillars on the hard stratum, built another stratum and abandoned the galleries and cysts below the surface. The entire coenosteum, with the soft parts, mostly confined to the upper surface, constituted a single, living creature, although there surely were individual soft polyps of unknown form (Carter, 1878, p. 304). The forms which had astrorhizae manifestly had some special living structure in the astrorhizae, perhaps reproductive polyps, or even medusae. Astrorhizae occur in the order Sphaeractinoidea (including the family Stromatoporinidae), descendants of the order Stromatoporoidea, and Carter figured (1878a, pl. 17, figs. 2, 6, 8, 10) astrorhizae in Recent *Hydractinia* and *Millepora.*

The placing of the Stromatoporoidea in the class Hydrozoa rests upon the following considerations: (1) The Stromatoporoidea are higher in organization than are Foraminifera or other Protozoa, more complex in structure, larger in size and wholly unlike any Paleozoic or later Foraminifera in tissue structure, skeletal structure, as well as gigantic size. (2) They lack the spicular structure and vaselike shape of Porifera and had no canals through the body, as do Porifera, and the skeleton was never siliceous nor chitinous, as are many sponges. (3) The scale of organization is similar to that of the Archaeocyatha, differing in the vaselike shape and lacking pores through the walls or skeleton, and lacking septa (parieties). (4) Stromatoporoidea are similar to hydroids, particularly the family Hydractiniidae of the order Hydroidea, in skeletal composition (calcium carbonate), attached form of life, general shape and size, habitat (shallow, warm, marine water), laminar and latilaminar structure, pillars, mamelons, and astrorhizae. (5) Stromatoporoids do not form corallites or living chambers, nor have septa, as do the Anthozoa; they are, therefore, lower in organization than typical corals. The dissepiments of the Rugosa occur inside the corallites and are convex inward, as noted by Billings (1865, p. 405), whereas the cysts of the stromatoporoids are convex outward. (6) The wall structure of the Labechiidae (thin, dense median layer, thin outer flocculent layer and thick inner flocculent layer) is the same as that of *Paleoalveolites,* a coral, indicating relationship between stromatoporoids and early corals. (7) The presence of typical astrorhizae in the lower Paleozoic order Stromatoporoidea, the late Paleozoic and Mesozoic order Sphaeractinoidea (including the Stromatoporinidae and Disjectoporidae) and the Recent order Hydroidea, indicates definite relationship, but not identity, between the three orders. (8) The gradation in structure from Stromatoporoidea to the Sphaeractinoidea, including especially the faimily Stromatoporinidae of the Mesozoic, and on into the Cenozoic and Recent Hydrozoa, is nearly complete, and convincing that Stromatoporoidea are Hydrozoa. (9) Lecompte (1956, p. F122) noted that stromatoporoids are latilaminate as is common in coelenterates, a feature unknown in Foraminifera and sponges.

Fossils in the class Hydrozoa include: (1) the order Stromatoporoidea, skeleton calcareous, composed of arcuate plates, laminae, pillars and having astrorhizae; Ordovician to Devonian; (2) the order Sphaeractinoidea, skeleton calcareous, composed of concentric and radial trabeculae and having astrorhizae; Permian to Cretaceous; and (3) the order Hydroidea, skeleton calcareous, matlike (*Hydractinia*) or upright (*Millepora, Stylaster*), some with astrorhizae; Cretaceous to Recent.

PART 2. SYSTEMATIC DESCRIPTIONS

ORDER, FAMILIES, AND GENERA OF STROMATOPOROIDEA

Phylum **COELENTERATA**

Class **HYDROZOA** Owen, 1843

Order **STROMATOPOROIDEA** Nicholson and Murie, 1878

Section *Stromatoporoidea* Nicholson and Murie, 1878, Jour. Linn. Soc., Zool., vol. 14, p. 241.
Order *Stromatoporoidea* Nicholson, 1886, Palaeont. Soc., vol. 39, p. 73; Kühn, 1939, in Schindewolf, Handbuch Paläozoologie, p. A36; Lecompte, 1956, in Moore, Treatise Invert. Paleont., Part F, p. F107.

Coenosteum originally calcareous and secreted as a skeleton by the animal; laminar, massive, cylindrical or dendroid, some with basal peritheca, usually latilaminate. Coenosteum composed of outwardly curved plates arranged in strata, or of thin or thick laminae, or rarely of cavernous tissue, usually with vertical or radial, short or long pillars, with or without vertical, superposed galleries. Skeletal tissue compact or minutely vesicular, maculate or tubulate, without spicules and not composed of trabeculae. The horizontal and vertical structures are discrete or amalgamated. Astrorhizae present or absent. Some with symbiotic, tubular organisms.

Occur in shallow, warm water, marine limestones, less commonly in shales, with corals and other marine organisms, frequently making bioherms and biostromes.

Ordovician, Silurian, and Devonian, not definitely known from the Mississippian; upper Paleozoic and Mesozoic forms belong in the order Sphaeractinoidea. Forms reported from the Cambrian of Siberia by Obrutschew (1926, p. 86 *et seq.*) are not described and may be stromatolites; those reported by Yavorsky (1932, p. 613) from the Cambrian of western Siberia, seem to belong to a Devonian form, and to a Jurassic genus which is not a stromatoporoid.

The writer agrees with Lindstrom (1876, p. 4), Carter (1887, p. 44), Nicholson (1886, p. 72), Kühn (1928, p. 25; 1939, p. A36), Lecompte (1951, p. 67; 1956, p. F121), Yavorsky (1955, p. 17) and other authors of the past and present that the Stromatoporoidea constitute an order of the class Hydrozoa. It is the unfortunate custom for each successive student of groups of fossils to divide the known group into more and more divisions and, at the same time, to raise the group into higher and higher taxonomic grades. The Stromatoporoidea, with their modest number of 35 genera, range from the Middle Ordovician to late Devonian, come within the systematic value of an order and are coordinate with the order Sphaeractinoidea and order Hydroidea in the class Hydrozoa.

Recently Shrock and Twenhofel (1953, p. 111) recognized Kühn's 1939 classification, but raised the Stromatoropoidea to a class and recognized the order Stromatoporoidea, the order Labechioidea, and included the Permian and Mesozoic Sphaeractinoidea as an order.

Kühn (1927, p. 546; 1939, p. A50) recognized the order Labechioidea and included in it the families Labechiidae, Idiostromatidae, and Aulaceratidae. The writer does not consider that the Labechiidae are of any greater systematic importance than a family, because it includes no more than 11 genera, and the coenostea are composed of cysts only slightly more primitive than those of the similar *Clathrodictyon* and *Actinodictyon*. Furthermore, as stressed above, cysts or interlaminar plates occur in most of the genera of typical stromatoporoids. There is little reason for including the Idiostromatidae in the Labechiidae, as was done by Kühn (1939, p. A52), for the Idiostromatidae have a delicate, ramose shape, and the skeleton does not consist of cysts and pillars. Furthermore, it is more simple and convenient to include the labechioides under the name stromatoporoids, rather than using two ordinal names for organisms naturally included under one name, Stromatoporoidea. The family Labechiidae is placed first because it comes first in time, and is the most primitive in structure.

Recently Lecompte (1956, p. F126) made a new classification of 11 faimilies, combining 36 Lower and Middle Paleozoic genera, the real Stromatoporoidea, with four Permian and 22 Mesozoic genera, which belong in the order Sphaeractinoidea. The later genera are included in families with older genera, the earliest families come last. Such a classification is unnatural, for it takes no account of development of structures and combinations of structure in geologic time. Such diverse forms as *Syringostroma* (form massive, tissue maculate, Silurian—Devonian), *Idiostroma* (form ramose, tissue compact, Devonian), *Syringostromina*, (form massive, tissue fibrous, Upper Jura) and *Trupetostroma* (massive, tissue compact, Devonian), are placed in the same family on the basis of continuous pillars, and "skeletal elements with dark axis", which later statement may be challenged. Lecompte's classification is unworkable. It is as incongruous to intersperse the Mesozoic genera in the families of Lower and Middle Paleozoic Stromatoporoidea as it would be to distribute the Mesozoic hexaseptate corals in the tetraseptate families of the Lower and Middle Paleozoic corals.

The writer has recognized the four families which Nicholson used (1886, p. 74), and has recognized the family Clathrodictyidae of Kühn (1939, p. 338; 1939, p. A42). The five families are natural families and permit showing the relationships of all the genera and the five families in a phylogenetic diagram. The writer's understanding of the finer tissue structure and the importance of tissue variations does not coincide with that of Lecompte but is in agreement with that of Nicholson. The placement of *Clathrocoilona, Synthetostroma,* and *Actinodictyon* is uncertain; those genera resemble *Anostylostroma* excepting in having maculate tissue.

It would be possible to erect two superfamilies of the Stromatoporoidea, one for families with tissue not maculate, and another for families with maculate tissue. It would also be possible to erect three subfamilies in the Labechiidae, for genera without pillars, with short pillars, and those with long pillars. Also, two subfamilies could be erected in the Stromatoporidae, for genera with long pillars and those with short pillars or none; and also two subfamilies for forms with short and long pillars in the Idiostromatidae. Erection of superfamilies and subfamilies would only add to the complications and difficulties in understanding the stromatoporoids but would add nothing to our knowledge of the group. Five families are enough for a small group of 35 genera.

DIAGNOSTIC CHARACTERS OF FAMILIES AND GENERA OF STROMATOPOROIDEA

Family 1. **LABECHIIDAE**

Tissue compact and flocculent; skeleton composed of overlapping, convex plates, without or with pillars; coenosteum laminar, massive or columnar.

CYSTOSTROMA, n. gen. Coenosteum massive; cysts arcuate; pillars absent.

AULACERA. Coenosteum columnar; cysts small; pillars absent in young, long, round in adult.

ROSENELLA. Coenosteum massive; curved plates broad; denticles short, conical, round.

PSEUDOSTYLODICTYON. Coenosteum massive; curved plates broad, crinkled; pillars absent.

SINODICTYON. Coenosteum columnar; axis not tubular; denticles short, conical, round.

CRYPTOPHRAGMUS. Coenosteum a column of hemispherical cysts, with short villi; outer sheaths absent; if present, some foreign organism.

LABECHIA. Coenosteum massive; cysts arcuate; pillars long, round, large.

LABECHIELLA. Coenosteum massive; cysts in young, laminae in adult; pillars long, round.

PSEUDOLABECHIA. Coenosteum massive; cysts in young, laminae in adult; pillars long, round.

DERMATOSTROMA. Coenosteum a thin encrustration of laminae and pillars.

STROMATOCERIUM. Coenosteum massive; cysts broad and low; pillars long, broad.

Family 2. CLATHRODICTYIDAE

Tissue compact, fibrous or porous, not maculate; cysts side by side, or with laminae; pillars short; coenostea laminar or massive.

CLATHRODICTYON. Skeleton composed of layers of cysts, not of regular laminae and pillars.

ANOSTYLOSTROMA. Laminae regular; pillars separate from laminae, spreading upward.

ATELODICTYON. Pillars with radial processes; tangential section areolate.

STICTOSTROMA. Tissue transversely porous; ring pillars absent or incipient.

STROMATOPORELLA. Tissue transversely porous; many ring-pillars.

Family 3. ACTINOSTROMATIDAE

Tissue compact; fibrous or porous; laminae regular; pillars long, or regularly superposed.

ACTINOSTROMA. Pillars continuous, with radial processes.

GERRONOSTROMA. Pillars superposed; laminae transversely porous, thick.

TRUPETOSTROMA. Pillars superposed; laminae with thin primary layer; secondary tissue with vacuoles.

LOPHIOSTROMA. Pillars large, superposed, with upturned laminae.

Family 4. **IDIOSTROMATIDAE**

Tissue compact, fibrous or porous, not maculate; coenosteum ramose, mostly with axial tube.

CLAVIDICTYON. Coenosteum caespitose, without axial tube or column; pillars short, round and vermiculate.

PARAMPHIPORA. Like *Amphipora* but tissue without dark, median line.

AMPHIPORA. Coenosteum small stems, with laminae and diverging pillars; tissue transversely fibrous, pillars with dark median line.

DENDROSTROMA. Laminae thickened; pillars confined to one interlaminar space.

IDIOSTROMA. Laminae thickened; pillars continuous, tissue compact, vacuolate.

STACHYODES. Tissue nearly filling interlaminar spaces; laminae transversely tubulate.

Family 5. **STROMATOPORIDAE**

Tissue maculate; laminae and pillars fused; coenosteum laminar to massive.

FERESTROMATOPORA. Like *Stromatopora*, but pseudozooidal tubes absent, and pillars confined to an interlaminar space.

STROMATOPORA. Interlaminar spaces largely filled with maculate tissue, leaving small galleries and long thin pseudozooidal tubes, but no definite pillars.

TALEASTROMA. Like *Stromatopora*, but with small, round, long, compact pillars.

SYRINGOSTROMA. Pillars large, long and short; composed of maculate tissue; galleries small; like *Stromatopora* except for the long pillars.

PARALLELOPORA. Pillars large, long, with vertical tubules and rods; maculae coarse.

HERMATOSTROMA. Pillars large, continuous, with outer light zones.
CLATHROCOILONA. Pillars short; laminae of three layers.
SYNTHETOSTROMA. Pillars superposed; laminae thick, of microlaminae.
ACTINODICTYON. Skeleton made of curved cysts, sphaerical cysts, and long and short pillars, and variable laminae with pores, foramina and vacuoles, and maculae.

KEY TO FAMILIES OF STROMATOPOROIDEA

1a. Tissue compact, fibrous, tubulose or flocculate, not maculate
- 2a. Skeleton composed mostly of overlapping, curved plates .... 1. LABECHIIDAE
- 2b. Skeleton composed of laminae and pillars
  - 3a. Coenosteum massive, tuberose or laminar
    - 4a. Pillars short, confined between two laminae .... 2. CLATHRODICTYIDAE
    - 4b. Pillars continuous or definitely superposed .... 3. ACTINOSTROMATIDAE
  - 3b. Coenosteum ramose, mostly with axial tube .... 4. IDIOSTROMATIDAE

1b. Tissue maculate; pillars long, short or absent .... 5. STROMATOPORIDAE

Family 1. **LABECHIIDAE** Nicholson, 1879

Family Labechiidae Nicholson, 1879, "Tabulate Corals of the Palaeozoic Period," pp. 28, 330.
Family Beatriceidae Ulrich, in Bassler, 1915, U. S. Nat. Mus., Bull. 92, p. 1409.
Family Aulaceratidea Kühn, 1927, Centralblatt Min., Geol. Paläont., Abt. B, p. 548; 1928, Fossilium Catalogus, Hydrozoa, p. 37; 1939, in Schindewolf, Handbuch Paläozoologie, Band 2A, p. A53.
Family Beatricidae Raymond, 1931, Bull. Mus. Comp. Zool., Harvard, Geol. Ser., vol. 9, p. 184.

Coenosteum laminar, massive, conical, columnar or fasciculate, without or with axial, cystose column. Skeleton composed of small or large curved, imbricating plates, forming latilaminae but rarely forming continuous microlaminae. Pillars strong, long, round or irregular, primitive or absent. Tissue of primary plates compact, usually with inner and outer flocculent layers. Primitive astrorhizae may occur.

Middle and Upper Ordovician abundant, Silurian uncommon, Devonian rare.

KEY TO GENERA OF LABECHIIDAE

1a. Pillars absent in all parts of the coenosteum
  2a. Cysts small, arcuate
    3a. Coenosteum massive, without axial column or pillars .... CYSTOSTROMA
    3b. Coenosteum columnar, with axial column of cysts, (immature) .... AULACERA
  2b. Cysts broad, flat .... PSEUDOSTYLODICTYON
1b. Pillars represented by denticles
  2c. Coenosteum laminar or massive
    3c. Denticles conical, on the cyst plates .... ROSENELLA
    3d. Denticles absent, simulated by crenulations of the plates .... PSEUDOSTYLODICTYON
  2d. Coenosteum columnar
    3e. Axial column not tubular; sheaths like *Rosenella* .... SINODICTYON
    3f. Axial column a tabulate tube; sheaths absent or with an attached organism .... CRYPTOPHRAGMUS
1c. Pillars continuous through several layers of cysts
  2e. Pillars round in tangential section
    3g. Coenosteum columnar; pillars only in mature stage .... AULACERA
    3h. Coenosteum massive
      4a. Pillars not in groups
        5a. Cysts arched, imbricating .... LABECHIA
        5b. Cysts convex and concave, edge to edge, making layers .... LABECHIELLA
      4b. Pillars in groups, diverging .... PSEUDOLABECHIA
    3i. Coenosteum a thin encrustation .... DERMATOSTROMA
  2f. Pillars broad, flanged in tangential section; cysts wide, low, simulating laminae .... STROMATOCERIUM

Genus **CYSTOSTROMA** Galloway and St. Jean, new genus
Pl. 31, fig. 1; Pl. 32, figs. 1, 2; Pl. 36, fig. 3

Type species, *Cystostroma vermontense* Galloway and St. Jean, n. sp. (Middle Ordovician, middle Chazy, 1 mile southeast of Isle La Motte village, Vermont)

Coenosteum massive, latilaminate, consisting of small, thin, convex, overlapping, unequal plates. Median cyst plate thin, dark, compact, with thin, outer flocculent plate and thick, inner flocculent layers; the lower plate may be composed of clusters of flocculent tissue, and between the clusters there may be pores which pass through all three plates. Pillars absent; surface smooth or with small or large mamelons and primitive astrorhizae.

Middle and Upper Ordovician, middle Chazyan, Isle La Motte, Vermont; Carters limestone, Tennessee; Richmondian, Haileybury, Ontario.

This genus embraces the simplest, oldest, and most primitive stromatoporoids, with skeleton composed only of arcuate cysts. It lacks the axial column of *Aulacera, Cryptophragmus,* and *Sinodictyon,* and lacks the pillars of *Labechia* and of the mature stage of *Aulacera.* It lacks the denticles of *Rosenella* and has smaller, more regularly imbricating cysts.

Cystostroma vermontense Galloway and St. Jean, n. sp.
Pl. 31, fig. 1; Pl. 32, fig. 1; Pl. 36, fig. 3

Coenosteum massive; surface smooth. Skeleton composed of imbricating, variable cyst plates, which have a thin, compact median layer and thicker lower and upper flocculent layers. Pillars, villi, mamelons and astrorhizae absent.

Middle Ordovician, middle Chazyan, one mile southeast of Isle La Motte village, Vermont. Holotype, Indiana University Paleo. Coll., No. KA2; slides 300-15, 16, 17, 18, 25, 26, 27.

Cystostroma simplex Galloway and St. Jean, n. sp. Pl. 32, fig. 2

Coenosteum massive; surface smooth. Skeleton composed of regularly imbricating, highly arched cyst plates, which have a thin, compact median layer and thicker, flocculent lower and upper layers; strong villi extend upward from the upper plate. Pillars, mamelons and astrorhizae absent.

Middle Ordovician, basal Trentonian, Carters limestone, at Mill Creek, seven miles south of Nashville, Tennessee. Holotype, part in the Vanderbilt University Paleo. Coll., and part in Indiana University Paleo. Coll.; slides 299-60, 61, 62.

Genus AULACERA Plummer, 1843
Pl. 31, fig. 2; Pl. 32, fig. 3; Pl. 37, figs. 1a-c

Type species (only species), *Aulacera plummeri,* n. sp. No species of *Aulacera* was named by Plummer, but the species was described, figured, and is recognizable, hence is the type species under Rules of Nomenclature, Opinion 46; "if only one species is involved, the generic description is equivalent to the publication of 'X-*us albus,* n. g., n. sp.' " (Upper Ordovician, late Richmondian, near Richmond, Indiana). Type of the species, Pl. 37, figs. 1a-c.

Aulacera Plummer, 1843, Amer. Jour. Sci., vol. 44, p. 293, fig. 1. The name is valid, under Rules of Nomenclature, Art. 2, and Opinion 46; a species is available as type species when it can be recognized from the original generic publication. Schuchert, 1919, Amer. Jour. Sci., vol. 47, p. 293, fig. 1; Kühn, 1928, Foss. Cat., Hydrozoa, p. 38; Ozaki, 1938, Jour. Shanghai Sci. Inst., ser. 2, vol. 2, p. 217; Kühn, 1939, in Schindewolf, Handbuch Paläozoologie, Bd. 2A, p. A53.

Beatricea Billings, 1857, Geol. Surv. Canada, Rep. Prog. for 1853-6, p. 343. (Type species, *B. nodulosa* Billings, selected by Miller, 1889, North Amer. Geol. Paleo., p. 155, late Ordovician, Anticosti Island); 1865, Canadian Nat., 2 ser., p. 405, figs. 1, 2; Nicholson, 1886, Palaeont. Soc., vol. 39, p. 86, pl. 8, figs. 1-8; Foerste, 1909, Bull. Sci. Lab. Denison Univ., vol. 14, p. 298; Parks, 1910, Univ. Toronto Studies, Geol. Ser., No. 7, p. 37; Yavorsky, 1955, Trudy Vsesoyuznogo Nauchno-issledovatelskogo Geol. Inst., Minister. Geol. i Ochrany Nedr, nov. ser., vol. 8, p. 69-80, pls. 32-42.

Coenosteum columnar, with axis usually made of large, hemispherical, upwardly curved cysts, usually simulating a tabulate tube; in some specimens the large cysts grade into the small, lateral cysts. Lateral skeleton latilaminate, composed of small, imbricating cyst plates. The cyst plates consist of a thin, dense, median layer, about 0.03 mm. thick, a thin, outer, flocculent layer, and a thick, inner, flocculent layer. Pillars absent or absent in the inner part of the lateral zones and with long, narrow, round pillars sporadically developed in the outer zone; pillars loose in texture, with outer more compact zone, but not hollow. Surface papillate, even or with mamelons or longitudinal ridges. Astrorhizae absent or rare. (Yavorsky, 1955, pp. 7, 70, said he showed in 1927 the presence of astrorhizae in *Beatricea.*)

Upper Ordovician, abundant in the Richmondian group, North America, China, and Russia. About 13 species.

The axial zone of cysts grading into the lateral zone cannot be a generic character, for several of the species have both tubular and gradational axes in the same specimen. *Aulacera* differs from *Cystostroma* in the columnar form and in having pillars in the outer zone of adult specimens. It differs from *Cryptophragmus* in having the outer zone of imbricating cysts. *Sinodictyon* is columnar with cystose axis, but there are strong denticles on axial and lateral cysts.

Aulacera plummeri Galloway and St. Jean, n. sp.
Pl. 31, fig. 2; Pl. 32, fig. 3; Pl. 37, figs. 1a-c

Coenosteum club-shaped, 10 to 90 cm. long, 2 to 11 cm. in diameter, enlarging upward; surface with round or sharp, spiral ridges. Axis 5 to 10 mm. in diameter, made of superposed, hemispherical plates. Lateral plates are low arches, six to ten in 2 mm. radially, two to four in 2 mm. vertically, arranged concentrically, not arranged radially even in the ridge; cysts with thin outer plate and thick flocculent inner plate largely filling the chambers. Pillars absent in young stages, small, round, radial, inclined upward in ephibic stage. Astrorhizae not seen.

Upper Ordovician, Richmond group, Indiana, Ohio, Kentucky, Ontario. Holotype, Saluda formation, four miles south of Richmond, Indiana. Indiana University Paleo. Coll., slides 285-46; 299-35, 36; 300-9.

Aulacera undulata (Billings) Pl. 37, fig. 2

Beatricea undulata Billings, 1857 (for 1853-1856), Geol. Surv. Canada Rept Prog., p. 344 (Upper Ordovician, Anticosti Island).

Type specimen.—Coenosteum subcylindrical, 20 cm. long and 5 cm. in diameter. Surface with sharp, discontinuous, slightly spiral ridges, 6 to 8 mm. apart. Axial column 6 to 7 mm. in diameter, with hemispherical tabulae. Lateral cysts large, 1 to 2.5 mm. in diameter, irregular cysts between ridges. Inner layer of cysts flocculent and moniliform. Pillars and astrorhizae unknown. The cysts differ from those of *A. plummeri* in size, shape, arrangement and structure. Large specimens may have pillars.

Upper Ordovician, Vaureal formation, Battery Cliff, Anticosti Island, Canada. Canadian Geological Survey, No. 2583, marked "type"; Indiana University Paleo. Coll., slides 299-88, 89, 90, 91.

Genus **ROSENELLA** Nicholson, 1886
Pl. 32, fig. 4

Type species (originally designated), *R. macrocystis* Nicholson, 1886, Palaeont. Soc., vol. 39, p. 84, pl. 7, figs. 12, 13 (Middle Silurian, Gotland); Nicholson, 1886, Ann. Mag. Nat. Hist., ser. 5, vol. 18, p. 19; Kühn, 1928, Foss. Cat., Hydrozoa, p. 46; Parks, 1907, Univ. Toronto Studies, Geol. Ser., No. 4, p 23; no. 5, 1908, p. 42; Gorsky, 1935, Trans. Arctic Inst., vol. 28, p. 94; Ozaki, 1938, Jour. Shanghai Sci. Inst., sec. 2, vol. 2, p. 215; Yavorsky, 1955, Trudy, Vsesoyuznogo Nauchno-issledovatelskogo Geol. Inst., Minister. Geol. i Ochrany Nedr, nov. ser., vol. 8, p. 67, pl. 30, Moscow.

Coenosteum laminar or massive, composed of large, upwardly convex or undulated plates, upon the surfaces of which are short, round, conical denticles. Tissue of primary plate compact, usually with lower and upper flocculent layers. Astrorhizae rare, obscure.

Middle Ordovician: China; North America. Middle Silurian: Europe; North America. Devonian ?: Novaya Zemlya. About eight species.

Pseudostylodictyon is much like *Rosenella* but lacks the denticles, and does have crinkled plates in places. *Sinodictyon* and *Ludictyon* are much like *Rosenella* excepting for the upright growth.

Genus **PSEUDOSTYLODICTYON** Ozaki, 1938
Pl. 32, figs. 5, 6

Type species (monotypic), *P. poshanense* Ozaki, 1938, Jour. Shanghai Sci. Inst., ser. 2, vol. 2, p. 208, pl. 24, fig. 2; pl. 25, figs. 1a-e (Middle Ordovician, Shantung).

Rosenella (part) Ozaki, 1938, Jour. Shanghai Sci. Inst., ser. 2, vol. 2, p. 215, pl. 32, fig. 1 (Middle Ordovician, Shantung).

Coenosteum thick laminar or massive, composed of large, convex or undulated plates, approximating laminae, with occasional small, arcuate cysts; pillars absent. There are small crenulations of the primary plate. Median layer thin, compact, with thick lower, and thin upper flocculent layers. Astrorhizae unknown.

Middle Ordovician: China; Vermont; three species. Silurian doubtful.

Pseudostylodictyon apparently differs from *Rosenella* in lacking denticles but there are crenulations of the primary wall. *Rosenella ?* sp. nov. Ozaki (1938, p. 216, pl. 31, fig. 2; pl. 32, figs. 1a-c) is a species of *Pseudostylodictyon*. The differences between the two genera are small. The name *Pseudostylodictyon* is unfortunate, for there is no structural similarity with *Stylodictyon*, nor family relationship. Any genus may have species with columns and other species without columns.

Pseudostylodictyon poshanensis Ozaki Pl. 32, fig. 5

Coenosteum attached, thick laminar, composed of large and small, thin cyst plates, with sharp crenulations but no pillars, with strong columns.

Pseudostylodictyon kayi Galloway and St. Jean, n. sp. Pl. 32, fig. 6

Coenosteum massive, with mamelons but no definite columns, composed of large, thick cyst plates, with sharp crenulations, but no pillars; lower plate of cysts thick and flocculent. Astrorhizae absent.

Middle Ordovician, middle Chazyan, one mile southeast of Isle La Motte village, Vermont. Collected by Dr. Marshall Kay. Indiana University Paleo. Coll., slides 300-21, 22, 23, 24.

Genus SINODICTYON Yabe and Sugiyama, 1930
Pl. 32, fig. 7

Type species (originally designated), *Sinodictyon columnare* Yabe and Sugiyama, 1930, Sci. Rep. Tôkoku Imp. Univ., Sendai, ser. 2, vol. 14, p. 52, pl. 18, figs. 7-10; pl. 19, figs. 2-5; pl. 20, figs. 1-4 (Middle Ordovician south Manchuria); Ozaki, 1938, Jour. Shanghai Sci. Inst., ser. 2, vol. 2, p. 218.

Ludictyon Ozaki, 1938, Jour. Shanghai Sci. Inst., ser. 2, vol. 2, p. 219 (Middle Ordovician, Shantung).

Coenosteum columnar and fasciculate, consisting of large axial zones and outer concentric zones. The axial zone has large, convex tabulae of variable size, on the upper sides of which are denticles. The outer zone is made up of low, convex cysts, partly imbricating and partly side by side, simulating laminae; strong, pointed denticles extend upward from the cysts; there are some continuous pillars; tissue compact and flocculent; astrorhizae unknown.

Middle Ordovician: Manchuria and Shantung, China. Two species.

The axial zone of *Sinodictyon* is not tubular but grades into the lateral zones, as is true of some species of *Aulacera*, but *Aulacera* is never fasciculate. *Ludictyon* seems to be the same as *Sinodictyon*, supposedly distinguished by large and small cysts.

Genus **CRYPTOPHRAGMUS** Raymond, 1914
Pl. 32, fig. 8

Type species (originally designated), *C. antiquatus* Raymond, 1914, Canada Dept. Mines, Geol. Surv. Mus., Bull. No. 5, p. 8, pls. 1-4, holotype, pl. 1, fig. 1. (Middle Ordovician, Pamelia limestone, Carden, Ontario); Bassler 1932, Tennessee Div. Geol., Bull. 38, p. 102, 214, pl. 16, fig. 9; 1935, Jour. Washington Acad. Sci., vol. 25, no. 9, p. 104; Shrock, 1937, Amer. Midland Natur., vol. 18, p. 536, pl. 2, figs. 1-3; Shimer and Shrock, 1944, Index Fossils North America, p. 63, pl. 19, figs. 6-8; Wilson, 1948, Canada Geol. Surv. Bull. 11, p. 46, pl. 25, figs. 3-5; Yavorsky, 1955, Trudy Vsesoyuznogo Nauchno-issledovatelskogo Geol. Inst. Minister. Geol. i Ochrany Nedr, nov. ser., vol. 8, p. 68, pls. 31, 32, 34 (doubtful).

Thamnobeatricea Raymond, 1931, Bull. Mus. Comp. Zool. Harvard, Geol. Ser., vol. 9, No. 6, p. 180, pl. 2, figs. 4-6 (Middle Ordovician, Bellefonte, Pennsylvania).

Cladophragmus Raymond, 1931, *ibid.*, p. 132, pl. 3, figs. 1-4. (Middle Ordovician, Ottawa, Ontario).

Rosenellina Radugin, 1936, Records of the Geology of the West Siberian Region, No. 35, p. 92, figs. 8, 9, 11.

Coenosteum upright, cylindrical or branching, 2 to 20 mm. in diameter and up to 46 cm. long, consisting of a tube, with thin, cystose wall about 1 mm. thick; the tube is crossed by large, superposed, highly arched tabulae or cysts. The cysts are composed of a primary, median, compact layer, and a thin inner and outer flocculent layer. Both inner and outer flocculent layers have irregular villi. Astrorhizae absent. The outer sheaths, when present, are attached organisms.

Middle and Upper Ordovician: Pamelia limestone, Aylmer, Quebec, Carden and Mechanicsville, Ontario, Clayton, New York; Lowville limestone, Pennsylvania, Virginia, Alabama, Kentucky, Kentland, Indiana, and Ontario; Lebanon and Cannon limestones, Tennessee; lower Trenton, Ottawa, Ontario; Auburn limestone, Lincoln County, Missouri. Six species: *C. antiquatus, C. parallelus,* *C. bifurcatus, C. arbusculus, C. gracilis* (Ulrich), and *C. gracilis* Yavorsky (homonym), and *C. ? rochensis*.

Most specimens consist of only the cystose column. In specimens from Carden, Ont., Loysburg, Pennsylvania, and Lee County, Virginia, the cystose columns are surrounded by calcite or by mud, which in turn may be covered by sheaths of organic tissue of indistinct structure; the sheaths may be composed of concentric laminae or cysts or both, and clear, radial tubes, much like an alga. In one specimen of *Cryptophragmus* from Carden, Ontario, the axial column is covered directly by a well-preserved bryozoan, *Monticulipora,* different in structure and preservation from the ordinary sheath organism. *C. gracilis* Yavorsky has an outer sheath of fine, close laminae, and radial pillars or pores, but no axial tabulae or cysts; it may be some other organism, as an alga.

There are small specimens in the Richmondian of the Cincinnati Arch (*C. gracilis* Ulrich), which have the structure of *Cryptophragmus,* but they may be young specimens of *Aulacera.* Some species of *Cryptophragmus* may be branched (*C. arbusculus*), as are *Thamnobeatricea* and *Cladophragmus.*

Genus **ROSENELLINA** Radugin, 1936

Type species (monotypic), *R. wellenformis* Radugin, 1936, Records of the Geology of the West Siberian Region, No. 35, p. 92, pl. 2, figs. 8, 9, 11 (Lower Silurian (?), Gornaya Shoria, west Siberia).

Coenosteum cylindrical, curved, 4-6 mm. in diameter; wall tubular, 1-2 mm. thick; overgrown by an alga; axial tube about 4 mm. in diameter, crossed by hemispherical tabulae.

Age doubtfully Lower Silurian, but the fauna, *Archeozoon (?), Strephocetus, Receptaculites, Rosenella, Pseudolabechia, Coccoseris, Tetradium, Lyopora, Halysites, Columnaria,* and *Calapoecia,* have an Ordovician aspect.

This genus appears to be a typical species of *Cryptophragmus* which is elsewhere confined to the Ordovician.

Genus **LABECHIA** Edwards and Haime, 1851
Pl. 31, fig. 3; Pl. 32, fig. 9

Type species (monotypic), *Monticularia conferta* Lonsdale, 1839, in Murchison, Silurian System, p. 686, pl. 16, fig. 5 (Lower Silurian, Wenlock, England).

Labechia Milne-Edwards and Haime, 1851, Mon. Polyp. Foss. Terra. Paleo., p. 155, 279; Nicholson, 1879, "Tab. Corals Palaeo. Per.," p. 330, fig. 44; 1886, Palaeont. Soc., vol. 39, p. 81, fig. 13, A. B.; pl. 3, fig. 7-15; 1891, vol. 44, pl. 20, figs. 1-3; 1886, Ann. Mag. Hist., ser. 5, vol. 18, p. 11; Yavorsky, 1931, Bull. United Geol. and Prosp. Serv. U. S. S. R., vol. 50, fasc. 94, p. 1408 (Devonian age doubtful); Smith, 1932, Summ. Prog. Geol. Surv. Great Britain, for 1931, pt. 2, p. 23 (Visean, doubtfully a stromatoporoid); Ozaki, 1938, Jour. Shangai Sci. Inst., sec. 2, vol. 2, p. 211; Kühn, 1939, in Schindewolf, Handbuch Paläozoologie, Band 2A, p. A50; Yavorsky, 1955, Trudy Vsesoyuznogo Nauchno-issledovatelskogo Geol. Inst., Minister. Geol. i Ochrany Nedr, nov. ser., vol. 8, pp. 58-65, pls. 24-25, 41.

Coenosteum laminar, encrusting or massive, possibly subcylindrical, consisting of outwardly convex cyst plates, and large, round, long pillars. Pillars with light centers, not hollow. Tissue of primary plates compact, with inner and outer flocculent layers. Surface papillate. Astrorhizae absent or not typically developed.

Upper Ordovician and Lower Silurian: Europe, Russia; China; North America. Upper Devonian ?: Russia. Mississippian; England, doubtful. About 13 species.

Labechia differ from *Stromatocerium* in being made entirely of short, convex plates and having large, round pillars instead of flat pillars; and from *Aulacera* in the large, round pillars in early as well as later parts of the coenosteum. Species with flat cysts and laminae and large, round pillars belong to *Labechiella*. (Yabe and Sugiyama, 1930; Ozaki, 1938; Sugiyama, 1939, 1940.)

The genus was named for Sir Henry de Labech; it is pronounced la-bāsh-i-ä.

Genus **LABECHIELLA** Yabe and Sugiyama, 1930
Pl. 32, fig. 10

Type species (originally designated), *Labechia scrotina* Nicholson, 1886, Palaeont. Soc., vol. 39, p. 45, fig. 4, A-C; 1891, vol. 44, p. 162, fig. 19, A-C (Middle Devonian, Devonshire).

Labechiella Yabe and Sugiyama, 1930, Sci. Rep. Tôhoku Imp. Univ., ser. 2, vol. 14, p. 54 subgenus of *Labechia;* Sugiyama, 1939, Yabe Jubilee Publ., vol. 1, p. 443; 1940, Sci. Rep. Tôhoku Imp. Univ., ser. 2, vol. 21, p. 111 (Silurian, Japan).

Actinostroma ? Ozaki, 1938, Jour. Shanghai Sci. Inst., ser. 2, vol. 2, p. 206, pl. 23, fig. 1; pl. 24, fig. 1 (Upper Ordovician, South Manchuria and Shantung)

Labechiellata Sugiyama (in error for *Labechiella*), 1941, Jour. Geol. Soc. Japan, vol. 48, p. 461, figs. 1-3 (Middle Ordovician, Tyosen, Korea).

Coenosteum massive, composed of thin, convex, concave and flat plates, arranged edge to edge, making laminae in places, and large, round or polygonal, continuous pillars. In the type species, the pillars have centers of darker and lighter, upwardly eccentric layers, giving a false appearance of being hollow; in tangential section, the pillars unite into chainlike groups but not in older species; tissue compact and flocculent; astrorhizae well developed or absent.

Middle and Upper Ordovician: northern China; Manchuria; Korea. Middle Ordovician; North America, three species; ? Silurian, Japan, one species; Middle Devonian, Devonshire, one species.

Sugiyama (1939, p. 443; 1940, p. 111) incorrectly claims credit for erecting the genus on the new species *Labechiella regularis*, from the Silurian of Japan. He included *Actinostroma ? mingshankouensis* Ozaki and an unnamed species (Ozaki, 1938, p. 206, 208) from the Ordovician of Manchuria and Shantung. *Labechiella* differs from *Labechia* in having continuous laminae in places rather than in being composed entirely of cystose plates; both have large, round pillars. The presence of astrorhizae is not a generic character, as Sugiyama thought. *Labechiellata* is an obvious *lapsis memoriae*, for Sugiyama, 1941, does not erect a new genus but refers to an old one, *Labechiella*, Sugiyama, 1939, a homonym of *Labechiella* Yabe and Sugiyama, 1930.

Genus **PSEUDOLABECHIA** Yabe and Sugiyama, 1930
Pl. 33, fig. 1

Type species (originally designated), *P. granulata* Yabe and Sugiyama, 1930, Sci. Rep. Tôhoku Imp. Univ., ser. 2, vol. 14, p. 59, pl. 22, figs. 5-12 (Middle Silurian, Gotland); Kühn, 1939, in Schindewolf, Handbuch Paläozoologie, Bd. 2A, p. A42; Yavorsky, 1955, Trudy Vsesoyuznogo, Nauchno-issledovatelskogo Geol. Inst., Minister. Geol. i Ochrany Nedr, nov. ser., vol. 8, p. 66, pl. 29, figs. 1-6; pl. 31, fig. 1.

Stromatocerium Endo, 1932, U. S. Nat. Mus., Bull. 164, p. 40 (Middle Ordovician, Manchuria).

Stylostroma Gorsky, 1938, Arctic Inst. Trans., vol. 101, p. 30. Type species (originally designated), *S. crassum* Gorsky, p. 32, pl. 2, figs. 1-9; pl. 3, figs. 1-7 ("age unknown", Novaya Zemlya).

Coenosteum laminar or massive, the surface with mamelons and tubercles; skeleton of delicate cyst plates, with delicate, short, vertical pillars, and strong continuous, diverging, round and plumose pillars, which are aggregated into groups of a score or more, making columns. The delicate and the strong pillars are united by three to six radial processes, much as in *Actinostroma;* tissue compact; astrorhizae absent or present.

Middle Ordovician: Manchuria; Russia. Silurian: Gotland. Age unknown, Novaya Zemlya. Seven species.

This genus differs from *Actinostroma* in the cyst plates and the groups of pillars. The authors ally the genus with *Labechia stylophora* Nicholson, and with *Actinostroma verrucosum* (Goldfuss), but the differences between *Actinostroma* and *Pseudolabechia* are of family rank. The genus is much like *Labechia,* as the name indicates, in the cyst plates and long pillars, but the groups of pillars distinguish the genus from *Labechia.* Gorsky's genus *Stylostroma* from Novaya Zemlya, seems to be typical *Pseudolabechia;* the columns of diverging pillars distinguish it from the *Labechia* with which it occurs.

Genus **DERMATOSTROMA** Parks, 1910
Pl. 33, fig. 2

Type species (originally designated), *Stromatopora papillata* James, 1878, The Paleontologist, No. 1, p. 1 (Upper Ordovician, Maysville group, Cincinnati, Ohio).

Dermatostroma Parks, 1910, Univ. Toronto Studies, Geol. Ser., No. 7, p. 29, pl. 23, figs. 8-10; Foerste, 1916, Bull. Sci. Lab., Denison Univ., vol. 18, p. 297, pl. 1, fig. 3.

Coenosteum laminar, encrusting foreign objects, 1-10 mm. thick and up to 10 cm. in diameter, consisting of several, irregular, undulating laminae, with oval chambers. Pillars large, conical, with lumina but not hollow, extending from epitheca to surface, and some short, small, solid pillars. Tangential sections show round pillars becoming polygonal at their base; tissue compact; surface papillate, without or with small monticules; astrorhizae unknown.

Ordovician, Black River to Richmond. North America. Six species.

The surface resembles that of *Labechia,* as do the strong pillars, but the skeleton is not definitely cystose. It is not a typical stromatoporoid. *D. corrugatum* (Foerste) and *D. glyptum* (Foerste) are composed of radially crystalline prisms and have no characteristics of stromatoporoids, nor of *Dermatostroma.*

Genus **STROMATOCERIUM** Hall, 1847
Pl. 33, figs. 3, 4

Type species (monotypic), *Stromatocerium rugosum* Hall, 1847, Pal. New York, vol. 1, p. 48, pl. 12, fig. 2 (Middle Ordovician, Black River group, Watertown, New York; Seely, 1904, Rept. State Geol. Vt., vol. 4, p. 144, pl. 70; pl. 74, fig. 5; Parks, 1910, Univ. Toronto Studies, Geol. Ser., No. 7, p. 8, pl. 21, figs. 3-7; Kühn, 1928, Fossilium Catalogus, Hydrozoa, p. 47; 1939, in Schindewolf, Handbuch Paläozoologie, p. A52, fig. 80; Galloway and St. Jean, 1955, Am. Novitates, No. 1728, pp. 1-11, figs. 1-7.

Labechia (part) Nicholson, 1891, Palaeont. Soc., vol. 39, p. 163, pl. 2, fig. 3-5.

Coenosteum hemispherical to discoidal, conspicuously latilaminate, composed of cystose plates, mostly broad and flat and edge to edge or overlapping at the ends, some short and arcuate. The cyst plates are composed of three layers, a median thin, dense layer, a thin, flocculent upper layer and a thin or thick, flocculent lower layer. Pillars long, continuous through many plates, flat, flaring and flocculent, but not hollow. In tangential section the pillars are angled and branching, zigzag, joined, curved or irregular, but not round. Surface smooth, undulating or strongly mamillate and papillate, with primitive astrorhizae.

Middle Ordovician, Black River and lower Trenton: United States and Canada, doubtfully in south Manchuria and Shantung. Four described and one or two new species.

Stromatocerium is the only genus in the Labechiidae in which the pillars are bladelike or irregular in shape, not round. It has been confused with *Labechia,* which has arcuate cyst plates and round pillars. The latilaminae give the impression that the fossil is composed of laminae, but the microlaminae are in reality broad, low cyst plates, and cyst plates edge to edge. The cyst plates and lack of laminae place the genus in the Labechiidae. *Stromatocerium* is in nowise suggestive of a honeycomb, as stated by Hall (he may have had in mind the associated *Columnaria*), and the contorted latilaminae are not constant, and are without generic or specific value in the genus.

Stromatocerium rugosum Hall — Pl. 33, fig. 3

Coenosteum massive; surface with low mamelons and primitive astrorhizae; cysts broad, low, strong, slightly overlapping; pillars large, broad, curved, with small flanges.

Middle Ordovician, Black River limestone, Watertown, New York. Holotype, American Museum of Natural History, No. 590/5, eight slides, 590/5A to H.

Stromatocerium amsterdamense Galloway and St. Jean, n. sp.
Pl. 33, fig. 4

Coenosteum massive; surface with low mamelons and primitive astrorhizae; cysts wide, low, thin, slightly overlapping; pillars small, flat, and irregular with numerous, small flanges.

Middle Ordovician, late Black River limestone, new lock just above Amsterdam, New York. Indiana University Paleo. Coll., slides 235-11, 12; 299-44, 45, 46, 47.

Family 2. **CLATHRODICTYIDAE*** Kühn, 1939

Family Clathrodictyonidae nov. fam., Kühn, 1939, Zentralbl. Miner., Abt. B, Geol., Palaeont., p. 338.

Familia Clathrodictyonidae Kühn, 1939, in Schindewolf, Handbuch Paläozoologie, Bd. 2A, p. A42.

Coenosteum laminar to massive, composed of cysts side by side in concentric layers, or of laminae, which are generally parallel, and short pillars. Galleries higher than the laminae are thick; foramina may occur between superposed galleries. Pillars normally present, confined between two laminae, but may be incidentally superposed. Tissue compact, fibrous or tubulose, especially the primary laminae, the secondary tissue on the laminae and pillars either compact, finely fibrous or tubulose or containing vacuoles, not maculate. Astrorhizae present or absent.

Ordovician and Silurian, one genus; Devonian abundant, most species with laminae and pillars. Post-Devonian absent.

KEY TO GENERA OF CLATHRODICTYIDAE

1a. Horizontal structures are cysts, in crumpled layers; pillars continuous with cysts plates .... CLATHRODICTYON

1b. Horizontal structures composed of regular laminae and separate pillars

*The plural of *dictyon* is *dictya,* the stem is *dicty,* hence the family name is Clathrodictyidae.

2a. Laminae transversely fibrous
  3a. Pillars without radial processes, but expanding upward, many dividing .... ANOSTYLOSTROMA
  3b. Pillars with radial processes .... ATELODICTYON
2b. Laminae transversely porous
  3c. Without ring-pillars, may have rare rings in tangential view .... STICTOSTROMA
  3d. With regular ring-pillars made of upturns of laminae .... STROMATOPORELLA

Genus **CLATHRODICTYON** Nicholson and Murie, 1878
Pl. 31, fig. 4; Pl. 33, fig. 5

Type species (originally designated), *C. vesiculosum* Nicholson and Murie, 1878, Jour. Linn. Soc. London, Zool., vol. 14, p. 220, pl. 2, figs. 11-13 (Middle Silurian, Yellow Springs, Ohio); Nicholson, 1886, Palaeont. Soc., vol. 39, p. 77; vol. 42, p. 147, pl. 17, figs. 10, 11; 1887, Ann. Mag. Nat. Hist., ser. 5, vol. 19, p. 1, pl. 1, figs. 1-3; Twenhofel, 1927, Canada Dept. Mines, Geol. Surv., Mem. 154, No. 135, p. 107; Ripper, 1937, Proc. Roy. Soc. Victoria, N. S., vol. 50, p. 1; Kühn, 1939, in Schindewolf, Handbuch Paläozoologie, Bd. 2A, p. A42; Lecompte, 1951, (part), Inst. Roy. Sci. Nat. Belgique, Mém. 116, p. 129; Yavorsky, 1955, Trudy Vsesoyuznogo Nauchno-issledovatelskogo Geol. Inst., Minister. Geol. i Ochrany Nedr, nov. ser., vol. 8, pp. 39-49, pls. 14-18

Coenosteum massive or laminar, usually without mamelons. Astrorhizae generally present. Skeleton not composed of regular laminae and definite pillars, but of imperfect cyst plates, which are placed side by side or end to end, rather than in an imbricating manner (as is true of the Labechiidae) forming vesicles, and having much the same appearance right side up or upside down. Plates typically thin, and galleries or vesicles oval, small, 8 to 20 in 2 mm. vertically. Pillars short, generally oblique, continuous with cyst plates, not superposed. The tops of the cysts atypically are in lines, like laminae, and the down-turned ends of the cyst serve as pillars. Dissepiments common; tissue compact or transversely fibrous.

Late Ordovician: Rare, Estonia and Anticosti Island. Silurian: Abundant, North America; Europe; Asia; Australia; Russia. Devonian: Rare, England, and Ohio. About 20 species and 20 doubtful species. The characteristic Silurian genus of stromatoporoid.

Forms with regular laminae, and pillars formed separately from the laminae which include most Devonian forms previously placed in *Clathrodictyon,* belong in *Anostylostroma.* The form from the Permian of Japan (Yabe and Sugiyama, 1933, p. 22) is not a stromatoporoid, certainly not a species of *Clathrodictyon.*

Genus **ANOSTYLOSTROMA** Parks, 1936

Pl. 31, fig. 5; Pl. 33, figs. 6, 7

Type species (originally designated), *A. hamiltonense* Parks, 1936, Univ. Toronto Studies, Geol. Ser., No. 39, p. 44 (Middle Devonian, Traverse group, Long Lake, Michigan).

Clathrodictyon (part) of authors, including forms with definite laminae and pillars. Yavorsky, 1955, pp. 40-58, pls. 19-23.

Stylodictyon Parks (not Nicholson and Murie, 1878), 1908, Univ. Toronto Studies, Geol. Ser., No. 5, p. 29, pl. 12. figs. 1, 2; Kühn, 1939, in Schindewolf, Handbuch Paläozoologie, Bd. 2A, p. A43, fig. 60; Shimer and Shrock, 1944, Index Fossils North America, p. 61, pl. 18, figs. 23, 24 (not Silurian, but Middle Devonian, Jeffersonville limestone).

Coenosteum flat to massive, composed of definite laminae and separate pillars. Laminae transversely fibrous or minutely porous, and containing small vacuities in typical species. Pillars in vertical section short, expanding, dividing and becoming vacuolate or Y-shaped at the top, or breaking into many secondary pillars, rarely superposed; pillars in tangential section round, elongate, vermicular, branching and confluent or ringlike. Galleries high, frequently with dissepiments; pillars transversely fibrous; skeleton without or with columns with uparched laminae and thicker pillars; astrorhizae present or absent.

Middle Devonian: North America; Europe; Asia; Africa; Australia. Fifty or more species. The most abundant Middle Devonian genus.

Anostylostroma includes forms with vacuoles in the heads of expanding pillars, as *A. hamiltonense* Parks, forms with pillars breaking into strands, as *A. substriatellum* (Nicholson), and forms with simple laminae and pillars, as *A. columnare* (Parks). *Anostylostroma* includes most Devonian and some Silurian species heretofore assigned to *Clathrodictyon,* those composed of laminae and short pillars rather than of cysts; it also includes Lecompte's "Groupe II" (1951, p. 133).

Genus **ATELODICTYON** Lecompte, 1951
Pl. 33, fig. 8

Type species (originally designated), *A. fallax* Lecompte, 1951, Inst. Roy. Nat. Belgique, Mém. 116, p. 124, pl. 15, figs. 1, 2 (Middle Devonian, Couvinian, Dinant Basin, Belgium).

Coenosteum laminar, discoidal or globular, some latilaminate; surface smooth or undulate; laminae definite, regular; cyst plates common; pillars short, confined to one interlaminar space, with intercalated, incomplete pillars, some superposed but not vertically continuous; in tangential section the pillars are round, with or without lumina, and joined in the laminae by radial processes, forming areolae and chainlike groups; tissue compact; astrorhizae well developed.

Middle Devonian: Belgium, and Indiana. Four species.

Atelodictyon differs from *Actinostroma* in lacking continuous pillars; from *Anostylostroma* by the radial processes.

Genus **STICTOSTROMA** Parks, 1936
Pl. 31, fig. 6; Pl. 33, fig. 9; Pl. 36, fig. 8

Type species (first species), *Stictostroma mamilliferum* Galloway and St. Jean, new name; *Stromatopora mammillata* Nicholson (not Schmidt, 1858), 1873, Ann. Mag. Nat. Hist., ser. 4, vol. 12, p. 94, pl. 4, fig. 4 (Middle Devonian, Port Colborne, Ontario); Nicholson, 1874, Rep. Pal. Prov. Ontario, p. 17, pl. 1, fig. 4; Nicholson and Murie, 1878, Jour. Linn. Soc., Zool., vol. 14, pl. 1, fig. 10; Galloway and St. Jean, 1957, Bull. Amer. Paleont., vol. 37, No. 162, p. 124, pl. 6, fig. 4.

Stictostroma Parks, 1936, Univ. Toronto Studies, Geol. Ser., No. 39, p. 78, pl. 14, figs. 3-6 (Onondaga formation, Ashton's quarry, Gorrie, Ontario).

Coenosteum a thin crust, cake-shaped or massive, composed of thin laminae, which in favorable sections shows a thin, transversely porous, light median layer, with thinner, darker, transversely fibrous and porous layers on each side; pillars short, spool-shaped, confined to one interlaminar space, rarely superposed; pillars in tangential sections mostly round, rarely hollow rings, but not well formed ring-pillars; galleries wider than the laminae, with a few dissepiments, rarely superposed with foramina between; surface smooth to mamillate; astrorhizae absent or present.

Middle Devonian, Onondaga and Hamilton groups, Ontario. Five species described S. *mamilliferum* G. & St. J., S. *problematicum* (Parks), *S. alpenense* (Parks), *S. elevatum* (Parks), and *S. kayi*

(Parks). The second group of Parks' original description of the genus, in which the tissue is fibrous and there are hollow ring-pillars, obviously cannot be included in the genus *Stictostroma,* and is removed to *Stromatoporella,* including *S. eriense* (Parks), *S. huronense* (Parks), and *S. insolitum* (Parks).

Stictostroma differs from *Stromatoporella* in lacking typical ring-pillars, but small rings may occur; it is much like *Anostylostroma,* but has more coarsely porous tissue, and is intermediate between the two genera. *Stromatopora mammillata* Nicholson is a homonym of *S. mammillata* Schmidt, 1858, and invalid, even if Schmidt's species is now considered to be a synonym of *Anostylostroma striatellum* (d'Orbigny), 1850.

Genus **STROMATOPORELLA** Nicholson, 1886
Pl. 31, figs. 7, 8; Pl. 33, fig. 10; Pl. 34, fig. 1; Pl. 36, fig. 6

Type species (originally designated), *Stromatopora granulata* Nicholson, 1873, Ann. Mag. Nat. Hist., ser. 4, vol. 12, p. 94, pl. 4, fig. 3.

Stromatoporella Nicholson, 1886, Palaeont. Soc., vol. 39, p. 92, pl. 1, figs. 4, 5, 15; pl. 4, fig. 6; pl. 7, figs. 5, 6; 1891, vol. 44, p. 202, pl. 26, fig. 1 (*S. granulata* restricted to the form from the Hamilton fm. of Arkona, Ontario); Parks, 1907, Univ. Toronto Studies Geol. Ser., No. 4, p. 29; 1936, No. 39, p. 90, pl. 16, figs. 1-7; Kühn, 1939, in Schindewolf, Handbuch Paläozoologie, Bd. 2A, p. A45; Yavorsky, 1943, Compte Rendu (Doklady) Acad. Sci. U. S. S. R., vol. 39, No. 9, p. 369; 1950, Problems of Paleontology, Leningrad State University, vol. 1, pp. 243-263, 7 pls.; 1955, Trudy Vsesoyuznogo Nauchno-issledovatelskogo Geol. Inst., Minister. Geol. i Ochrany Nedr, nov. ser., vol. 8, pp. 111-128, pls. 60-67, 89; Lecompte, 1951, Inst. Roy. Sci. Nat. Belgique, Mém. 116, p. 152.

Coenosteum laminar, massive or subramose, composed of laminae and wide interspaces, which are transversed by short pillars of three kinds, (1) small, round, (2) large, hollow, cylindrical or oval, pillars making thick-walled rings in tangential section, formed by sharp upturns of the laminae, and (3) irregular. Pillars not regularly superposed; dissepiments frequent; superposed galleries may be connected by large foramina; tissue coarsely to finely porous and fibrous transversely, typically but rarely with anastomosing tubules, not maculate; astrorhizae largely developed.

Silurian: Rare. Devonian: Abundant. Europe; North America; Asia; Australia. Carboniferous; Poland. About 55 species, plus 18 new species in Yavorsky's 1950 paper, and 19 new species in Yavorsky's 1955 paper.

Stromatoporella is similar to *Stictostroma* in vertical section, but differs in having abundant ring-pillars; from *Anostylostroma* in the more porous tissue and the ring-pillars. The ring-pillars made of upturned laminae are the diagnostic feature of the genus. *S. eriensis* (Parks) and *S. huronensis* (Parks) have porous tissue, but the pores are difficult to detect; they have prominent ring-pillars.

Family 3. **ACTINOSTROMATIDAE*** Nicholson, 1886

Family Actinostromidae Nicholson, 1886, Palaeont. Soc. London, vol. 39, p. 74.

Family Actinostromatidae Stechow, 1922, Archiv. Naturg., Abt. A, vol. 88, Heft 3, p. 151.

Coenosteum laminar or massive, rarely cylindrical, composed of definite laminae and continuous or superposed, strong pillars. The laminae are regular, irregular or irregularly cystose, with much secondary thickening tissue. Tissue compact, fibrous, porous or vacuolate, not maculate. Galleries usually superposed. Astrorhizae present or absent.

Silurian common. Devonian abundant.

KEY TO GENERA OF ACTINOSTROMATIDAE

1a. Pillars connected by radial processes ............................ACTINOSTROMA
1b. Pillars not connected by radial processes
  2a. Pillars throughout interlaminar spaces
    3a. Laminae transversely porous ............................GERRONOSTROMA
    3b. Laminae not transversely porous but compact
TRUPETOSTROMA
  2b. Pillars only in the mamelons ....................................LOPHIOSTROMA

Genus **ACTINOSTROMA** Nicholson, 1886

Pl. 31, fig. 9; Pl. 34, fig. 2

Type species (originally designated), *A. clathratum* Nicholson, 1886, Palaeont. Soc., vol. 39, p. 75, pl. 1, figs. 8-13; pl. 2, fig. 11; p. 131, pl. 12, figs. 1-5 (Middle Devonian, Gerolstein, Germany); Lecompte, 1951, Inst. Roy. Sci. Nat., Mém. 116, p. 67; Yavorsky, 1955, Trudy Vsesoyuznogo Nauchno-issledovatelskogo Geol. Inst., Minister. Geol. i Ochrany Nedr, nov. ser., vol. 8, pp. 17-34, pls. 1-10, 23.

Rosenia Waagen and Wentzel, 1887, Mem. Geol. Surv. India, Pal. Indica, ser. 13, vol. 1, p. 943, monotypic, *Stromatopora astroites* Rosen (Silurian, Oesel Island); Nicholson, 1889, Palaeont. Soc., vol. 42, p. 143, pl. 17, figs. 1-7.

* The plural of *stroma* is *stromata,* the stem is *stromat,* hence the name of the family is Actinostromatidae.

Actinostromella Boehnke, 1915, Palaeontographica, vol. 61, p. 162, type species(first species), *A. tubulata* Boehnke, *ibid.,* text figs. 6, 7. (Silurian boulders, north Germany). (Differs from *Actinostroma* only in having wall-less, tabulated tubes, probably astrorhizae).

Coenosteum massive, laminar to globular, some latilaminate, composed of strong laminae, and strong, continuous pillars; pillars with or without lumina, but not hollow, connected in the laminate with 3-6 adjoining pillars by radiating processes; tissue compact; surface tuberculate; astrorhizae generally present.

Silurian and Devonian: Europe; North America; Asia; Africa; Australia. Over 70 species. *Actinostroma trentonense* Ulrich and Everett (1890, Illinois State Geol. Surv., vol. 8, p. 282, pl. 7, fig. 3) is a sponge.

Genus **GERRONOSTROMA** Yavorsky, 1931
Pl. 31, fig. 10; Pl. 34, fig. 3

Type species (first species, here selected), *G. elegans* Yavorsky, 1931, Bull. United Geol. and Prosp. Service, U. S. S. R., vol. 50, fasc. 94, p. 1406, pl. 1, fig. 12; pl. 2, figs. 3-6 (Middle Devonian, Kuznetsk Basin, south of Bachat, Russia) ; Riabinin, 1941, U. S. S. R. Acad. Sci., Palaeont. Inst., vol. 1, p. 91, 108; Yavorsky, 1955, Trudy Vsesoyuznogo Nauchno-issledovatelskogo Geol. Inst. Minister Geol. i Ochrany Nedr, nov. ser., vol. 8, pp. 34-38 pls. 11, 12.

Coenosteum massive or nodular, with thick laminae and wide interlaminar spaces; pillars strong, spool-shaped between laminae, superposed through many interlaminar spaces, not composed of rods nor with lumina. In tangential section the pillars are round or coalescing, without radial processes. Laminar tissue transversely porous but not maculate; galleries superposed, frequently with dissepiments; astrorhizae present or absent.

Middle or Upper Devonian: Kuznetsk Basin, Urals, and Leningrad regions, Russia. Middle Devonian: Indiana. Twelve species.

Gerronostroma is similar to *Hermatostroma,* but the laminae and pillars are not bordered with clear tissue. It is much like *Trupetostroma,* but seems to differ in having thick, transversely porous laminae. A paratype of *G. elegans* sent by Yavorsky (Pl. 31; fig. 10) has laminae extending between short, superposed pillars, the laminae are transversely porous and the pillars are transversely fibrous; small vacuities are spaces left by secondary thickening and without generic significance.

Genus **TRUPETOSTROMA** Parks, 1936
Pl. 31, fig. 11; Pl. 34, fig. 4

Type species (originally designated), *T. warreni* Parks, 1936, Univ. Toronto Studies, Geol. Ser., No. 39, p. 52, pl. 10, figs. 1, 2 (Middle Devonian, Great Slave Lake, Canada); Lecompte, 1952, Inst. Roy. Sci. Nat., Belgique, Mém. 117, p. 219.

Coenosteum massive. Primary laminae typically thin, secondarily thickened on both sides, leaving a clear or dark middle line; pillars stronger than the laminae, round, regularly superposed, composed of secondary material, spreading on both sides of the microlaminae; galleries superposed; dissepiments rare to abundant; tissue compact, not maculate nor with tubular pores, and the thickenings have small, ovoid vacuoles; astrorhizae and mamelons strong to weak.

Middle and Upper Devonian: North America; Belgium. Five American and twelve Belgium species.

Trupetostroma is characterized by (1) the continuous microlaminae, (2) the superposed pillars and galleries, (3) the pillars and secondary thickening on the microlaminae, with oval vacuities. The type species almost lacks cyst plates but they are abundant in most species. *Trupetostroma* seems to differ from *Gerronostroma* in lacking pores in the laminae, and in the presence of vacuoles in the pillars and secondary tissue. The laminae, pillars and superposed galleries resemble *Parallelopora* but the tissue lacks the large maculae, tubules, and rods in the pillars. *Trupetostroma* might better be placed in synonomy with the older *Gerronostroma,* since there is no essential difference in the two genera which can be seen in figures enlarged 10 times.

Genus **LOPHIOSTROMA** Nicholson, 1891
Pl. 34, fig. 5

Type species (monotypic), *Lophiostroma schmidti* (Nicholson) = *Labechia ? schmidtii* Nicholson, 1886, Ann. Mag. Nat. Hist., ser. 5, vol. 18, p. 16, pl. 2, figs. 6-8 (Silurian, Oesel Island).

Lophiostroma Nicholson, 1891, Palaeont. Soc., vol. 44, p. 160, footnote; Kühn, 1928, Foss. Cat., Hydrozoa, p. 46, (part); Yabe and Sugiyama, 1930, Sci. Rept. Tôkohu Imp. Univ., Sendai, ser. 2, vol. 14, p. 57; ?Ozaki, 1938, Jour. Shanghai Sci. Inst., ser. 2, vol. 2, p. 214; Kühn, 1939, in Schindewolf, Handbuch Paläozoologie, Bd. 2A, p. A51.

Chalazodes Parks, 1908, Univ. Toronto Studies, Geol. Ser., No. 5, p. 33, pl. 9, fig. 7; pl. 11, figs. 1, 2, 7, 8 (type species, *C. granulatum* Parks, Middle Silurian, Drummond Island, Michigan).

Coenosteum laminar to massive, consisting of continuous laminae which are sharply inflected upward into small columns, without pillars between the columns. Tissue compact; surface strongly papillate; astrorhizae absent.

?Upper Ordovician: China. Silurian: Europe; North America. Six species.

Crystallization and silicification obscures the structure, as stated by Nicholson (1886b, p. 17), so that the genus is imperfectly understood.

Family 4. **IDIOSTROMATIDAE** Nicholson, 1886

Family Idiostromidae Nicholson, 1886, Palaeont. Soc., vol. 39, pp. 74, 98.

Familia Idiostromatidae Kühn, 1939, in Schindewolf, Handbuch Paläozoologie, p. A52.

Coenosteum cylindrical, dendroid or fasciculate, the erect branches usually with axial tube, which gives off branches, the superposed galleries or pseudozooidal tubes. Skeleton composed of thick laminae and irregular pillars, mostly short; skeletal tissue transversely fibrous or porous, not maculate; astrorhizae absent.

Silurian: Japan; and Russia. Devonian, widespread. Carboniferous improbable.

KEY TO GENERA OF IDIOSTROMATIDAE

1a. Coenosteum without axial tube .... CLAVIDICTYON
1b. Coenosteum with axial tube, or intermittent
  2a. Skeleton with large marginal vesicles
    3a. Tissue without dark median line .... PARAMPHIPORA
    3b. Tissue with dark median line .... AMPHIPORA
  2b. Skeleton without large marginal vesicles
    3c. Tissue not tubulate; galleries open
      4a. Pillars confined to one interlaminar space .... DENDROSTROMA
      4b. Pillars continuous or regularly superposed .... IDIOSTROMA
    3d. Tissue finely tubulate; galleries largely filled .... STACHYODES

Genus **CLAVIDICTYON** Sugiyama, 1939
Pl. 34, fig. 6

Type species (originally designated), *Clavidictyon columnare* Sugiyama, 1939, Yabe Jubilee Publ. vol. 1, p. 441, pl. 25, figs. 6-8; 1940, Sci. Rept. Tôhoku Imp. Univ., Sendai, ser. 2, vol. 21, p. 109, pl. 14, figs. 7-9; pl. 15, fig. 7; pl. 16, figs. 1, 2; pl. 29, fig. 4 (Middle Silurian, Kawauti Series, Hikoroitimura, Japan).

Amphipora Sugiyama (part), 1939, Yabe Jubilee Publ., vol. 1, p. 445; 1940, Sci. Rept. Tôhoku Imp. Univ., Sendai, ser. 2, vol. 21, p. 114.

Coenosteum consisting of small, isolated or fasciculated cylindrical columns, without axial tube, composed of thick, concentric laminae; in cross section the axis is broad and shows round and vermicular pillars; peripheral area concentric and clathrate. Pillars confined to one interlaminar space. Galleries rectangular, usually not superposed; tissue structure undescribed; astrorhizae and mamelons unknown.

Middle Silurian, Kitakami Mountainland, northeastern Honshu, Japan, and ? Niagaran of Gaspé, Quebec. *C. columnare* and *C. japonicum* seem to be the same species; *C. delicatulum* is unrecognizable.

Clavidictyon differs from other Idiostromatidae in the lack of an axial tube, although the axial tube is missing in some branches of other genera. *Clavidictyon* does not have the large peripheral vesicles of most species of *Amphipora* and *Paramphipora*, and the laminae tend to be parallel with the axis rather than transverse.

Genus **PARAMPHIPORA** Yavorsky, 1955
Pl. 37, fig. 3

Type species (first species, here selected), *P. mirabilis* Yavorsky, 1955, Trudy Vsesoyuznogo Nauchno-issledovatelskogo Geol. Inst., Minister. Geol. i Ochrany Nedr, nov. ser., vol. 8, p. 154, pl. 84, figs. 3, 4 (Upper Silurian, northeast slope of the Salair, Russia).

Coenosteum small, ramose, 3-7 mm. in diameter, with intermittent axial tube with curved tabulae, and large vesicles near the surface. Skeleton composed of vague, upward curved laminae and short, diverging pillars and large galleries; tissue amalgamated, transversely fibrous but without dark, median line (differing from *Amphipora*); surface smooth; astrorhizae absent.

Upper Silurian, eight species; Lower Devonian, one species; Middle Devonian, two species; Upper Devonian, one species. All in Russia. Not yet distinguished from other countries.

Paramphipora occurs with *Amphipora* and differs from it only in lacking the dark line in the tissue. It is scarcely possible to distinguish the two genera from figures, even the excellent figures of Yavorsky. Some species of *Paramphipora* have few large, marginal vesicles (*P. tschussovensis* Yavorsky, 1955, pl. 88). In *Clavidictyon* there are neither axial tube nor marginal vesicles, and the laminae tend to be parallel to the axis rather than nearly transverse, as in *Amphipora* and *Paramphipora.*

Genus **AMPHIPORA** Schulz, 1883
Pl. 31, fig. 13; Pl. 34, fig. 7

Type species (monotypic), *Caunopora ramosa* Phillips, 1841, Paleozoic Foss. Cornwall, p. 19, pl. 8, fig. 22 (Middle Devonian, South Devon, England).
Amphipora Schulz, 1883, Jahrb. Konigl. preuss. geol. Landesanstalt, for 1882, p. 245, pl. 22, figs. 5, 6; pl. 23, fig. 1; Nicholson, 1886, Palaeont. Soc., vol. 39, p. 109, pl. 9, figs. 1-4; 1892, vol. 46, p. 223, pl. 29, figs. 3-7; Felix, fig.; Yabe and Sugiyama, 1933, Japanese Jour. Geol. Geog., vol. 11, p. 19; fig.; Yabe and Sugiyama, 1933, Japanese Jour. Geol. Geol., vol. 11, p. 19; Ripper, 1937, Jour. Roy. Soc. Western Australia, vol. 23, p. 37; Kühn, 1939, in Schindewolf, Handbuch Paläozoologie, p. A54; Sugiyama, 1942, Jour. Geol. Soc. Japan, vol. 49, p. 112; Lecompte, 1952, Inst. Roy. Sci. Nat. Belgique, Mém. 117, p. 321; Yavorsky, 1955, Trudy Vsesoyuznogo Nauchno-issledovatelskogo Geol. Inst. Minister. Geol. i Ochrany Nedr, nov. ser., vol. 8, pp. 149-154, pls. 80-84.

Coenosteum consisting of slender, vermicular stems which may branch at long intervals, with large, variable, axial tube, and large vesicles near the surface. Both tube and vesicles may have irregular, curved tabulae; skeleton composed of anastomosing galleries and pillars; tissue transversely fibrous, with darker median line in the triple walls; surface tuberculate around the apertures; astrorhizae absent.

Upper Silurian: three species, Russia. Middle Devonian: England, Belgium, France, Germany, Moravia, Poland, Estonia, Italy, Yunnan, Russia, Turkestan, China, Australia, Indiana, Montana, California, Alberta. Upper Devonian: Russia, Belgium, Montana. Carboniferous: Urals. ? Permian: China, Japan. Ten species or more.

Amphipora resembles a tabulate coral; such as *Cladopora* (*Coenites*). Öpik, (1935, Ann. Natur. Soc. Tartu University, No.

41, p. 3) considered *Amphipora* to be calcareous sponge, but the lack of spicules, and lack of corallites and septa, ally the genus with the stromatoporoids. It is one of the most widespread forms of stromatoporoid, and a good index fossil of the Middle Devonian because of its abundance.

Genus **DENDROSTROMA** Lecompte, 1952
Pl. 34, fig. 8

Type species (originally designated), *Dendrostroma oculatum* (Nicholson); *Idiostroma oculatum* Nicholson, 1886, Palaeont. Soc., vol. 29, p. 101, figs. 14, 15; 1892, vol. 46, p. 225, pl. 29, figs. 10, 11; text figs. 32, 33 (Middle Devonian, Büchel, Germany).

Dendrostroma Lecompte, 1952, Inst. Roy. Sci. Nat. Belgique, Mém. 117, p. 320, pl. 61, fig. 1.

Idiostroma (part) Ripper, 1937, Proc. Roy. Soc. Victoria, N. S., vol. 49, pt. 2, p. 195; Kühn, 1939, in Schindewolf, Handbuch Paläozoologie, Bd. 2A, p. A53, fig. 81; Yavorsky, 1955, Trudy Vsesoyuznogo Nauchno-issledovatelskogo Geol. Inst. Minister. Geol. i Ochrany Nedr, nov. ser., vol. 8, p. 138, pls. 74, 75, 81, 83.

Stromatopora caespitosa Quenstedt, 1878, Petref. Deutschlands, Abt. 1, Bd. 5, Schwämme p. 584, pl. 152, fig. 14. (Pillars short.)

Coenosteum dendroid and cespitose, with irregular axial tube and thick, concentric laminae; pillars thick, short, confined to one interlaminar space, rarely superposed, vermiculate and confluent in tangential section; galleries oval to irregular in shape, with infrequent interlaminar septa, some superposed and with connecting foramina; tissue transversely porous and fibrous in both laminae and pillars; astrorhizae unknown.

Middle Devonian: Paffrath district, Germany; Russia; Michigan. Three species.

This genus differs from *Idiostroma* in the short pillars, rather than superposed pillars. The tissue is not maculate as that of *Stromatopora* nor as clearly transversely porous as that of *Stachyodes*. *Dendrostroma* appears to be identical with *Clavidictyon* Sugiyama, 1939, excepting for having an axial tube. Specimens from Kegomic quarry, Mud Lake, one mile northeast of Bay View, Michigan, lack a well-formed axial tube but do have elongate vacuoles in the coenosteal axis.

Genus **IDIOSTROMA** Winchell, 1867
Pl. 31, fig. 12; Pl. 34, fig. 9

Type species (first species, selected by Nicholson, 1886, p. 11), *Stromatopora caespitosa* Winchell, 1866, The Grand Traverse Region, Appendix, p. 91 (Middle Devonian, Traverse group, Petoskey formation, cliff, north edge Petoskey, Michigan).

Idiostroma Winchell, 1867, Proc. Amer. Assoc. Adv. Sci. p. 99; Nicholson, 1886, Palaeont. Soc., vol. 39, p. 10, 99, pl. 9, figs. 6-11; Grabau and Shimer, 1909, North America Index Fossils, vol. 1, p. 43; Grabau, 1910, Michigan Geol. Biol. Surv., Pub. 2, Geol. Ser. 1, p. 94; Kühn, (part) 1928, Foss. Cat., Hydrozoa, p. 40; 1939, in Schindewolf, Handbuch Paläozoologie, Bd. 2A, p. A52; Ripper, 1937, Proc. Roy. Soc. Victoria, N. S., vol. 49, pt. 2, p. 194; Lecompte, 1952, Inst. Roy. Sci. Nat. Belgique, Mém. 117, p. 311, pl. 66, figs. 3, 3a, 3b; Yavorsky, 1955, Trudy Vsesoyuznogo Nauchno-issledovatelskogo Geol. Inst., Minister. Geol. i Ochrany Nedr, nov. ser., vol. 8, p. 136, pl. 73.

Coenosteum dendritic or cespitose, the surface with confluent papillae and grooves; stems with irregular axial tube, with smaller branches; stems composed of thick, arching, concentric laminae, with thin primary layer, and long, thick, spool-shaped, superposed, radial pillars, round, irregular and confluent in tangential section; laminae and pillars fused, consisting of compact, vesicular tissue; galleries oval to irregular in shape, superposed, often appearing as long, thin, tabulate, pseudozooidal tubes; astrorhizae doubtful.

Middle Devonian: North America, Europe, Asia, and Australia. About 13 species.

Neither Winchell's types nor authentic topotypes have ever been figured. He said, (1866, p. 91), "A longitudinal section shows the characteristic layers arching across the stem . . . a transverse section exhibits radiating lamellae." The original generic diagnosis emphasized the branchng masses and "lamellar system, represented by radial structures" (1867, p. 99). The types of *Idiostroma caespitosum* Winchell, which the writer sectioned, (Pl. 31, fig. 12) has superposed pillars, as understood by Nicholson, (1886, pl. 9, figs. 6, 7, 8) and by Lecompte, (1952, p. 311, pl. 66, figs. 3, 3a, 3b). Lecompte's *Idiostroma crassum* (pl. 66, fig. 2, 2a) and *I. roemeri irregularis* (pl. 67, fig. 1, 1a) are *Stachyodes*. Yavorsky's *I. comulus* and *I. oculatum* Nicholson (1955, pp. 138, 139, pls. 74, 75, 81, 83) are *Dendrostroma*.

Genus **STACHYODES** Bargatzky, 1881
Pl. 34, fig. 10

Type species (monotypic) *Stachyodes verticillata* (McCoy) = *Stromatopora* (*Caunopora*) *verticillata* McCoy, 1851, Brit. Palaeo. Foss., p. 66, text figs. a, b. = *Stachyodes ramosa* Bargatzky, 1881, Zeit. Deut. Geol. Gesell. vol. 33, p. 688. (Middle Devonian, Germany); Nicholson, 1886, Palaeont.

Soc., vol. 39, p. 107, pl. 8, figs. 9-14; pl. 11, fig. 5; 1892, vol. 46, p. 221, pl. 29, figs. 1, 2; Kühn, 1939, in Schindewolf, Handbuch Paläozoologie, p. A52; 1942, Zool. Anz., Leipzig, vol. 140, p. 250; Lecompte, 1952, Inst. Roy. Sci. Nat. Belgique, Mém. 117, p. 298.

Sphaerostroma Gürich, 1896, Paleoz. Polnischen Mittelgebirges, p. 128, pl. 1, Fig. 2a-c (Middle Devonian, Poland).

Coenosteum dendroid, with tabulate axial tube, composed of thick laminae which are separated by thin dark lines, so that the laminae themselves represent the interlaminar spaces of most stromatoporoids; the thick laminae are traversed by numerous, tabulate pseudozooidal tubes or superposed galleries, which branch near the surface, and also by minute tubules parallel to the larger tubes. Pillars, indefinite, confined to one interlaminar space; astrorhizae absent.

Middle and Upper Devonian: Europe. About 14 species.

The laminae are thicker and more definite than in *Idiostroma* and are finely tubulate.

Family 5. **STROMATOPORIDAE** Winchell, 1867

Family Stromatoporidae Winchell, 1867, Proc. Amer. Assoc. Adv. Sci., p. 98; Nicholson, 1886, Palaeont. Soc., vol. 39, p. 74; Kühn, 1939, in Schindewolf, Handbuch Paläozoologie, p. A44.

Coenosteum massive to laminar, composed of latilaminae, laminae and short and long pillars, the interlaminar spaces more or less filled with secondary tissue; tissue finely or coarsely maculate and amalgamated; pseudozooidal tubes common; astrorhizae and mamelons common.

Upper Ordovician doubtful: China; Japan. Silurian common. Devonian abundant, not definitely known above the Devonian. Upper Paleozoic and Mesozoic forms probably do not belong to the order Stromatoporoidea but to the order Sphaeractinoidea.

KEY TO GENERA OF STROMATOPORIDAE

1a. Pillars absent or indefinite
  2a. Pseudozooidal tubes absent or indefinite; pillars indefinite, confined between two laminae ..... FERESTROMATOPORA
  2b. Vertical pseudozooidal tubes dominant ..... STROMATOPORA
1b. Pillars long, definite

2c. Pillars narrow, of compact tissue .... TALEASTROMA
2d. Pillars large, dominating vertical sections of maculate tissue
3a. Pillars without lighter borders
4a. Maculae small, not making parallel tubules .... SYRINGOSTROMA
4b. Maculae coarse, making parallel tubules and rods .... PARALLELOPORA
3b. Pillars with lighter borders .... HERMATOSTROMA
1c. Pillars short, not passing through laminae
2e. Laminae of three layers; pillars incidentally superposed .... CLATHROCOILONA
2f. Laminae of microlaminae; pillars normally superposed .... SYNTHETOSTROMA
1d. Pillars long and short; skeleton mostly of dissepiments .... ACTINODICTYON

Genus **FERESTROMATOPORA** Yavorsky, 1955

Pl. 36, figs. 1, 2, 4

Type species (first species, here designated) *Ferestromatopora krupennikovi* Yavorsky, 1955, Trudy Vsesoyuznogo Nauchno-issledovatelskogo Geol. Inst., Minister. Geol. i Ochrany Nedr, nov. ser., vol. 8, p. 109, pl. 58, figs. 1-5 (Middle Devonian, Kuznetz Basin, Tyrgan, Russia).

Stromatopora concentrica (not Goldfuss) Lecompte, 1952, Inst. Roy. Sci. Nat. Belgique, Mém. 117, p. 271, pl. 53, figs. 2-4 (Middle Devonian, Belgium); 1956, in Moore, Treatise on Invertebrate Paleontology, p. F133, figs. 91, 2 and 108, 2.

Coenosteum laminar to massive, latilaminate, the latilaminae in turn composed of laminae, with the interlaminar spaces largely filled with finely maculate and amalgamate tissue, leaving oval to oblique galleries, but without definite pillars, and without or with short and obscure pseudozooidal tubes; dissepiments and tabulae rare; astrorhizae present.

Silurian: Canada. Middle Devonian: Russia; Belgium; Germany; Indiana. Ten species.

Ferestromatopora differs from *Stromatopora* in lacking definite, vertical pseudozooidal tubes. It lacks the small, round pillars of *Taleastroma*. *Ferestromatopora* includes *F. krupennikovi* Yavorsky, *F. krupennikovi talovensis* Yavorsky, *F. tyrganensis* Yavorsky, *F.*

compta (Počta), *F. dubia* (Lecompte), *F. obscura* (Galloway and St. Jean), *F. marpleae* (Galloway and St. Jean) *F. larocquei* (Galloway and St. Jean).

Genus **STROMATOPORA** Goldfuss, 1826
Pl. 35, figs. 1-3; Pl. 36, fig. 5

Type species (monotypic), *Stromatopora concentrica* Goldfuss, 1826, Petrefacta Germaniae, 1st ed., vol. 1, p. 22, pl. 8, fig. 5 (Middle Devonian, Gerolstein, Germany); Nicholson, 1886, Palaeont. Soc., vol. 39, p. 91, pl. 11, figs. 15-18; 1891, vol. 44, p. 164, pl. 21, figs. 1-3 (topotypes); Ripper, 1937, Proc. Roy. Soc. Victoria, N. S., vol. 49, p. 184; Kühn, 1939, in Schindewolf, Handbuch Paläozoologie, p. A44; Lecompte, 1952, Inst. Roy. Sci. Nat. Belgique, Mém. 117, p. 263; Yavorsky, 1955, Trudy Vsesoyuznogo Nauchno-issledovatelskogo Geol. Inst., Minister. Geol. i Ochrany Nedr, nov. ser., vol. 8, pp. 81-109, pls. 42-57; Galloway and St. Jean, 1957, Bull. Amer. Paleont., vol. 37, No. 162, p. 164.

Coenostroma Winchell, 1867, Proc. Am. Assoc. Adv. Sci., p. 99, type species (selected by Miller, 1889), *Stromatopora monticulifera* Winchell (Middle Devonian, N. Michigan). (Supposedly distinguished from *Stromatopora* by mamelons and astrorhizae.)

Lioplacocyathus Ludwig, 1866, Palaeontographica, vol. 14, pp. 139, 142, pl. 72, fig. 1 (*Stromatopora* renamed).

Prisciturben Kunth, 1870, Zeitschr. Deutsch. Geol. Gesell., vol. 22, p. 82. (A combination of a stromatoporoid and a coral.)

Pachystroma Nicholson and Murie, 1878, Jour. Linn. Soc. London, Zool., vol. 14, p. 214, 223. Monotypic, *P. antiquum* Nicholson and Murie (Silurian, Ontario).

? *Caunopora* Phillips, 1841, Palaeoz. Foss. Cornwall, Devon and W. Somerset, p. 18, pl. 10, fig. 29. Type species, *Coscinopora placenta* Lonsdale (Middle Devonian, Devonshire). (An unknown stromatoporoid with symbionts.)

? *Stromatopora* Yabe and Sugiyama, 1930, Sci. Rep. Tôhoku Imp. Univ., Sendai, ser. 2, vol. 14, p. 58, pl. 19, fig. 1, pl. 21, figs. 1-4 (Ordovician). (May be a sponge.)

Not *Stromatopora* Lecompte, 1956, in Moore, Treatise Invert. Paleont., Part F, p. F133; Fig. 91 = *Ferestromatopora;* Fig. 109, 1 = *Taleastroma;* Figs 88 and 92, 1 are *Stromatopora, s. s.* Fig. 89 is indeterminate.

Coenosteum massive to laminar, composed of latilaminae, which in turn are usually composed of thin, close-set, discontinuous microlaminae, which are thickened by secondary, maculate tissue, leaving small galleries, tabulate pseudozooidal tubes and filling tissue which serves as pillars. The tissue is greater in amount than the galleries and is fused. Tissue finely to coarsely maculate, not compact nor with tubules, the maculae consisting of small, light and dark, spheroidal dots; astrorhizae well developed; some specimens with mamelons; dissepiments usually rare.

Ordovician: Japan, doubtful. Silurian and Devonian: Europe, North America, Asia, Arctic, and Australia. About 60 species. In addition to *S. concentrica,* as determined by Nicholson (1886, p. 91; 1891, p. 164), some other typical species are: *S. hüpschi* (Bargatzky), *S. typica* Rosen, *S. laminosa* Lecompte, *S. dybowskii* Yavorsky, and *S. divergens* Galloway and St. Jean. *Stromatopora concentrica* of Lecompte, (1952, pl. 53, figs. 2-4; pl. 54, fig. 1) is not a *Stromatopora,* much less *S. concentrica* Goldfuss, but is *Ferestromatopora tyrganensis* Yavorsky.

Stromatopora lacks the large pillars of *Syringostroma* and the small, compact pillars of *Taleastroma.* Typical species of *Stromatopora* have the interlaminar spaces largely filled with maculate, amalgamated tissue, as stated by Nicholson (1886, p. 91), and pseudozooidal tubes are dominant over laminae.

Genus **TALEASTROMA,** new genus
Pl. 35, fig. 4

Type species *Stromatopora cumingsi* Galloway and St. Jean, 1957, Bull. Amer. Paleont., vol. 37, No. 162, p. 182, pl. 15, fig. 4 (Middle Devonian, Logansport limestone, Logansport, Indiana).

Coenosteum massive, latilaminate, the latilaminae in turn composed of thin laminae, with the interlaminar spaces largely filled with maculate and amalgamate tissue, leaving small, round and irregular galleries. Pillars long, thin, 0.06 to 0.2 mm. in diameter, with light, compact centers and borders of dark maculae; pseudozooidal tubes short, lighter and larger than the pillars; dissepiments and tabulae scarce; astrorhizae usually well developed, small.

Middle Devonian: Indiana; Belgium; probably Russia. Five species, *T. cumingsi* (Galloway and St. Jean), *T. pachytextum* (Lecompte), *T. cooperi* (Lecompte), *T. conicomamillatum* (Galloway and St. Jean), *T. magnimamillatum* (Galloway and St. Jean).

Stromatopora has conspicuous pseudozooidal tubes but no pillars; *Ferestromatopora* lacks both pseudozooidal tubes and pillars; *Taleastroma* has small, compact pillars and imperfect pseudozooidal tubes. The pillars of *Syringostroma* are large and composed of maculate tissue. The name *talea* means a small rod and refers to the narrow pillars.

Genus **SYRINGOSTROMA** Nicholson, 1875
Pl. 35, fig. 5; Pl. 36, fig. 7

Type species (selected by Nicholson, 1886, p. 98), *S. densum* Nicholson, 1875, Palaeont. Ohio, vol. 2, pt. 2, p. 251, pl. 24, fig. 2. (Middle Devonian, Kelleys Island, Ohio); Nicholson, 1886, Palaeont. Soc., vol. 39, p. 97, pl. 11, figs. 13, 14; 1891, Ann. Mag. Nat. Hist., ser. 6, vol. 7, p. 326, pl. 10, figs. 8, 9; Girty, 1895, 48th Ann. Rep. State Geol. New York, for 1894, p. 289; Parks, 1909, Univ. Toronto Studies, Geol. Ser., No. 6, p. 8; Ripper, 1937, Proc. Roy. Soc. Victoria, N. S., vol. 49, p. 179; Kühn, 1939, in Schindewolf, Handbuch Paläozoologie, p. A46; Lecompte, 1951, Inst. Roy. Sci. Nat. Belgique, Mém. 116, p. 195; Yavorsky, 1955, Trudy Vsesoyuznogo, Nauchno-issledovatelskogo Geol. Inst., Minister. Geol. i Ochrany Nedr, nov. ser., vol. 8, pp. 128-136, pls. 68-72.

Stylodictyon Nicholson and Murie, 1878, is probably a synonym.

Coenosteum massive or tuberose, composed of latilaminae and thin, porous laminae. Interlaminar spaces largely filled with maculate tissue, leaving small oval, and narrow, superposed galleries. Pillars large and long, and short and spool-shaped; the large pillars are usually marked by sharp upturns of the laminae, and are filled with more compact, maculate tissue. In some species the laminae are flat. Tangential section with large, roundish pillars or concentric circles, round, or irregular small pillars and round and anastomosing galleries; tissue fused and conspicuously maculate; astrorhizae largely developed.

Silurian and Devonian: North America; Europe; Australia. About 20 species.

Syringostroma differs from *Stromatopora* only in the large, continuous, round pillars, which are in the groundmass, as seen in tangential section. It resembles *Parallelopora* but has smaller maculae. *Syringostroma* of Lecompte (1951, p. 195) is not typical, and most of his species belong in other genera.

Genus **STYLODICTYON** Nicholson and Murie, 1878

Type species (originally designated), *Syringostroma columnaris* Nicholson, 1875, Geol. Surv. Ohio, vol. 2, pt. 2, p. 253, pl. 24, figs. 1, 1a (Middle Devonian, Columbus limestone, Sandusky, Ohio).

Stylodictyon columnare Nicholson and Murie, 1878, Jour. Linn. Soc. Zool., vol. 14, p. 221, pl. 3, figs. 4-8; Nicholson, 1886, Palaeont. Soc., vol. 39, p. 79, pl. 7, figs. 7-11; Grabau and Shimer, 1909, North American Index Fossils, p. 41, fig. 65.

Not *Stylodictyon* Parks, 1908, Univ. Toronto Studies, Geol. Ser., No. 5, p. 29, pl. 12, figs. 1, 2 (not Silurian but Devonian, a species of *Anostylostroma);* Kühn, 1939, in Schindewolf, Handbuch Paläozoologie, Bd. 2a, p. A43, fig. 60; Shimer and Shrock, 1944, Index Fossils North America, p. 61, pl. 18, figs. 23, 24.

Coenosteum massive. Laminae thin and close, rising sharply into large pillars or small columns; interlaminar spaces largely filled with secondary tissue, leaving small, oval galleries; large pillars solid, without axial, astrorhizal tubes; pillars between columns small, short, spool-shaped; tissue amalgamated and probably finely maculate; astrorhizae large.

Middle Devonian, northern Ohio. One species.

Stylodictyon seems to be a *Syringostroma* with small columns. The presence of columns made by upturns of laminae is not a generic character but a specific character, occurring in many genera. The type species of *Syringostroma columnare* Nicholson has never been found, and no one but Nicholson and Murie has added a species to the genus. *Stylodictyon columnare* of Parks (1908, p. 29), Kühn (1939, p. A46), and Shimer and Shrock (1944, p. 61), is a species of *Anostylostroma,* from the Jeffersonville limestone, not Silurian, from near Louisville, Kentucky.

Genus **PARALLELOPORA** Bargatzky, 1881
Pl. 31, fig. 16; Pl. 35, fig. 6

Type species (first species, selected by Nicholson, 1891, p. 193) *P. ostiolata* Bargatzky, 1881. Die Stromatoporen des rheinischen Devons, Verhandl, naturhist. preuss. Rheinland u. Westfalens, vol. 38, p. 291 (Middle Devonian, Germany); Nicholson, 1886, Palaeont. Soc., vol. 39, p. 95, pl. 2, figs. 6, 7; 1891, vol. 44, p. 191; Parks, 1936, Univ. Toronto Studies, Geol. Ser., No. 39, p. 53; Kühn, 1939, in Schindewolf, Handbuch Paläozoologie Bd. 2A, p. A45; Lecompte, 1952, Inst. Roy. Sci. Nat. Belgique, Mém. 117, p. 292, pl. 51, figs. 3, 3a-c.

Not *Parallelopora* Newell, 1935, Jour. Paleont., vol. 9, p. 341; a sponge.

Not *Parallelopora* Johnson and Pfender, 1939, Jour. Paleont., vol. 13, p. 515; may be *Ferestromatopora.*

Coenosteum laminar to massive, composed of thin laminae or multiple microlaminae with maculate tissue between, above, and below the microlaminae. Pillars large, continuous, composed of small, parallel, vertical tubules and vertical rods or columns of dark dots; in tangential section the pillars are roundish in the interlaminar spaces and irregular and connected in the laminae. Galleries superposed, making pseudozooidal tubes (the parallel pores of Bargatzky), not characteristic but occurring in other genera with continuous pillars; dissepiments uncommon; tissue coarsely maculate. In tangential section the galleries are round, vermiculate and anastomosing; astrorhizae large and numerous.

Silurian, Middle Devonian: Europe, North America, and Australia; Permian ?, Japan. About 10 species. Many species in Kühn (1928, Foss. Cat., p. 51) belong in *Syringostroma* or *Stromatopora*.

This genus differs from other genera of the Stromatoporoidea in the coarse superposed maculae. It differs from the Actinostromatidae, which have superposed chambers but lack maculate tissue.

Genus **HERMATOSTROMA** Nicholson, 1886
Pl. 35, fig. 7

Type species (monotypic), *H. schlüteri* Nicholson, 1886, Palaeont. Soc., vol. 39, p. 105, pl. 3, figs. 1, 2 (Middle Devonian, Hebborn, Germany); Nicholson, 1892, Palaeont. Soc., vol. 46, p. 215, pl. 28, figs. 12, 13; Parks, 1907, Univ. Toronto Studies, Geol. Ser., No. 4, p. 34, pl. 4, figs. 1, 2: pl. 6, figs. 3, 4 (Middle Silurian, Guelph, Elora, Ontario); Ripper, 1937, Roy. Soc. Victoria, vol. 50, pt. 1, N.S., p. 29; Lecompte, 1952, Proc. Roy. Sci. Nat. Belgique, Mém. 117, p. 247; Yavorsky, 1955, Trudy Vsesoyuznogo Nauchnoissledovatelskogo Geol. Inst., Minister. Geol. i Ochrany Nedr, nov. ser., vol. 8, pp. 140-149, pls. 72, 76-79.

Coenosteum massive, tuberose or discoidal, composed of strong laminae and large, continuous, or definitely superposed pillars with darker or lighter centers, the dark tissue typically extending into the laminae. Pillars and laminae not originally hollow. Pillars in tangential section round and frequently coalescing, not connected by radial processes. Galleries superposed, some species with cyst plates. The margins of both pillars and laminae are lighter in color and appear coarsely vesiculate; tissue coarsely maculate; astrorhizae generally well developed.

Silurian: Canada. Middle Devonian: Europe; North America. Nine or more species.

This genus differs from *Syringostroma* in the light borders of the pillars. It is much like *Parallelopora*, but the light borders of the pillars and lack of tubules and rods in the pillars distinguish it. The laminae are stronger than in *Trupetostroma* which lacks the light-colored layers on pillars and laminae but does have vacuoles in the tissue. *Gerronostroma* lacks both the light-colored layers on pillars and the laminae and the vacuoles. Coarse maculae are obvious in *H. logansportense* and obscure in *H. schlüteri*.

Genus **CLATHROCOILONA** Yavorsky, 1931
Pl. 35, fig. 8

Type species (monotypic), *Clathrocoilona abeona* Yavorsky, 1931, Bull. United

Geol. and Prosp. Service, U. S. S. R., vol. 50, fasc. 94, p. 1407, pl. 1, figs. 9-11; pl. 2, figs. 1, 2, 2a (Middle Devonian, S.W. border Kuznetsk Basin, Russia); 1955, Trudy Vsesoyuznogo Nauchno-issledovatelskogo Geol. Inst., Minister. Geol. i Ochrany Nedr, nov. ser., vol. 8, pp. 38, 39, pl. 13, figs. 1-7.

Stromatoporella (part) Lecompte, 1951, Inst. Roy. Sci. Nat. Belgique, Mém. 116, p. 152.

Coenosteum lamellar to massive; laminae thick, tripartite, with white median layer. Pillars mostly confined to one interlaminar space, spool-shaped in vertical section and frequently superposed, oval in cross section but not hollow rings. Galleries round or oval, scarcely higher than the laminae are thick, with thin dissepiments, and additional larger, round or elongate oval cavities with tabulae, the astrorhizal canals. Yavorsky said, "Tissue fibers compact," but Yavorsky's tangential section shows maculae or pores, and Indiana specimens of *Clathrocoilona* are coarsely maculate. Mamelons and astrorhizae may occur.

Middle Devonian: Kuznetsk Basin, Russia; Belgium; Indiana. Thirteen species.

If the tissue were solid, this genus would belong in the Actinostromatidae near *Trupetostroma.* The large cavities (astrorhizal canals), which Yavorsky said distinguishes *Clathrocoilona* from *Clathrodictyon,* occur in many genera. The triple laminae, with median light zone, occurs in the type species of *Trupetostroma,* and in *Stromatoporella, Syringostroma,* and *Stictostroma.* A recently figured form close to *Clathrocoilona* is *Stromatoporella saginata* Lecompte (1951, pl. 22, fig. 62, which has "Une vague structure alveolaire," p. 173).

Genus **SYNTHETOSTROMA** Lecompte, 1951
Pl. 35, fig. 9

Type species (originally designated), *S. actinostromoides* Lecompte, 1951, Inst. Roy. Sci. Nat. Belgique, Mém. 116, p. 193, pl. 20, figs. 3, 4 (Middle Devonian, Givetian, Dinant Basin, Belgium).

Coenosteum thickly laminar and undulating; laminae thick, composed of interlaced microlaminae, separated by wider galleries with numerous dissepiments; galleries oval, superposed, without connecting pores; pillars large, regularly superposed, round in tangential section, not connected by radial processes; tissue "cellulaire", or finely maculate; astrorhizae present.

Middle Devonian: Belgium. One species.

This genus is much like *Clathrocoilona*, differing in the larger number of microlaminae and superposed pillars, and tripartite laminae. It has no ring-pillars as does *Stromatoporella*, nor radial processes on the pillars, as does *Actinostroma*. The tissue is maculate rather than transversely porous as it is in *Gerronostroma*. This genus may include *Actinodictyon vagans* Parks and other species like *Actinodictyon* but with definite laminae.

Genus **ACTINODICTYON** Parks, 1909

Pl. 35, fig. 10

Type species (first species, selected by Bassler, 1915), *A. canadense* Parks, 1909, Univ. Toronto Studies, Geol. Ser., No. 6, p. 30, pl. 20, figs. 1, 2 (Middle Silurian, Southampton Island, Canada); Bassler, 1915, U. S. Nat. Mus., Bull. 92, p. 16; Kühn, 1928, Foss. Cat., p. 25; 1939, in Schindewolf, Handbuch Paläozoologie, Bd. 2A, p. A43, fig. 59; Parks, 1936, Univ. Toronto Studies, Geol. Ser., No. 39, p. 113, pl. 18, figs. 1, 2; Lecompte, 1951, Inst. Roy. Sci. Nat. Belgique, Mém. 116, p. 149; in Moore, 1956, Treatise Invert. Paleont., Part F, p. F130

Coenosteum cylindrical to massive, latilaminate. Laminae variably developed, dissepiments conspicuous, pillars short and superposed, appearing continuous. In tangential section the pillars are round to irregular, both solid and maculate, joined by curved dissepiments, but not by radiating processes; dissepiments may be cut as rings; tissue maculate and porous; astrorhizae present or absent.

Silurian: Canada, four species. Devonian: Canada; Ohio, Indiana; Belgium; Germany. Seven or more species.

The maculate tissue, predominance of dissepiments, and short and superposed pillars are characteristic. The genus only faintly resembles *Labechia* or *Labechiella*. Laminae are subordinate to dissepiments in Silurian species and in some Devonian species of *Actinodictyon*.

APPENDIX TO STROMATOPOROIDEA

INVALID NAMES AND FORMS NOT STROMATOPOROIDEA

Genus **APHRALYSIA** Garwood, 1914

Type species (originally designated), *A. carbonaria* Garwood, 1914, Geol. Mag., p. 268, pl. 21, figs. 3, 4 (Lower Carboniferous, Westmoreland); Kühn, 1928, Fossilium Catalogus, Hydrozoa, p. 38.

Body nodular, a thick incrustation surrounding fragments of various organisms, up to 10 mm. in diameter, composed of minute, blisterlike plates, 0.2 to 0.5 mm. broad and about 0.12 mm. high, convex outwardly, more or less concentrically arranged, overlapping irregularly; tissue dense; no pillars, zooidal tubes or astrorhizae.

Lower Carboniferous, England. One species.

It is doubtful to which group this organism belongs; it may be an alga, as suggested by Garwood. It bears little resemblance, other than in the curved plates, to the Labechiidae, which are confined to the Ordovician and Silurian. The cyst plates are much smaller and less regular than those of *Cystostroma* and *Aulacera.* It is the only stromatoporoid-like organism so far reported from rock of definite Mississippian age. It has much the appearance of *Girvanella,* an alga.

Genus **AULOCERIUM** Parks, 1909

Type species (monotypic), *A. savagei* Parks, 1909, Univ. Toronto Studies, No. 6, p. 44, pl. 18, figs. 13, 15 (Lower Silurian, Wilmington, Illinois).

Coenosteum laminar, composed of vesicular cystose tissue, without pillars but with large, vertical, thin-walled, tabulated tubes and lunaria; tissue dense; astrorhizae absent.

Lower Silurian, Illinois. One species.

The writer has studied the type slides of *Aulocerium* and recognized it as the bryozoan genus *Fistulipora.*

Genus **CAUNOPORA** Phillips, 1841

Type species (designated by Miller, 1889) *Coscinopora placenta* Lonsdale, 1840, Trans. Geol. Soc. London, ser. 2, vol. 5, p. 697, fig.

Caunopora Phillips, 1841, Paleo. Foss. Cornwall, Devon and W. Somerset, p. 18, pl. 10, fig. 29 (Middle Devonian, Devonshire); Nicholson, 1886, Palaeont. Soc., vol. 39, pp. 110-130; Yavorsky, 1955, Trudy Vsesoyuznogo Nauchno-issledovatelskogo Geol. Inst., Minister. Geol. i Ochrany Nedr, nov. ser., vol. 8, p. 14; Lecompte, 1956, in Moore, Treatise Invert. Paleont., Part F, Geol. Soc. Amer., p. F108.

The nature of *Caunopora,* both as a genus and a structure, was thoroughly discussed by Nicholson. He reached the conclusion, as many students had previously, that "*Caunopora,*" Phillips is a composite of various stromatoporoids and a coral, *Syringopora,* rarely

Aulopora, and that the generic name is invalid. Subsequent workers have been in agreement with Nicholson. The tubes occur in many genera of Devonian stromatoporoids and in a few Silurian forms. The tubes have been referred to as "*Caunopore*-tubes," "caunopore tubes," and more recently as *Syringopora*.

Genus **DIAPORA** Bargatzky, 1881

Type species (monotypic), *Diapora laminata* Bargatzky, 1881, Die Stromatoporen des rheinischen Devons, Verhand. naturhist. Vereins, Preuss. Rheinland u. Westfalens, vol. 38, p. 287, figs. 8, 9 (Middle Devonian, Paffrath and Büchel, Germany).

Fig. 8, tangential section, is an *Actinostroma* and Fig. 9, vertical section, appears to be an *Anostylostroma*. According to Nicholson, *Diapora* from Büchel, is a *Stromatoporella*, with larger vertical tubes with walls, probably the coral *Syringopora* (Nicholson, 1886, Palaeont. Soc., vol. 39, p. 93, pl. 10, figs. 1-4). The name *Diapora* refers to the combination of a stromatoporoid and a coral; it has been considered nomenclaturally invalid and unrecognizable by all workers on the stromatoporoids since Bargatzky.

Genus **DICTYOSTROMA** Nicholson, 1875

Type species (monotypic), *D. undulosum* Nicholson, Geol. Surv., Ohio, vol. 2, pt. 2, p. 254, pl. 24, fig. 6 (Middle Silurian, Louisville, Kentucky; 1886, Palaeont. Soc., vol. 39, p. 85; 1892, vol. 46, p. 232; Rominger, 1886, Proc. Acad. Nat. Sci., Philadelphia, p. 54; Parks, 1908, Univ. Toronto Studies, Geol. Ser., No. 5, p. 56, pl. 14, figs. 3, 4; pl. 15, figs. 3, 4; Bassler, U. S. Nat. Mus. Bull. 92, p. 428; Hill and Stumm, in Moore, Treatise Invert. Paleont., Part F, p. F466.

Dictyostroma is generally considered to be a tabulate coral near to or identical with *Coenites*.

Genus **KENTLANDIA** Shrock, 1937

Type species (originally designated), *Kentlandia imbricata* Shrock, 1937, Amer. Midland Naturalist, vol. 18, p. 537, pl. 1, figs. 5-13; pl. 2, fig. 4. (Middle Ordovician, Kentland, Indiana); Bassler, 1950, Geol. Soc. America, Mem. 44, p. 292.

Synonym of *Paleoalveolites* Okulitch (1935), a coral of the family Tetradiidae.

Genus **KITAKAMIIA** Sugiyama, 1940

Type species (monotypic), *Kitakamiia mirabilis* Sugiyama, 1940, Sci. Rep. Tôhoku Imp. Univ., Sendai, ser. 2, vol. 21; p. 112, No. 2, pl. 32, figs. 3-6 (Silurian, near Sakarimati, north of Sendai, Japan).

Corallum thick laminar, in vertical section consisting of thin curved plates, which are arranged in irregular, vertical tiers, the junctions of the tiers making zigzag walls, mistaken by Sugiyama for vertical pillars. Corallites crescentic, four times as thick as the walls. Walls apparently solid with some indications of mural pores; septa and tabulae apparently absent.

Silurian, northern Honshu, Japan.

This form is surely a species of the coral *Alveolites,* which genus occurs at the same locality as the supposed stromatoporoid. The genus has no particular similarity to either *Stromatocerium, Lophiostroma,* or *Chalazodes,* as claimed by Sugiyama.

Genus **TIENODICTYON** Yabe and Sugiyama, 1941

Type species (monotypic), *Tienodictyon zonatum* Yabe and Sugiyama, 1941, Proc. Imp. Acad. Japan, vol. 17, No. 5, p. 139, figs. 1-6 (Middle Devonian ?, Eastern Yunnan, China ?).

Coenosteum massive, with granulate surface, composed of thick laminae, which in turn are composed of densely crowed trabeculae. Some thicker, round trabeculae connect the laminae across the interlaminar spaces, which are divided in a general horizontal direction by thin, undulating plates. Upper part of interlaminar space with vertical trabeculae prolonged from the upper lamina; lower part with vermiculate trabeculae, and rarely with tabulae. "All trabeculae radially fibrous, without exhibiting any other structure." Astrorhizae apparently absent.

Middle Devonian?, eastern Yunnan, China. One species.

This genus, being composed of trabeculae or rods, can scarcely be a stromatoporoid. It fits better in the family Sphaeractinidae of the order Sphaeractinoidea. The structure is like that of Mesozoic hydroids, not like that of any known Devonian stromatoporoid. The age of the specimen, and its locality, might be questioned, since it was found, "in an early collection of Chinese fossils stored in the Institute of Geology and Paleontology." All too often old specimens lose their original labels!

Order Sphaeractinoidea Kühn, 1927, Zentralbl. Min. Geol. Paleont., Abt. B, p. 546-551; 1939, in Schindewolf, Handbuch Paläzoologie, Bd. 2A, p. A55.

Skeleton calcarous, composed of concentric and radial trabeculae or rods, with superposed galleries and reduced astrorhizae. Permian to Cretaceous. Families, Disjectoporidae, Stromatoporinidae, Sphaeractinidae, Heterastriidae, Spongiomorphidae, and Milleporellidae.

REFERENCES

The following bibliography includes only the most important references on structure and classification of the Stromatoporoidea. A bibliography of over 500 items was published by Galloway and St. Jean, 1956, and a supplement of 88 items by Flügel, 1956.

Bargatsky, A.

1881a, *Stachyodes, eine neue Stromatoporengattung.* Zeitschr. Deutschen Geol. Ges., vol. 33, pp. 688-691.

1881b, *Die Stromatoporen des rheinisches Devons.* Verhandl. naturhist. Vereins Preuss. Rheinlande Westfalens, vol. 38, pp. 233-304; separate pp. 1-19, 11 text figures.

Bassler, R. S.

1932, *The stratigraphy of the Central Basin of Tennessee.* Geol. Sur. Tennessee, Bull. 28, pp. 214, 226, pl. 16, fig. 9; pl. 22, figs. 10, 11.

1935, *Descriptions of Paleozoic fossils from the Central Basin of Tennessee.* Jour. Washington Acad. Sci., vol. 25, p. 104.

Billings, E.

1857, *Ordovician and Silurian rocks of North America.* Geol. Sur. Canada, Rept. Prog. 1853-56, pp. 343-345.

1865, *Notes on some of the more remarkable genera of Silurian and Devonian fossils.* Canadian Nat. and Geol., ser. 2, vol. 2, pp. 405-409, figs. 1, 2.

Boehnke, K.

1915, *Die Stromatoporen der nordischen Silgurgesciebe in Norddeutschland und in Holland.* Palaeontographica Beitr. Natur. Vorzeit, vol. 61, pp. 147-190, pls. 16-18, 35 text figures.

Carter, H. J.

1877, *On the close relationship of Hydractinia, Parkeria, and Stromatopora.* Ann. Mag. Nat. Hist., ser. 4, vol. 19, pp. 44-76.

1878a, *On new species of Hydractiniidae, Recent and fossil and on the identity in structure of Millepora alcicornis with Stromatopora.* Ann. Mag. Nat. Hist., ser. 5, vol. 1, pp. 298-311.

1878b, *On the probable nature of the animal which produced the Stromatoporoidea, traced through Hydractinia, Millepora alcicornis and Caunopora to Stromatopora.* Ann. Mag. Nat. Hist., ser. 5, vol. 2, pp. 304-324.

1879, *On the mode of growth of Stromatopora including the commensalism of Caunopora.* Ann. Mag. Nat. Hist., ser. 5, vol. 4, pp. 101-106.

Cumings, E. R., and Shrock, R. R.

1928a, *The geology of the Silurian rocks of northern Indiana.* Ind. Dept. Cons., Div. geol., publ. 75, pp. 59, 189.

Endo, R.

1932, *The Canadian and Ordovician formations and fossils of south Manchuria.* U. S. Nat. Mus. Bull. 164, p. 40.

Felix, J.

1905, *Ueber die Gattung Amphipora.* Sitzungsbericht Naturforsch. Ges. Leipzig, vols. 30, 31, pp. 73-76.

Flügel, E. H.

1956, *Zur Bibliographie der Stromatoporen.* Mitteil. Naturwiss. Vereins Steinmark, Bd. 86, pp. 28-31. Graz.

Foerste, A. F.

1909, *Preliminary notes on Cincinnatian and Lexington fossils.* Bull. Sci. Lab. Denison Univ., vol. 14, pp. 298-300, pls. 7-9.

1910, *Preliminary notes on Cincinnatian and Lexington fossils of Ohio., Indiana, Kentucky, and Tennessee.* Bull. Sci. Lab. Denison Univ., vol. 16, pp. 86, 87, pl. 1.

1916, *Notes on Cincinnatian fossil types.* Bull. Sci. Lab. Denison Univ., vol. 18, pp. 297-304, pls. 1, 2.

Fritz, M. A., and Waines, R. H.

1956, *Stromatoporoids from the upper Abitibi River limestone.* Proc. Geol. Assoc. Canada, vol. 8, pt. 1, pp. 87-126, pls. 1-3.

Galloway, J. J., and St. Jean, J., Jr.

1955, *The type of the stromatoporoid species Stromatocerium rugosum Hall.* Am. Mus. Novitates, no. 1728, pp. 1-11, figs. 1-7.

1956a, *A bibliography of the order Stromatoporoidea.* Jour. Paleont., vol. 30, pp. 170-185.

1957, *Middle Devonian Stromatoporoidea of Indiana, Kentucky and Ohio.* Bull. Amer. Paleont., vol. 37, No. 162, pp. 25-296, pls. 1-23.

Garwood, E. J.

1914, *Some new rock-building organisms from the Lower Carboniferous beds of Westmoreland.* Geol. Mag., ser. 5, vol. 11, p. 268, pl. 21, figs. 3,4.

Goldfuss, A.

1826, *Petrefacta Germaniae.* List and Francke, Leipzig, 1st ed., p. 21, pl. 8, figs. 5a-c. 2nd ed., 1862.

Gorsky, I. I.

1935, *Some Coelenterata from the Lower Carboniferous beds of Novaya Zemlya.* Trans. Arctic Inst., vol. 28, pp. 7, 9-23, 70, 71, 73-76, 82-97, pls. 1-5, text figs. 1-4. (Russian with English summary.)

1938, *Some Stromatoporoidea from Palaeozoic beds of Novaya Zemlya.* In Gorsky, I. I., and others, *Palaeontology of the Soviet Arctic.* Arctic Inst. U. S. S. R., vol. 101, pt. 3, pp. 7-45, pls. 1-7. (Russian with English summary.)

Grabau, A. W., in Grabau, A. W., and Sherzer, H. W.

1910, *The Monroe formation of southern Michigan and adjoining regions.* Michigan Geol. and Biol. Survey, publ. 2, geol. ser. 1, pp. 87-94, pls. 8, 9, 13, 16.

Grabau, A. W., and Shimer, H. W.

1909, *North American index fossils.* A. G. Seiler Co., New York, vol. 1, pp. 34-37, figs. 56-74.

Hall, James

1847, *Palaeontology of New York.* Nat. Hist. New York, vol. 1, pp. 48, 323, pl. 12, figs. 2, 2a, 2b.

Hickson, S. J.

1934, *On Gypsina plana and on the systematic position of the stromatoporoids.* Quart. Jour. Micro. Sci., new ser. 303, vol. 76, pp. 433-480, 2 pls., 13 figs.

Johnson, J. H., and Pfender, J.

1939, *Parallelopora goldfussii from the Devonian near Cody, Wyoming.* Jour. Paleontology, vol. 13, pp. 515, 516, pl. 60. (A species of *Ferestromatopora.*)

Kühn, O.

1927, *Zur Systematik und Nomenklatur der Stromatoporen.* Zentralb. Min. Geol. Paläont., Abt. B, pp. 546-551.

1928, *Fossilium Catalogus 1. Animalia. Pars 36: Hydrozoa.* W. Junk, Berlin, pp. 1-114.

1939a, *Eine neue Familie der Stromatoporen.* Zentralb. Min. Geol. Paläont., Abt. B., pp. 338-345, figs. 1-3.

1939b, *Hydrozoa:* in Schindewolf, *Handbuch der Paläozoologie.* Band 2A, pp. A36-A68, figs. 51-96.

1942, *Die Gattung Stachyodes.* Zool. Anz., Leipzig, vol. 140, pp. 250, 251.

Kunth, A.

1870, *Beitrage zur Kenntnis fossiler Korallen.* Zeitschr. Deutschen Geol. Ges., vol. 22, p. 82.

Lecompte, M.

1951-1952, *Les Stromatoporoides du Dévonien moyen et superieur du Bassin de Dinant.* Inst. Roy. Sci. Nat. Belgique, Mém. 116, pp. 1-215, pls. 1-35; Mém. 117, pp. 216-369, pls. 36-70.

1956, *Stromatoporoidea,* in Moore, R. C., *Treatise on Invertebrate Paleontology,* Part F, Geol. Soc. Amer., pp. F107-F144, figs. 86-114.

Le Maître, D.

1949, *Sur Quelques genres de Stromatopores Dévoniens et leur microstructure.* Bull Soc. Géol. France, ser. 5, vol. 19, pp. 513-526, pls. 16-18, figs. 1-8.

Lonsdale, W., in Murchinson, R. I.

1839, *Corals, The Silurian system, founded on geological researches.* John Murray, London, pt. 2, pp. 676, 680, 681, 711, pl. 15, figs. 31, 31a-d.

Nicholson, H. A.

1873, *On some new species of Stromatopora.* Ann. Mag. Nat. Hist., ser. 4, vol. 12, pp. 89-95, pl. 4.

1874, *On the affinities of the genus Stromatopora with descriptions of two new species.* Ann. Mag. Nat. Hist., ser. 4, vol. 13, pp. 4-14, figs. 1-3.

1875, *Descriptions of Amorphozoa from the Silurian and Devonian formations.* Geol. Survey Ohio, vol. 2, pt. 2, pp. 245-255, pl. 24.

1879, *On the structure and affinities of the Tabulate Corals of the Palaeozoic period.* Edinburgh and London, pp. 28, 29, 330-337, figs. 12, 44; pl. 15, figs. 4, 4a.

1886a, *On some new or imperfectly known species of stromatoporoids.* Ann. Mag. Nat. Hist., ser. 5, vol. 17, pp. 225-239, pls. 6-8.

1886b, *On some new or imperfectly known species of stromatoporoids.* Ann. Mag. Nat. Hist., ser. 5, vol. 18, pp. 8-82, pls. 1, 2.

1887, *On some new or imperfectly known species of stromatoporoids.* Ann. Mag. Nat. Hist., ser. 5, vol. 19, pp. 1-17, pls. 1-3.

1891, *On some new or imperfectly known species of stromatoporoids.* Ann. Mag. Nat. Hist., ser. 6, vol. 7, pp. 309-328, pls. 8-10.

1886c, 1889, 1891b, 1892, *A monograph of the British stromatoporoids.* Palaeont. Soc. London, vols. 39, 42, 44, 46, pts. 1-4, pp. 1-234, pls. 1-29.

Nicholson, H. A., and Murie, J.

1878, *The minute structure of the skeleton of Stromatopora and its allies.* Jour. Linn. Soc. London, Zoology, vol. 14. pp. 187-246, pls. 1-4. (Published August 31, 1878)

Öpik, A.

1935, *Amphipora ramosa (Phillips) in the marine Devonian of Estonia.* Ann. Nat. Soc. Tartu Univ., Pub. Geol. Inst. 41, pp. 1-8, pls. 1, 2.

Ozaki, Kin-Emon

1938, *On some stromatoporoids from the Ordovician limestone of Shantung and south Manchuria.* Jour. Shanghai Sci. Inst., sec. 2, vol. 2, pp. 205-233, pls. 23-34.

Parks, W. A.

1907, *The stromatoporoids of the Guelph formation in Ontario.* Univ. Toronto Studies, Geol. Ser., No. 4, pp. 1-40, pls. 1-6.

1908, *Niagara stromatoporoids.* Univ. Toronto Studies, Geol. Ser., No. 5, pp. 1-68, pls. 7-15.

1909, *Silurian stromatoporoids of America.* Univ. Toronto Studies, Geol. Ser., No. 6, pp. 1-52, pls. 16-20.

1910, *Ordovician stromatoporoids.* Univ. Toronto Studies, Geol. Ser., No. 7, pp. 1-52, pls. 21-25.

1935, *Systematic position of the Stromatoporoidea.* Jour. Paleontology, vol. 9, pp. 18-29, pls. 6, 7; 1934, abstract; Geol. Soc. America Proc. for 1933, pp. 344, 345.

1936, *Devonian stromatoporoids of North America.* Univ. Toronto Studies, Geol. Ser., No. 39, pp. 1-125, pls. 1-19.

Phillips, J.

1841, *Figures and descriptions of the Palaeozoic fossils of Cornwall, Devon, and West-Somerset.* Longman, Brown, Green and Longmans, London, pp. 18, 19, 143, 173, 203, 205, 210, pls. 8, 10.

Plummer, J. T.

1843, *Suburban geology or rocks, soil and water, about Richmond, Wayne County, Indiana.* Amer. Jour. Sci., vol. 44, pp. 293, 294, fig. 8.

Quenstedt, F. A.

1876-1878, *Petrefaktenkunde Deutschlands.* Abt. 1, Bd. 5, Schwämme, 612 pp., 28 pls.

Radugin, K. V.

1936, *Some coelenterates from the Lower Silurian of Gornaya Shoria.* Rec. Geol. W. Siberian Region, No. 35, pp. 86-106, 2 pls.

Raymond, P. E.

1914, *A Beatricea-like organism from the Middle Ordovician.* Canada Dept. Mines, Geol. Surv. Mus. Bull. No. 5, pp. 1-19, pls. 1-4.

1924, *The oldest coral reef.* Rept. State Geol. Vermont, vol. 14, pp. 72-75, 1 text fig.

1931, *Notes on invertebrate fossils, with descriptions of new species.* Bull. Museum Comp. Zoology, Harvard College, Geol. Ser., vol. 9, pp. 177-184, pls. 2, 3.

Riabinin, V. N.

1932, *On some Upper Devonian Stromatoporoidea.* Bull. United Geol. Prosp. Serv. U. S. S. R., vol. 51, pp. 1125-1133, pls. 1, 2.

Riabinin, V. N., in Hecker et al.

1941, *Fauna of the Main Devonian field.* U. S. S. R. Acad. Sci., Paleont. Inst, vol. 1, pp. 85-106 (Russ.), pp. 106-109 (English summary), 8 figs., 5 pls.

Ripper, E. A.

1933, *The stromatoporoids of the Lilydale limestone. Part I—Actinostroma and Clathrodictyon.* Roy. Soc. Victoria, Proc., new ser., vol. 45, pp. 152-164, figs. 1-6.

1937a, *A note on the occurrence of Amphipora ramosa (Phillips) in Western Australia.* Roy. Soc. Western Australia Jour., vol. 23, pp. 37-41, 1 pl., 3 text figs.

1937b, *The stromatoporoids of the Lilydale limestone. Part II—Syringostroma, Stromatopora, and other genera.* Roy. Soc. Victoria Proc., new ser., vol. 49, pp. 178-205, pls. 8, 9, text figs. 1-4.
1937c, *On some stromatoporoids from Griffith's quarry, Loyola, Victoria.* Roy. Soc. Victoria Proc., new ser. vol. 50, pp. 1-8, pl. 1.
1937d, *On the stromatoporoids of the Buchan district, Victoria.* Roy. Soc. Victoria Proc., new ser., vol. 50, pp. 11-38, pls. 2-5.
1938, *Notes on the middle Palaeozoic stromatoporoid faunas of Victoria.* Roy. Soc. Victoria Proc., new ser., vol. 50, pp. 221-243, figs. 1-4.

Rominger, C. L.
1886, *Minute structure of Stromatopora and its allies.* Proc. Acad. Nat. Sci. Philadelphia, vol. 38, pp. 39-56.

Rosen, F. B.
1867, *Ueber die Natur der Stromatoporen und uber die Erhaltung der Hornfaser der Spongien im fossilen Zustande.* Verhandlgn. Russ. Kaiserl. Min. Ges., St. Petersburg, ser. 2, vol. 4, pp. 1-98, pls. 1-11.

Schuchert, C.
1919, *The proper name for the fossil hydroid Beatricea.* Am. Jour. Sci., vol. 47, pp. 293-296, fig. 1.

Schulz, E.
1883, *Die Eifelkalkmulde von Hillesheim. Nebst einem palaeontolog Anhang.* Jahrg. Königl. Preuss. geol. Landesanstalt und Bergakad., for 1882, Abhandl., pp. 160, 182-184, 187, 197, 200, 208, 245-247, pl. 22, figs. 5-7; pl. 23, fig. 1.

Seely, H. M.
1904, *The Stromatoceria of Isle La Motte, Vermont.* Rept. State Geol. Vermont, vol. 4, pp. 144-152.

Shideler, W. H.
1946, *Beatricidae* (Abstract). Geol. Soc. America, Bull., vol. 57, p. 1230.

Shrock, R. R. and Raasch, G. O.
1937, *Stratigraphy and structure of the area of disturbed Ordovician rocks near Kentland, Indiana.* Am. Midland Naturalist, vol. 18, pp. 484, 489, 491, 492, 498-501, 507, 511-513, 515, 536-538, pl. 2, figs. 1-3.

Smith, S.
1932, *Labechia carbonaria nov. sp. a lower Carboniferous stromatoporoid from West Cumberland.* Summary Prog. Geol. Surv. Great Britain and Mus. Practical Geol. for 1931, pt. 2, pp. 23-33, pl. 1. (Includes description and figures of *Labechia conferta* Lonsdale from the Middle Silurian)

Stechow, E.
1922, *Zur Systematik der Hydrozoen, Stromatoporen, Siphonophoren, Anthozoen und Ctenophoren.* Archiv. Naturg. Abt. A, vol. 88, pp. 141-155.

Steiner, A.
1932, *Contribution á étude des Stromatopores secondaires.* Bull. Lab. Géol. Univ. Lausanne, vol. 50, 117 pp., 14 pls.

Sugiyama, T.
1939, *Geological and geographical distribution of stromatoporoids in Japan, with notes on some interesting forms.* Yabe Jubilee Pub., vol. 1, pp. 427-456, pls. 24-26.
1940, *Stratigraphical and paleontological studies of the Gotlandian deposits of the Kitakami Mountainland.* Sci. Rep. Tôhoku Imp. Univ., ser. 2, vol. 21, pp. 86, 88-91, 93-96, 98-114, pls. 13-18, 22, 23, 25, 29, 31, 32.
1941, *A new form of the genus Labechiellata from Chosen (Korea).* Jour. Geol. Soc. Japan, vol. 48, pp. 461-463, figs. 1-3.

1942, *Amphipora from the Devonian of China.* Jour. Geol. Soc. Japan, vol. 49, No. 587, pp. 112-116, pls. 4 (3), 5 (4).

Twenhofel, W. H.

1927. *Geology of Anticosti Island.* Canada Dept. Mines, Geol. Survey, Mem. 154, No. 135, pp. 16, 24, 27, 28, 30, 31, 35, 37, 44-46, 49-54, 56, 60, 64-67, 69, 70, 75, 83, 104, 107.

Twitchell, G. B.

1928-1929, *The structure and relationship of the true stromatoporoids.* Amer. Midland Naturalist, vol. 11, pp. 270-306, pls. 18-24, figs. 1, 2.

Ulrich, E. O., in Bassler, R.

1915, *Family Beatriceidae,* U. S. Nat. Mus. Bull. 92, p. 1409.

Ulrich, E. O., and Everett, O.

1890, *Description of Lower Silurian sponges.* Illinois Geol. Survey Bull., vol. 8, pp. 221, 282, pl. 7, figs. 3, 3a, 3b, 5, 5a, 5b.

Waagen, W., and Wentzel, J.

1887, *Salt Range fossils.* Paleont. Indica, ser. 13, pp. 925-939, 943, pls. 120-121.

Wilson, A. E.

1948, *Miscellaneous classes of fossils, Ottawa formation, Ottawa-St. Lawrence Valley.* Canada Geol. Survey Bull., No. 11, pp. 5, 45-50, pls. 22-25.

Winchell, A.

1866, *The Grand Traverse Region; a report on the geological and industrial resources of the counties of Antrim, Grand Traverse, Benzie and Leelanaw in the Lower Peninsula of Michigan.* Dr. Chase's Steam Printing House, Ann Arbor, Michigan, pp. 1-82; Appendix, pp. 83-97.

1867, *Stromatoporidae: their structure and zoological affinities.* Proc. Amer. Assoc. Adv. Sci., for 1866, vol. 15, pp. 91-99.

Yabe, H.,and Sugiyama, T.

1930a, *On some Ordovician stromatoporoids from south Manchuria, north China and Chosen (Korea), with notes on two new European forms.* Sci. Repts. Tôhoku Imp. Univ., ser. 2, vol. 14, pp. 47-62, pls. 17-23.

1933, *Discovery of Amphipora and Clathrodictyon in the Permian of Japan.* Japan Jour. Geol. Geog., vol. 11, p. 19, 3 text figs.

1935, *Jurassic stromatoporoids from Japan.* Sci. Repts. Tôhoku Imp. Univ., Sendai, Japan. 2d ser. (Geol.), vol. 14, No. 2B, pp. 135-192, pls. 40-71.

1941, *Tienodictyon zonatum, a new stromatoporoid from eastern Yunnan, China.* Imp. Acad. Tokyo Proc., vol. 17, pp. 139-141, figs. 1-6.

Yavorsky, V. I.

1929, *Silurian stromatoporoids.* Bull. Com. Geol., vol. 48, No. 1, pp. 77-114, pls. 5-12.

1931, *Some Devonian stromatoporoids from the outskirts of the Kuznetsk Basin, the Ural, and other localities.* Bull. United Geol. Prosp. Serv., U. S. S. R., vol. 50, fasc. 94, pp. 1387-1415, pls. 1-4.

1932. *Ein Stromatoporenfund in Cambrium.* Centralbl. Min. Geol. Palaeont., Abt. B, pp. 613-616, 5 figs.

1943, *Devonian Stromatoporellidae and their role in the study of the stratigraphy of the Kuznetsk Basin.* Acad. Sci. U. S. S. R., Comptes Rendus (Doklady), vol. 39, pp. 369, 370.

1950, *Devonian Stromatoporella and their significance for stratigraphy.* In Voprosy Paleontologii, vol. 1, Izdatel'stvo Leningradskogo Gosudarstvennogo Universiteta, pp. 243-263, pls. 1-7.

1955, *Stromatoporoidea Sovetskogo Soyuza.* Trudy Vsesoyuznogo Nauchno-issledovatelskogo Geol. Inst., Minister. Geol. i Ochrany Nedr, nov. ser., vol. 8, pp. 1-173, pls. 1-89, text figs. 1-11.

PLATES

Explanation of Plate 31

Finer tissue structure. Original drawings from vertical sections. Numbers in parentheses are numbers on slides in the Indiana University Paleontological collections.

Figure — Page

1. **Cystostroma vermontense** Galloway and St. Jean, n. sp. 421
   Cyst plates with compact median layer, minutely crenulate in places, with thick, flocculent lower and upper layers; X 20. From holotype. Middle Chazy ls., 1 mi. SE. of Isle La Motte, Vt. (Pl. 32, fig. 1) (300-17).

2. **Aulacera plummeri** Galloway and St. Jean, n. sp. 423
   Primary plates of cysts compact and dusty, with vertical pores in places; chambers largely filled with dusty and flocculent lighter tissue; X 20. From topotype of the genus. Late Ordovician, Elkhorn Creek, 4 mi. S. of Richmond, Ind. (282-58).

3. **Labechia conferta** (Lonsdale) 427
   Tissue showing compact median layer, with upper and lower dusty layers; secondary layers confluent with pillars; X 20. From topotype. Wenlock ls., Trowbridge, England. (301-93).

4. **Clathrodictyon vesiculosum** Nicholson and Murie 433
   Tissue dusty and minutely fibrous and porous transversely; X 40. From typical specimen. Middle Silurian, Charlestown, Ind. (303-65).

5. **Anostylostroma hamiltonense** Parks 434
   Tissue with transverse fibers and pores in the laminae, and finer, transverse fibers in the pillars; X 20. From topotype. Lower Traverse group, 8 mi. N. of Alpena, Mich. (Pl. 33, fig. 6) (282-51).

6. **Stictostroma mamilliferum** Galloway and St. Jean 435
   Tissue with transverse fibers and conspicuous pores in the laminae, and transverse fibers in the pillars; X 40. From typical specimen. Onondaga ls., Ashton's quarry, 1½ mi. E. of Gorrie, Ont. (300-91).

7. **Stromatoporella granulata** (Nicholson) 436
   Tissue compact and finely granular, with minute median branching tubules; X 40. From typical specimen. Hamilton sh., Thedford, Ont. (282-38).

8. **Stromatoporella eriensis** (Parks) 436
   Tissue finely fibrous and porous transversely; X 20. From typical specimen. Columbus ls., Columbus, Ohio. (303-9).

9. **Actinostroma expansum** (Hall and Whitfield) 437
   Tissue minutely granular, compact and nearly homogeneous, showing upward growth lines in the pillars, which were not hollow; X 20. From topotype. Upper Devonian, Shell Rock fm., Nora, Iowa. (302-36).

10. **Gerronostroma elegans** Yavorsky 438
Tissue transversely fibrous and porous; X 20. From paratype. Middle Devonian, Kuznetsk Basin, Russia. (306-44).

11. **Trupetostroma warreni** Parks 439
Tissue compact, minutely granular and nearly homogenous; laminae with light microlamina with secondary upper and lower, dark layers continuous with pillars, and foramina; secondary tissue with common, roundish vesicles; X 20. From topotype. Middle Devonian, Hoosier Ridge, Northwest Territories, Canada. (282-26).

12. **Idiostroma caespitosum** Winchell 443
Tissue compact, minutely granular, mottled; laminae with light microlaminae with secondary tissue with abundant roundish vesicles, but not maculate; X 20. From Winchell's type specimen. Traverse group, Petoskey ls., Petoskey, Mich. Univ. Michigan Mus., No. 32701.

13. **Amphipora ramosa** (Phillips) 442
Tissue transversely fibrous, with dark median line in the pillars; X 20. Jeffersonville ls., Independent Quarry, 4 mi. S. of Dupont, Ind. (306-6).

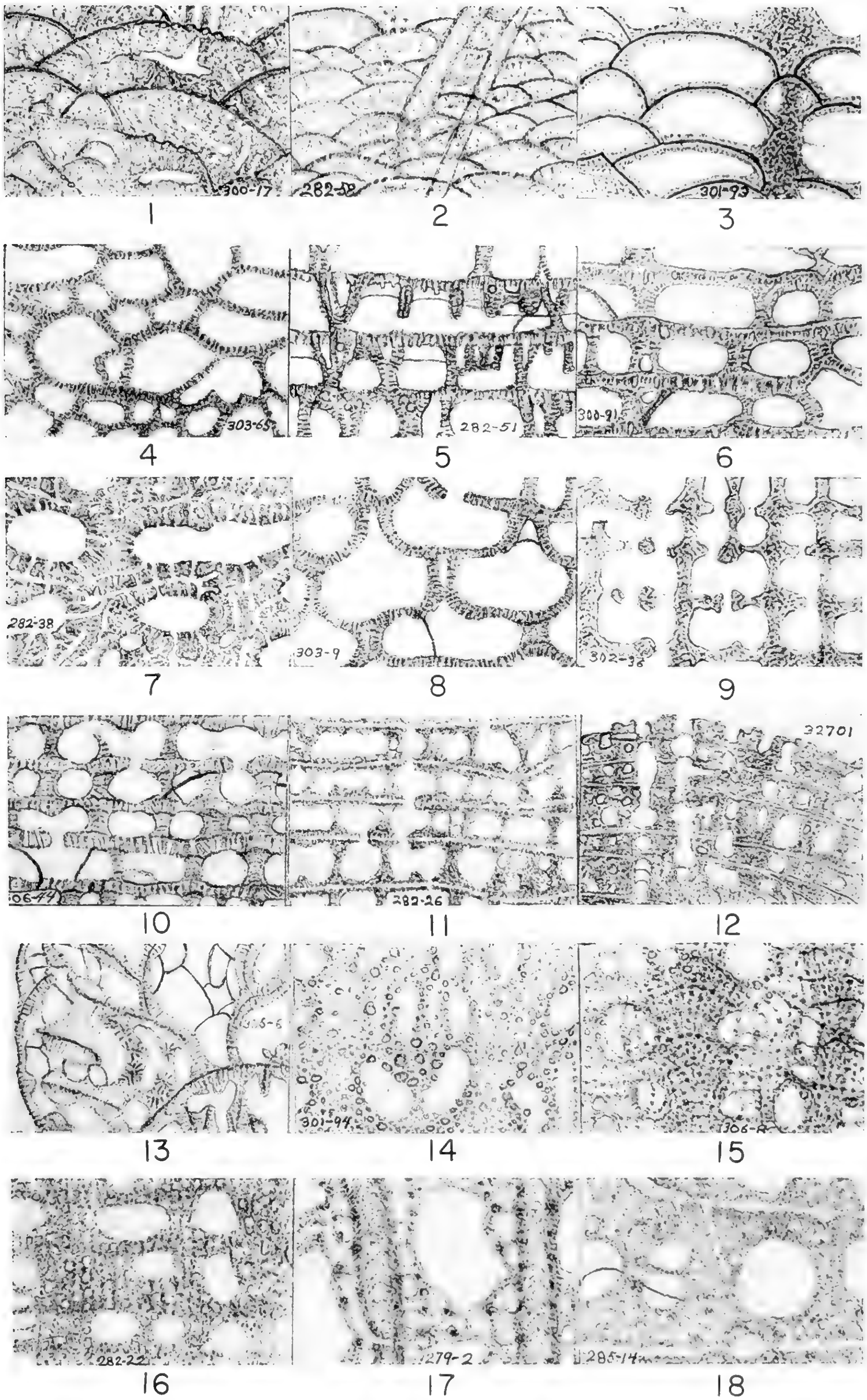
14. **Ferestromatopora tyrganensis** Yavorsky 350
Tissue amalgamated, strongly maculate; maculae dark circles with light centers, irregularly distributed, strongest around galleries, varying from 0.02 to 0.03 mm. in diameter, laminae, pillars and pseudozooidal tubes obscure; X 40. Middle Devonian, Gerolstein, Germany, Royal Ontario Mus. Paleont., No. 2412D. Indiana Univ. Paleont. Coll., (301-94).

15. **Syringostroma densum** Nicholson 350
Tissue amalgamated, with minute, dark specks; maculae small, 0.02 to 0.03 mm. in diameter, mostly fuzzy, tending to be arranged in diverging lines in the long, large pillars; X 40. From topotype. Columbus Is., Kelleys Island, Ohio. (306-8).

16. **Parallelopora nodulata** (Nicholson) 361, 450
Tissue amalgamated, full of minute black specks; maculae large, 0.03 to 0.05 mm. in diameter, with light lumina, arranged in vertical files; galleries superposed, making the "parallel pores" of Bargatzky; X 40. From topotype. Middle Devonian, Kelleys Island, Ohio. (282-22).

17. **Hermatostroma logansportense** Galloway and St. Jean 363
Tissue amalgamated, with minute, dark specks; maculae large, and fuzzy, 0.03 to 0.05 mm. in diameter, not to be confused with the large light areas, 0.07 to 0.10 mm. in diameter surrounding the pillars; X 40. From holotype. Middle Devonian, Logansport, Ind. (279-2).

18. **Clathrocoilona** cf. **abeona** Yavorsky 358
Tissue finely but unequally granular, with flocculent maculae, 0.02 to 0.05 mm. in diameter, some with light lumina, and larger light spots and streaks; light median line in the laminae; X 40. Middle Devonian, 6 mi. NE. of Logansport, Ind. (285-14).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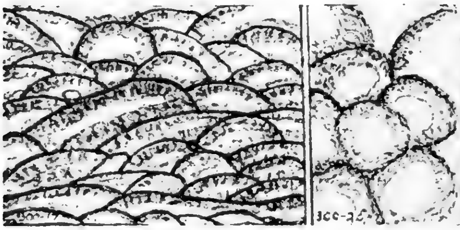
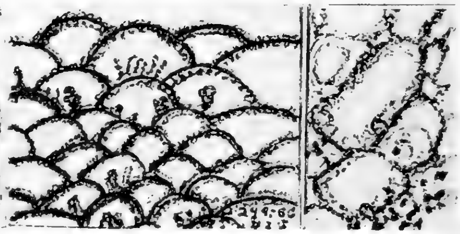

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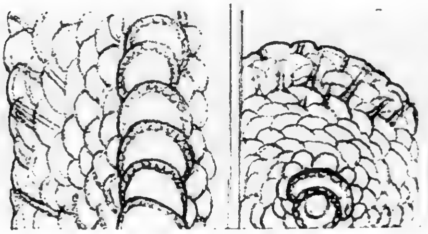
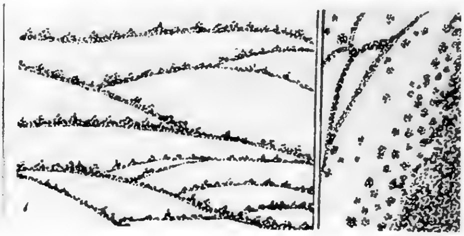

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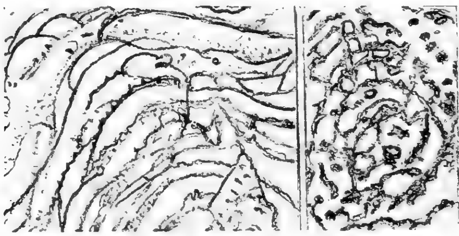
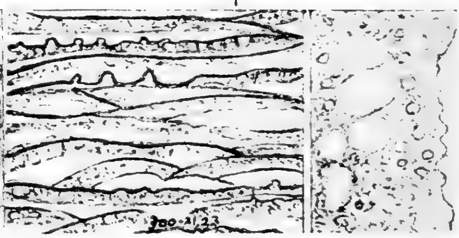

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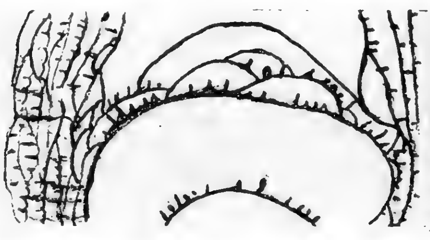


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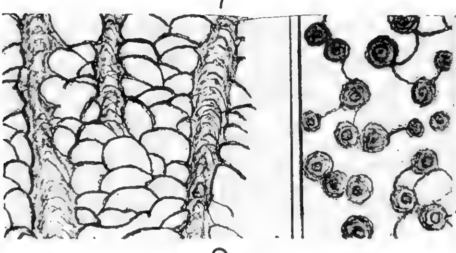
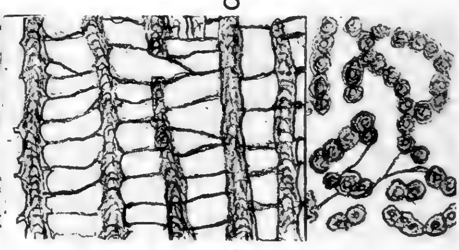

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Explanation of Plate 32

Vertical section on left, tangential section on right
Family 1. Labechiidae

Figure | Page

1. **Cystostroma vermontense** Galloway and St. Jean, n. sp. 421
Compact and flocculent layers of cyst plates; pillars absent; X 10. Original, from holotype. Middle Ordovician, middle Chazy ls., 1 mi. SE. of Isle La Motte, Vt. (Pl. 31, fig. 1) (300-17, 25).

2. **Cystostroma simplex** Galloway and St. Jean, n. sp. 421
Villi on upper plate of cysts; X 10. Original, from holotype. Middle Ordovician, Carters ls., 7 mi. SE. of Nashville, Tenn. (299-60).

3. **Aulacera plummeri** Galloway and St. Jean, n. sp. 423
Vertical and cross section showing oblique pillars in mature region; X 2. Original, from topotype. Late Ordovician, Elkhorn Creek, 4 mi. S. of Richmond, Ind.

4. **Rosenella macrocystis** Nicholson. 352
Denticles on cyst plates; X 12. After type figures by Nicholson, 1886, pl. 7, figs. 12, 13.

5. **Pseudostylodictyon poshanensis** Ozaki 425
Crenulations of cyst plates; X 8. After type figure by Ozaki, 1938, pl. 25, fig. 1d.

6. **Pseudostylodictyon kayi** Galloway and St. Jean, n. sp. 425
Crenulations of plates showing as rings in tangential section; X 10. Original, from holotype. Middle Ordovician, middle Chazy, 1 mi. SE. of Isle La Motte, Vt. (300-21, 23).

7. **Sinodictyon columnare** Yabe and Sugiyama 425
Vertical section. Strong denticles on plates; X 8. After type figure by Yabe and Sugiyama, (1930, pl. 19, fig. 3).

8. **Cryptophragmus antiquatus** Raymond 384, 426
Vertical section. Sheaths are not connected with the cystose axis, which is the real *Cryptophragmus*. After Raymond (1914, pl. 2, fig. 2, X 4; pl. 3, fig. 4, X 3). Paratype.

9. **Labechia conferta** (Lonsdale) 427
Large pillars and strongly arched cyst plates; X 10. After topotype by Nicholson (1886, pl. 20, figs. 1, 2).

10. **Labechiella serotina** (Nicholson) 428
Cysts approximate laminae; X 12. After type figure by Nicholson (1886, p. 46, fig. 4).

Explanation of Plate 33

Vertical section on left, tangential section on right.

Family 1. Labechiidae

Figure — Page

1. **Pseudolabechia granulata** Yabe and Sugiyama 429
Cysts and groups of diverg'ng pillars; X 8. After type figures by Yabe and Sugiyama (1930, pl. 22, figs. 11, 12).

2. **Dermatostroma papillatum** (James) 430
Attached to *Herbertella;* showing pillars and indefinite laminae; bases of pillars are polygonal; X 10. Original. Upper Ordovician, Richmondian, Kentucky end of Madison, Indiana, bridge. (299-50).

3. **Stromatocerium rugosum** Hall 431
Pillars large, broad and irregular; cysts in part tend to make laminae; X 10. Original, from holotype; slide 590/5 E. Black River group, Watertown, N. Y.

4. **Stromatocerium amsterdamense** Galloway and St. Jean, n. sp. 432
Pillars irregular in shape and branching; cysts approximate laminae; X 10. Original, from holotype. Black River ls., Amsterdam, N. Y. (235-12).

Family 2. Clathrodictyidae

5. **Clathrodictyon vesiculosum** Nicholson and Murie 433
Cysts tend to be in horizontal layers; X 12. After type figures by Nicholson, 1886, pl. 17, figs. 10, 11. Middle Silurian, Yellow Springs, Ohio.

6. **Anostylostroma hamiltonese** Parks 434
Pillars short, div:ding upward; laminae transversely fibrous; dissepiments common; X 10. Original, from topotype. Traverse group, 8 mi. N. of Alpena, Mich. (Pl. 31, fig. 5) (282-51).

7. **Anostylostroma columnare** (Parks) 434
Laminae strong, pillars short, columns strong, dissepiments few; X 10. Original, from topotype. Columbus ls., Marblehead, Ohio. (282-65, 66).

8. **Atelodictyon fallax** Lecompte 435
Laminae strong; pillars short, joined in chains; X 12. Modified from type f:gure by Lecompte (1951, pl. 15, figs. 1a, 1d).

9. **Stictostroma mamilliferum** Galloway and St. Jean, n. name 435
Laminae porous; pillars short, not making regular rings; X 10. After Parks (1936, pl. 14, figs. 4, 5).

10. **Stromatoporella granulata** (Nicholson) 436
Laminae porous, ring-pillars large, abundant; X 10. After type figure by Nicholson (1892, pl. 26, figs. 1a, 1b).

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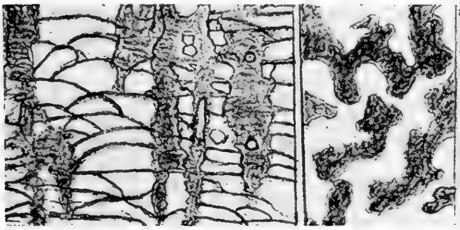

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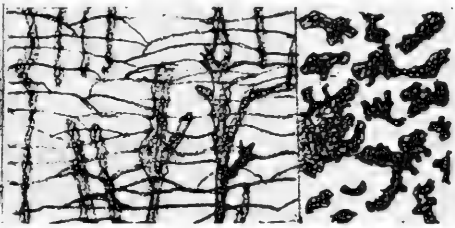

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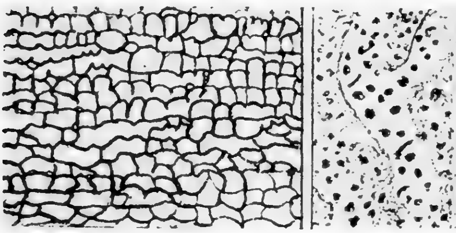

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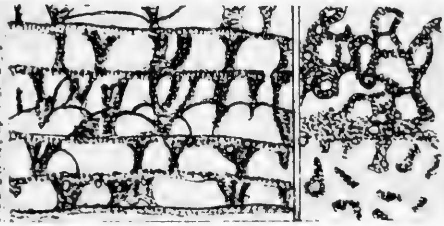

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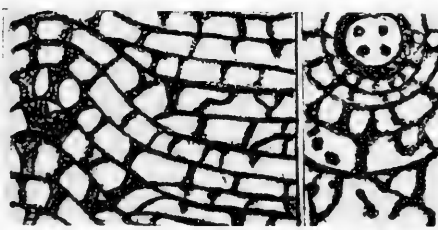

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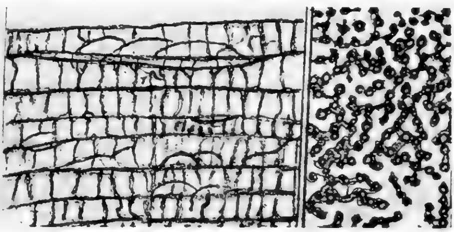

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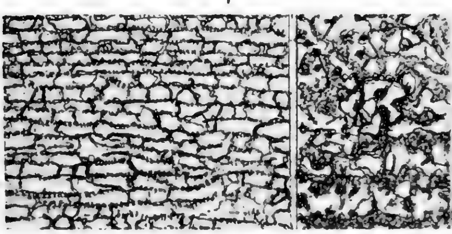

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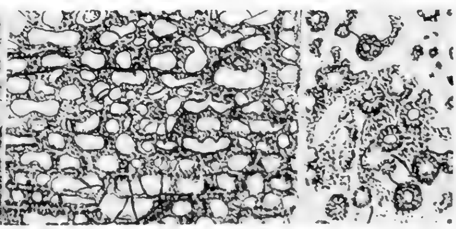

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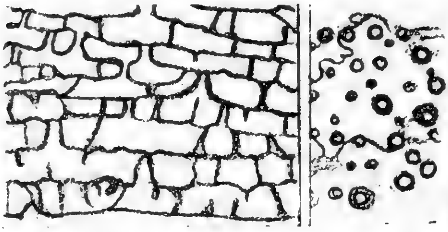
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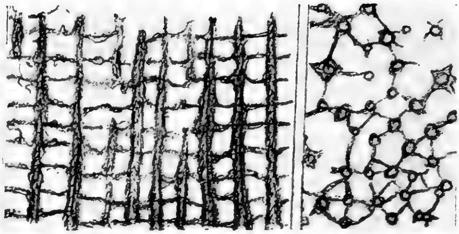
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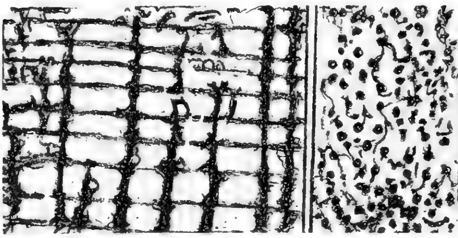
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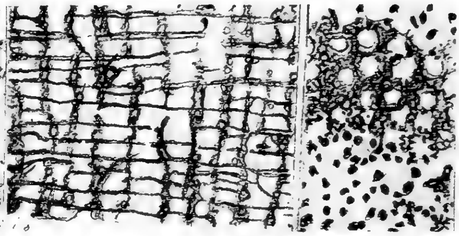
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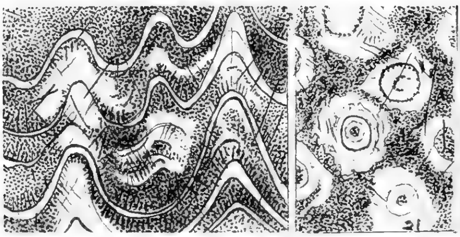
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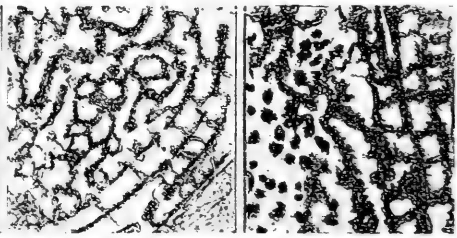
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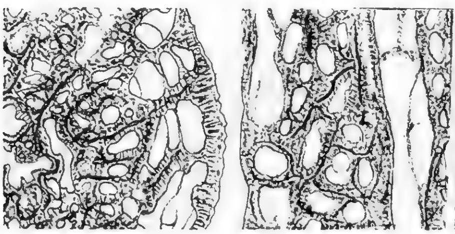
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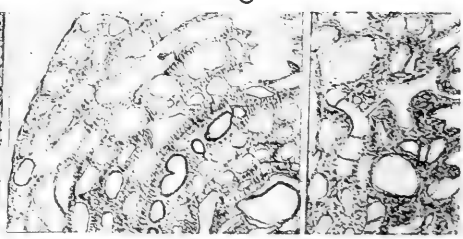
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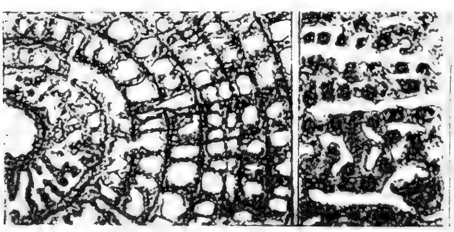
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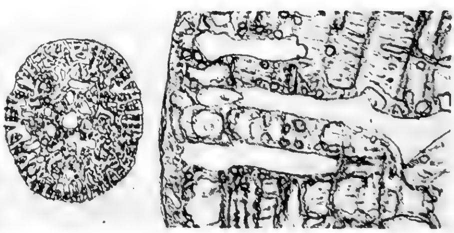
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Explanation of Plate 34

Vertical section on left, tangential section on right.

Family 2. Clathrodictyidae

Figure		Page
1.	**Stromatoporella eriense** (Parks)	436
	Laminae fibrous and porous; making abundant ring-pillars; X 10. Modified from Parks (1936, pl. 5, figs. 1, 2). Columbus Is., Marblehead, Ohio. (Pl. 31, fig. 8).	

Family 3. Actinostromatidae

2.	**Actinostroma clathratum** Nicholson	437
	Pillars long, with radial arms, making laminae; X 12. After type figure by Nicholson (1886, pl. 1, figs. 8, 12).	
3.	**Gerronostroma elegans** Yavorsky	438
	Pillars superposed, without arms; laminae porous; X 9. After type figure by Yavorsky (1931, pl. 2, figs. 4, 6).	
4.	**Trupetostroma warreni** Parks	439
	Pillars superposed; tissue compact; X 10. After type figures by Parks (1936, pl. 10, figs. 1, 2).	
5.	**Lophiostroma schmidti** (Nicholson)	439
	Laminae compact, inflected into columns; X 12. After type figures by Nicholson (1886, pl. 2, figs. 7, 8).	

Family 4. Idiostromatidae

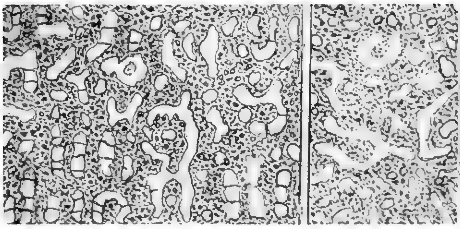
6.	**Clavidictyon columnare** Sugiyama	441
	Cross and vertical sections; no axial tube; X 10. After type figures by Sugiyama (1939, pl. 25, figs. 6, 7).	
7.	**Amphipora ramosa** (Phillips)	442
	Axial tube; tissue transversely fibrous, with dark median line; X 12. After Nicholson (1886, pl. 9, figs. 2, 3).	
8.	**Dendrostroma oculatum** (Nicholson)	443
	Pillars short; tissue fibrous and porous; X 10. After type figures by Nicholson (1886, text fig. 33; pl. 29, fig. 10). Cross and tangential sections.	
9.	**Idiostroma roemeri** Nicholson	443
	Pillars superposed; tissue compact; X 6. After Lecompte (1952, pl. 66, figs. 3a, 3b). Cross section and tangential section.	
10.	**Stachyodes verticillata** (McCoy)	444
	Cross sections; left, X 2, after Nicholson (1886, pl. 8, fig. 11); right, X 20, after Lecompte (1952, pl. 62, fig. 3).	

Explanation of Plate 35

Vertical section on left, tangential section on right.
Family 5. Stromatoporidae

Figure Page

1. **Stromatopora concentrica** Goldfuss 363, 365, 447
Tissue amalgamated, maculate; laminae not developed, galleries superposed making conspicuous pseudozooidal tubes which are not in general round; X 12. After Nicholson (1886, p. 164, pl. 11, figs. 16, 18). Topotype, Middle Devonian. Gerolstein, Germany.
2. **Stromatopora hüpschii** (Bargatzky) 447
With *Syringopora* (caunopore tubes), strong maculae, vertical pseudozooidal tubes, and tabulae which are remnants of microlaminae; X 12. Vertical section, after figure of holotype by Lecompte (1952, pl. 52, figs. 2a); tangential section, after Nicholson (1886, pl. 10, fig. 8).
3. **Stromatopora laminosa** Lecompte 363, 447
Maculate tissue, microlaminae, obscure laminae, small galleries, short pseudozooidal tubes, and astrorhizal tubes; X 12. After paratype by Lecompte (1952, pl. 56, figs. 2a, 1b).
4. **Taleastroma cumingsi** (Galloway and St. Jean) 448
Maculate tissue, microlaminae and laminae, small galleries, small, round, compact pillars, and a few pseudozooidal tubes; X 12. Original, paratype. Middle Devonian, Logansport ls., 6 mi. NE. of Logansport, Ind. (282-95, 97).
5. **Syringostroma superdensum** Galloway and St. Jean 448
Large pillars of maculate tissue; X 15. Original, from holotype. Jeffersonville ls., Jeffersonville, Ind. (285-27, 29).
6. **Parallelopora ostiolata** Bargatzky 450
Galleries and maculae superposed; pillars with parallel tubules and rods; X 24. After holotype by Lecompte (1952, pl. 51, figs. 3a, 3c).
7. **Hermatostroma schlüteri** Nicholson 369, 451
Pillars with lighter borders; X 12. After type figures by Nicholson (1886, pl. 3, figs. 1, 2).
8. **Clathrocoilona abeona** Yavorsky 451
Pillars short; laminae of three layers; X 15. After type figures by Yavorsky (1931, pl. 1, figs. 9, 11).
9. **Synthetostroma actinostromoides** Lecompte 452
Pillars superposed, laminae of microlaminae; X 12. After type figures by Lecompte (1951, pl. 20, figs. 3, 3a).
10. **Actinodictyon canadense** Parks 453
Long and short pillars and dissepiments; X 10. After type figures by Parks (1909, pl. 20, figs. 1, 2).



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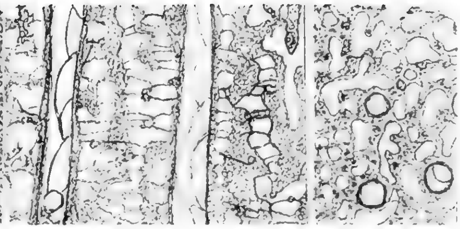

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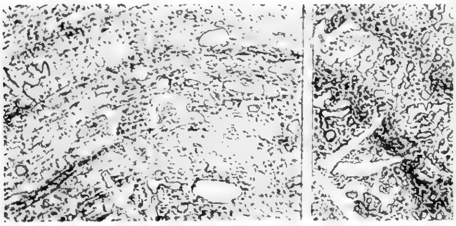

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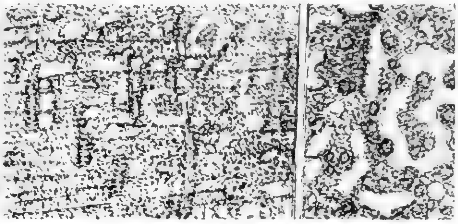

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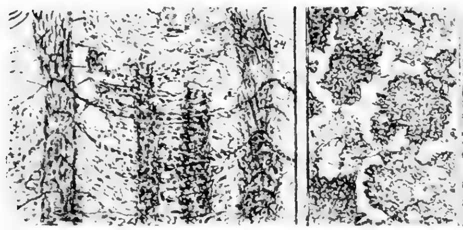

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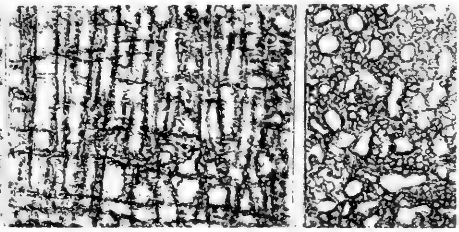

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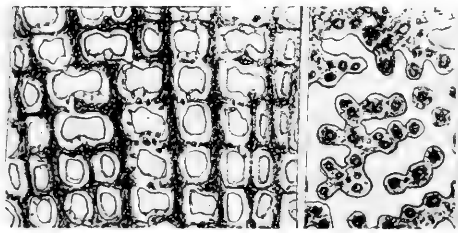

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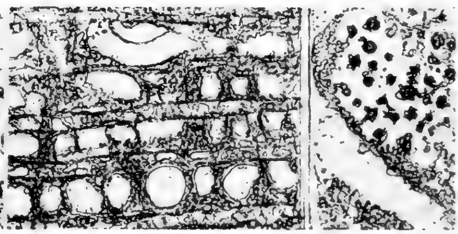

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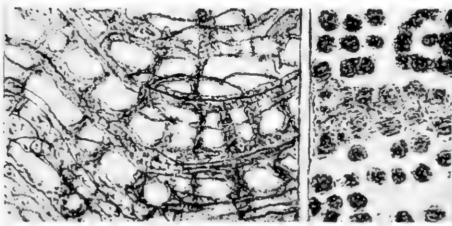

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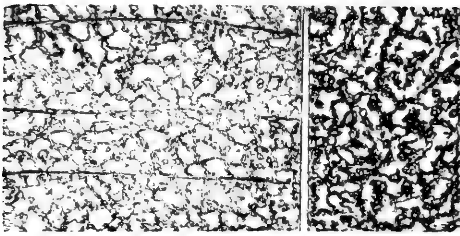

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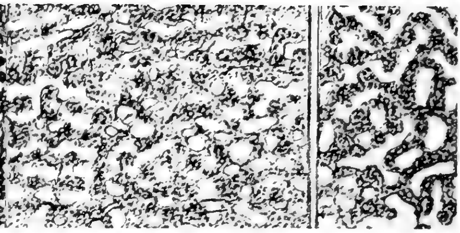

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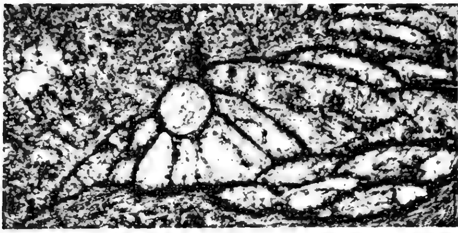

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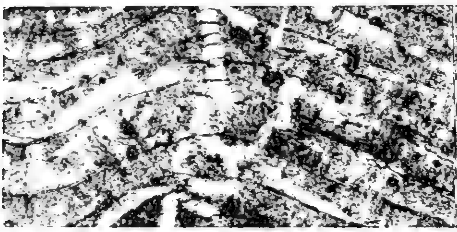

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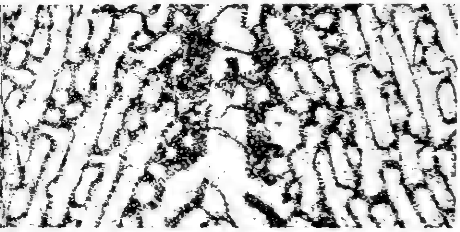

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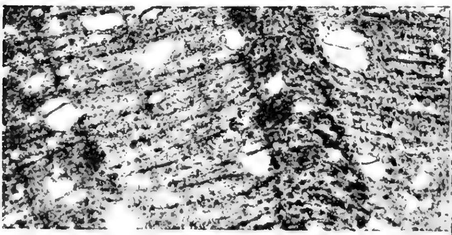

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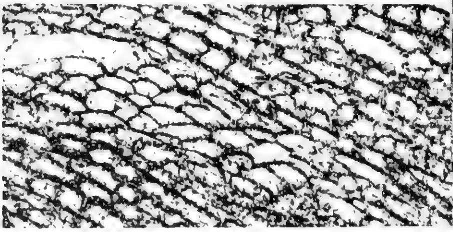

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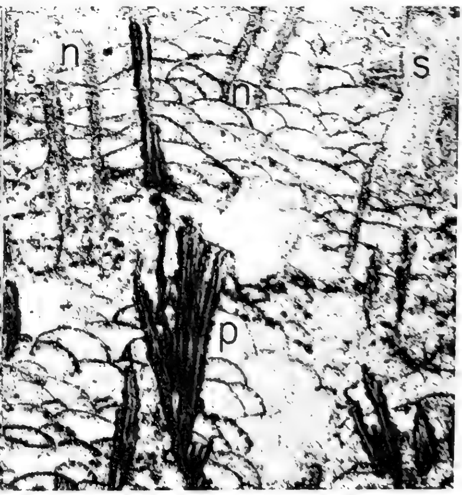

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Explanation of Plate 36

Figure — Page

1. **Ferestromatopora krupennikovi** Yavorsky 446
Amalgamate, maculate tissue, largely filling interlaminar spaces and obliterating most of the laminae, leaving small galleries; pillars short, oblique; pseudozooidal tubes absent; X 10. After type figure by Yavorsky (1955, pl. 58, figs. 3, 5). Middle Devonian, Tyrgan, Russia.
2. **Ferestromatopora tyrganensis** Yavorsky 446
Amalgamate, maculate tissue, largely filling interlaminar spaces; galleries round and coalescent; laminae, pillars and pseudozooidal tubes indefinite; X 12. After Lecompte (1952, pl. 53, figs. 2a, 4). Middle Devonian, Belgium.
3. **Cystostroma vermontense** Galloway and St. Jean, n. sp. 393
Protocoenosteum growing on and overgrown by a calcareous alga similar to *Cryptozoon;* X 15. Middle Ordovician, upper Chazy ls., 1½ mi. S. of Isle La Motte, Vt. (300-72).
4. **Ferestromatopora larocquei** (Galloway and St. Jean) 446
Astrorhizae with regularly dividing branches, joining adjacent astrorhizae; X 1. Middle Devonian, Columbus ls., Columbus Ohio. Cat No. 5404.
5. **Stromatopora divergens** Galloway and St Jean 447
Astrorhizal axis in a mamelon, oblique astrorhizal canals merging with galleries and pseudozooidal tubes; X 15. Middle Devonian, Logansport ls., 5 mi. E. of Logansport, Ind. (294-30).
6. **Stromatoporella huronensis** (Parks) 436
Tabulate mamelon tube, with confluent galleries but no astrorhizal canals; fibrous laminae and upturns into ring-pillars; X 10. Middle Devonian, Camden, Carroll Co., Ind. (282-88).
7. **Syringostroma radicosum** Galloway and St. Jean 448
Vertical section; scattered astrorhizal canals, small galleries, microlaminae, maculae, and large pillars; X 15. Jeffersonville ls., quarry 1.2 mi. NE. of Louisville, Ky., city limits on Highway 42. (305-88).
8. **Stictostroma mcgraini** Galloway and St. Jean 435
Vertical section; imbricating cysts at junction of two latilaminae composed of laminae and pillars; X 15. Jeffersonville ls., 3.3 mi. SW. of Prospect, Ky., on Highway 42 near Louisville. (305-27).
9. **Labechia huronensis** (Billings) 393
Vertical section showing cyst plates, normal, straight, round, loose-textured pillars (n), and pathologic, branching, irregular, dense pillars (p); X 10. Some of the cysts were not preserved, and there is some silicification (s). Late Ordovician, Muscatatuck State Farm, Butlerville, Ind. (288-80).

Explanation of Plate 37

1a. The specimen was originally 315 mm. long and 120 mm. thick at the top; 55 mm. of the top and 5 mm. of the base have been cut off, and the specimen was cut lengthwise. Note enlargement upward, and the low, round, spiral ridges. Topotype of the genus; X 5/13.

1b. Longitudinal section, showing axial column of hemispherical cysts, fine texture of lateral zones, latilaminae 2 to 4 mm. thick, and large lacunae filled with calcite; X 1.

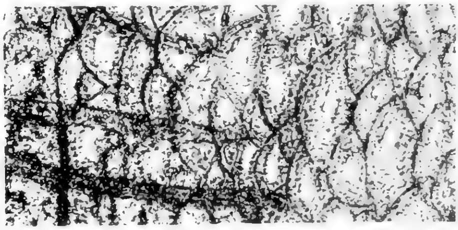
1c. Vertical section of lateral zone; low, small cysts, consistent in shape, not making radial ridges; chambers largely filled with flocculent tissue; pillars thin, slanting upward; X 15. Late Ordovician, Saluda limestone, Elkhorn Creek 4 mi. S. of Richmond, Ind. Coll. W. H. Shideler. (300-9). Holotype of the species.

Cross section, axis to right, showing large superposed, hemispherical cysts, about 2 mm. across, making, discontinuous radial ridges, between which the cysts are irregular in shape and size; cysts with outer thin, dense layer, and lower, thick, flocculent and moniliform layer; pillars not seen; X 6. Type specimen. Upper Ordovician, Vaureal fm., Battery Cliff, Anticosti Island, Canada. Canadian Geol. Sur. No. 2583. (299-89).

Vertical section; tissue fibrous, without dark, median line; X 10; type figure by Yavorsky (1955, pl. 84, fig. 3).

1a

1b



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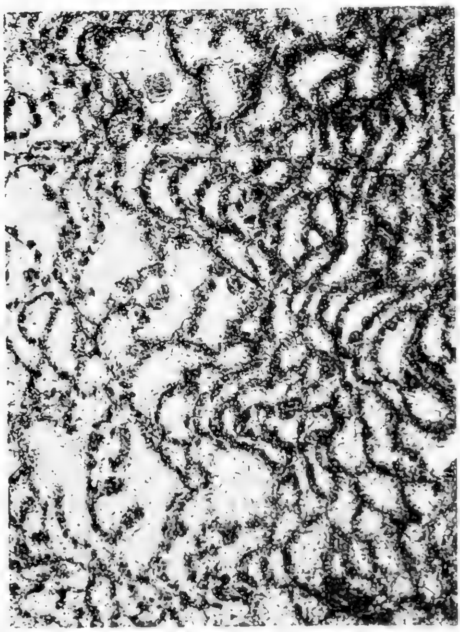

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